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NAS KEY WEST
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SITE INVESTIGATION WORK PLAN FOR TEN BASE REALIGNMENT AND CLOSURE PROPERTIES REVISION 2 WITH TRANSMITTAL LETTER NAS KEY WEST FL

1/23/1998

BROWN AND ROOT ENVIRONMENTAL

7593-7.1.2

42

Brown & Root Environmental

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AIK-98-0009

January 23, 1998

Project Number HK 7593

Mr. Dudley Patrick - Code 1858
Southern Division
NAVFACENGCOM
2155 Eagle Drive
North Charleston, South Carolina 29419-9010

QA Record

Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 0032

Subject: Base Realignment and Closure Site Investigation Workplan, Revision 2
Naval Air Station Key West, Florida

Dear Mr. Patrick:

Brown and Root Environmental (B&R Environmental) is pleased to submit one copy of Rev. 2 to the Base Realignment and Closure (BRAC) Site Investigation (SI) Workplan, NAS Key West, Florida. This revision includes minor technical and editorial changes made by B&R Environmental. No comments were received from the U.S. Navy, U.S. Environmental Protection Agency, Florida Department of Environmental Protection, and NAS Key West Restoration Advisory Board community members. This deliverable includes pages that have been modified from the previous version. Please replace the corresponding pages in the Rev. 1 version of the report with the enclosed pages. B&R Environmental has also enclosed an instruction document to assist with updating the Rev. 1 copy of the report to Rev. 2. Delivery of the enclosed Rev. 2 version initiates the document finalization process, whereby the regulatory agencies will perform their final review and provide the Navy with written approval of the report or provide additional comments.

At your request, copies of the enclosed documents are being distributed to the recipients of the Rev. 1 version of this report. An extra copy is provided to NAS Key West for inclusion in the information repository.

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

Sincerely,

C. M. Bryan
Task Order Manager

Enclosure

c: Ms. D. Evans-Ripley, SOUTHDIV (w/o encl.)
Ms. M. Berry, EPA (2 copies)
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Files: 7593-7.1.2, 1.1.1

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0042

7593-3.3-25

Site Investigation Workplan

for

Ten BRAC Properties
Naval Air Station
Key West, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0032

January 1998

Brown & Root Environmental

Revision 2

7593-Z2

Site Investigation Workplan
for
Ten BRAC Sites
NAS Key West

Replacement Instructions

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Site Investigation Workplan

for

Ten BRAC Properties
Naval Air Station
Key West, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0032

January 1998

Brown & Root Environmental

Revision 2

7593-1PC

AIK-98-0009

SITE INVESTIGATION WORKPLAN

FOR

TEN BRAC PROPERTIES
NAVAL AIR STATION
KEY WEST, 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:
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Foster Plaza 7
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0032

JANUARY 1998

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PITTSBURGH, PENNSYLVANIA

This document, Site Investigation Work Plan for Ten BRAC Properties, Naval Air Station, Key West, Florida, has been prepared under the direction of a Florida Registered Professional Geologist. The work and professional opinions rendered in this document were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice. If conditions are determined to exist that differ from those described, the undersigned geologist should be notified to evaluate the effects of any additional information on the recommendations in this document. This document was prepared for US Naval Air Station, Key West, Florida, and should not be construed to apply to any other site.

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Paul E. Calligan
Professional Geologist
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Date: 1/12/97

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ABB	ABB Environmental Services, Inc.
ACBM	asbestos containing building materials
AIMD	Aircraft Intermediate Maintenance Department
ARARs	Applicable, Relevant, and Appropriate Requirements
AST	aboveground storage tank
ASTM	American Society of Testing and Materials
AVG	average
B&R Environmental	Brown and Root Environmental
BFB	bromofluorobenzene
BG	background
bls	below land surface
BRAC	base realignment and closure
CAR	Contamination Assessment Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIH	certified industrial hygienist
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
cm	centimeters
CMS	Corrective Measures Study
COC	Chain of custody
CSP	certified safety professional
CTO	Contract Task Order
CVAA	cold vapor atomic absorption
DBH	diameter at breast height
DO	dissolved oxygen
DOD	Department of Defense
DOT	Department of Transportation
DPT	Direct Push Technology
DQA	Data Quality Assessmenr
DQO	Data Quality Objectives
DRI	direct reading instrument
DRMO	Defense Reultilization and Marketing Office
EB	equipment blank
EBS	Environmental Baseline Study
EIC	engineer-in-charge
EPA	Environmental Protection Agency
EQL	estimated quantitation limit
ER	ecological risk
FB	field blank
FDA	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FGFWFC	Florida Game and Fresh Water Fish Commission
FID	flame ionizatio detector
FKAA	Florida Keys Aqueduct Authority
FNAI	Florida Natural Areas Inventory
FOL	field operations leader
FOTW	federally owned treatment works
FTMR	field task modification request
FWS	United States Fish and Wildlife Service
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrometer
GFAA	graphite furnace atomic absorption
gpm	gallons per minute

ACRONYMS (Continued)

GPS	global positioning system
GS	groundwater screening sample
GW	groundwater
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHCR	human health cancer risk
HHNCR	human health non-cancer risk
HAS	hollow stem auger
HSM	Health and Safety Manager
ICP	inductively coupled plasma
ID	inner diameter
IDW	investigation derived waste
IR	installation restoration
IRA	Interim Remedial Investigation
LBP	lead-based paint
LCS	laboratory control sample
mg/kg	milligrams per kilograms
mg/L	milligrams per liter
MS	matrix spike
MS/MSD	matrix spike/matrix spike duplicate
MSD	matrix spike duplicate
msl	mean sea level
MW	monitoring well
NA	not applicable
NAS	Naval Air Station
NFEC	Naval Facilities Engineering Command
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NPWC	Navy Public Worsk Center
NSF	National Sanitation Foundation
NTU	nephelometric turbidity unit
OD	outside diameter
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PC	patrol craft
PCB	polychlorinated biphenyl
PHSO	Project Health and Safety Officer
PM	project manager
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QAM	Quality Assurance Manager
QC	quality control
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	request for proposal
RI/FS	Remedial Investigation/Feasibility Study
RPD	relative percent difference
RPM	Navy Restoration Project Manager
SALs	Screening Action Levels
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SD	sediment

ACRONYMS (Continued)

SI	Site Inspection
SO	soil
SOP	standard operating procedure
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
SOW	statement of work
SS	surface soil
SSC	Species of Special Concern
SUPSHIP	Supervisor of Shipbuilding, Conversion, and Repair
SVOC	semivolatile organic compound
SW	surface water
TAL	Target Analyte List
TBD	to be determined
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOM	task order manager
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USCBS	United States Census Bureau Service
USCG	United States Coast Guard
USN	United States Navy
UST	underground storage tank
VOA	volatile organic analysis
VOC	volatile organic compound
VTSR	validated time of sample receipt
WAVES	Women Accepted for Volunteer Emergency Service

1.0 INTRODUCTION

The Workplan was developed to conduct the Site Inspection (SI) of Base Realignment and Closure (BRAC) properties at the Naval Air Station (NAS) Key West, Florida. The Workplan presents the approach used for the SI and addresses the following elements applied during the inspection process: (1) Data Quality Objectives, (2) Sampling and Analysis Plan, (3) Data Management Plan, (4) Investigation Derived Waste Plan, (5) Health and Safety Plan, and (6) Quality Assurance Elements. The document is based on available NAS Key West background information and findings from the Draft Environmental Baseline Studies (EBSs) on the BRAC properties.

1.1 PURPOSE

Under the authority of the BRAC Act of 1992, Brown & Root Environmental (B&R Environmental) will conduct the SI at the NAS Key West. The execution of the SI will be performed in accordance with the guidelines in place under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA). The SI will evaluate potential threats to human health and the environment posed by BRAC properties on Key West classified as "grey" in the Draft EBS. "Grey" category (i.e., areas that have not been evaluated or require additional evaluation) properties cannot be considered for deed transfer until necessary actions have been taken and the property has been reclassified into a property category eligible for deed transfer. The objectives of the SI are to gather information to support a reclassification of these properties and to evaluate the need for any additional remedial activities.

1.2 SCOPE

The scope of the investigation will include the collection of suspected source samples to evaluate the types and concentrations of any hazardous substances on these properties, and the collection of media samples to evaluate the migration of any hazardous substances that are found to be present.

During the SI process, modifications to the scope of work (SOW) or procedures used in the sample collection may be required to satisfy program objectives. In the event that factors or conditions are revealed that require a modification of the Workplan, technical memoranda will be used to convey the proposed modification. The modification would be enacted upon gaining consensus between the United States Environmental Protection Agency (EPA), the Florida Department of Environmental Protection (FDEP), and Navy reviewers and the contractor responsible for executing the program.

1.3 REPORT ORGANIZATION

This Workplan consists of eight Sections and five Appendixes. Section 1 provides the Introduction, Purpose, and Scope of the document. Section 2 presents a facility description, an overview of the environmental setting at NAS Key West, and a characterization of the 10 BRAC Zones addressed in this Workplan. Sections 3 through 7 provide the elements of the investigation process used during the SI of the Zones. Section 8 contains a list of the references used during the development of this document. The Workplan also includes Appendix A (Health and Safety Plan), Appendix B (Data Quality Objective Process Documentation), Appendix C [Brown and Root Environmental Forms], and Appendix D (Quality Assurance Elements).

2.0 FACILITY BACKGROUND

NAS Key West is in southern Monroe County, Florida. The U.S. Navy manages 6,323 acres of land divided into 20 separate tracts in the lower Florida Keys, concentrated around Key West and Boca Chica Key (Figure 2-1). The Naval Station at Key West was disestablished in 1974, resulting in the relocation of several units. At present, NAS Key West is proceeding with realignment of aviation operations, a research laboratory, communications intelligence, counternarcotics air surveillance operations, a weather service, and several other activities on Key West. In addition to the Naval activities and units, other Department of Defense (DOD) and Federal agencies at NAS Key West include the U.S. Air Force, U.S. Army, and U.S. Coast Guard.

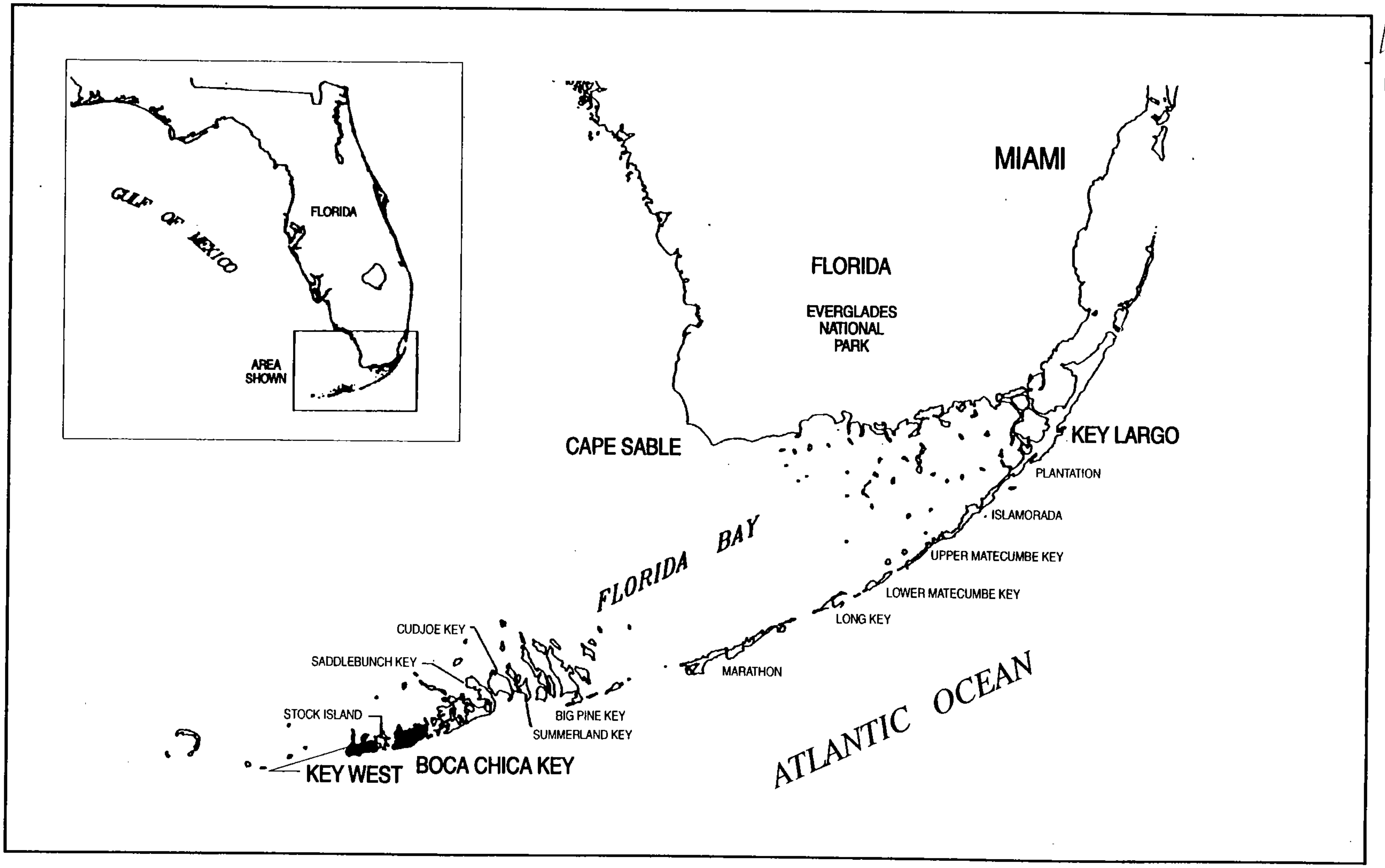
2.1 FACILITY DESCRIPTION

Several installations in various parts of the lower Florida Keys comprise the Naval Complex at Key West. Most of these are on Key West and Boca Chica Key. Key West, one of the two westernmost major islands of the Florida Keys, is approximately 150 miles southwest of Miami and 90 miles north of Havana, Cuba. Key West connects to the mainland by the Overseas Highway (U.S. Highway No. 1). The topography at the NAS Key West, which is generally flat, consists of average land-surface elevations less than 5 feet above mean sea level (msl) with the exception of filled areas that underlie the Overseas Highway (IT Corporation, 1994).

2.2 ZONE DESCRIPTIONS AND HISTORIES

The 1992 BRAC Act identified a series of DOD properties for closure. The closure could involve the turnover of a property to another government agency or sale of the property. On NAS Key West, BRAC properties have been identified for closure by the Navy.

This SI Workplan addresses portions of five contiguous BRAC properties on the island of Key West. Those portions, which may encompass the entire property or small portions of a contiguous property, are known as BRAC Zones (Figure 2-2). Descriptions of each of the 10 BRAC Zones addressed in this Workplan are found below. For discussion purposes, the 10 Zones are grouped into three areas based on their location (Truman Annex, Trumbo Point, and Key West Interior).



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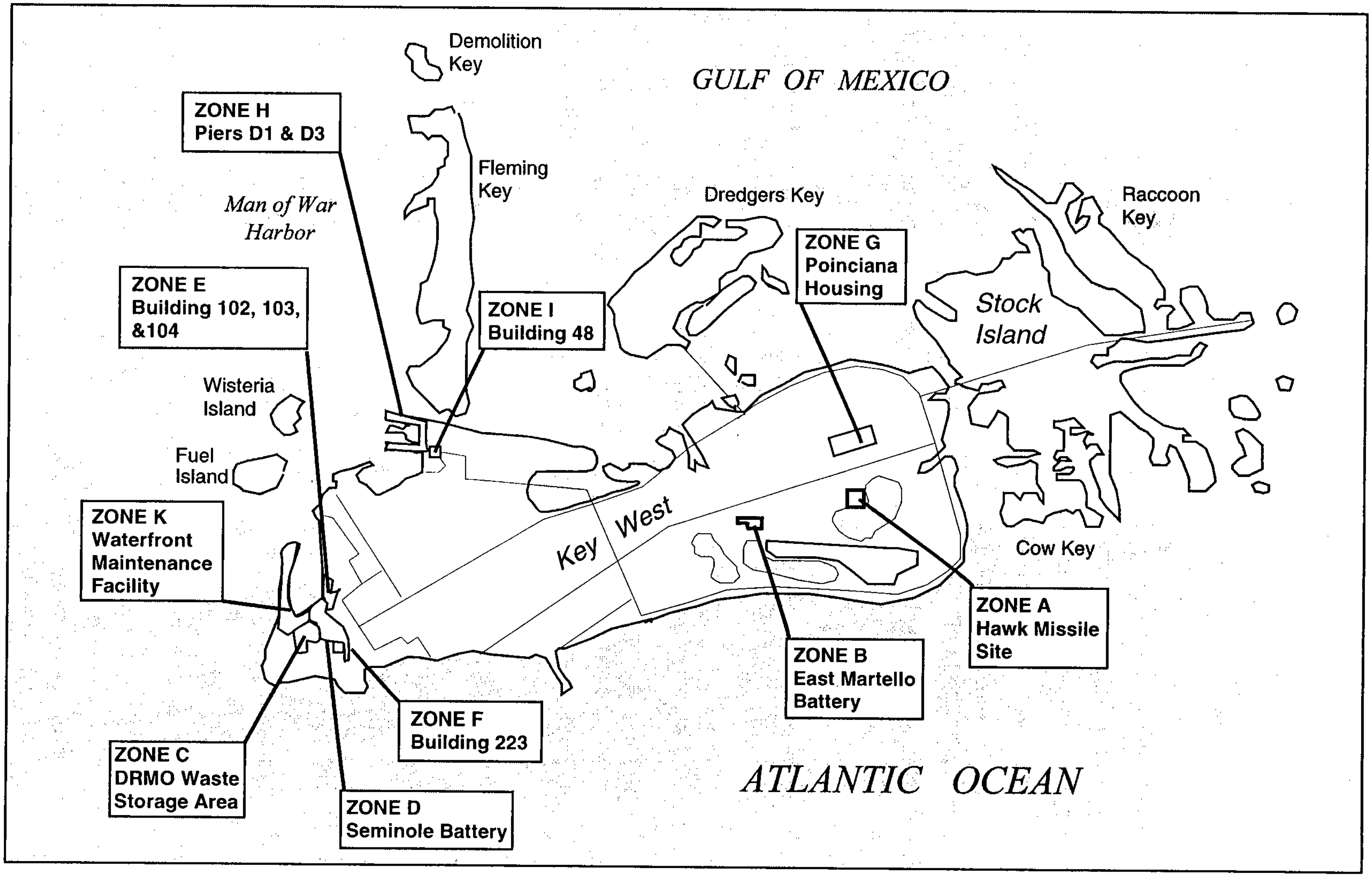
0 20 40
SCALE IN MILES

FIGURE 2-1. FACILITY LOCATION MAP NAS KEY WEST

NAS KEY WEST		KEY WEST, FLORIDA	
DRAWN BY: LHO	SCALE:	DATE 09/03/97	REV 1
CHECKED BY: RML	CONTRACT NO.	FILE NAME: 7593-2PC\BRAC-WP\F2-1FACL.CDR	



Brown & Root Environmental

0 1.5 3.0
Scale in Miles (Approximate)

FIGURE 2-2. BRAC ZONE LOCATION MAP

NAS KEY WEST		KEY WEST, FLORIDA	
DRAWN BY: LHO	SCALE:	DATE: 09/03/97	REV 2
CHECKED BY:	CONTRACT NO.:	FILE NAME: 7593-1PC/BRAC-WP\F2-2BRAC	

Each BRAC Zone has been broken into a number of subzones based on physical geographical boundaries and the previous use of the area. The nomenclature used for the subzones indicates both the zone and the subzone (e.g., GRYZNA-SZN1 is the designation for grey zone A, subzone 1).

2.2.1 Truman Annex

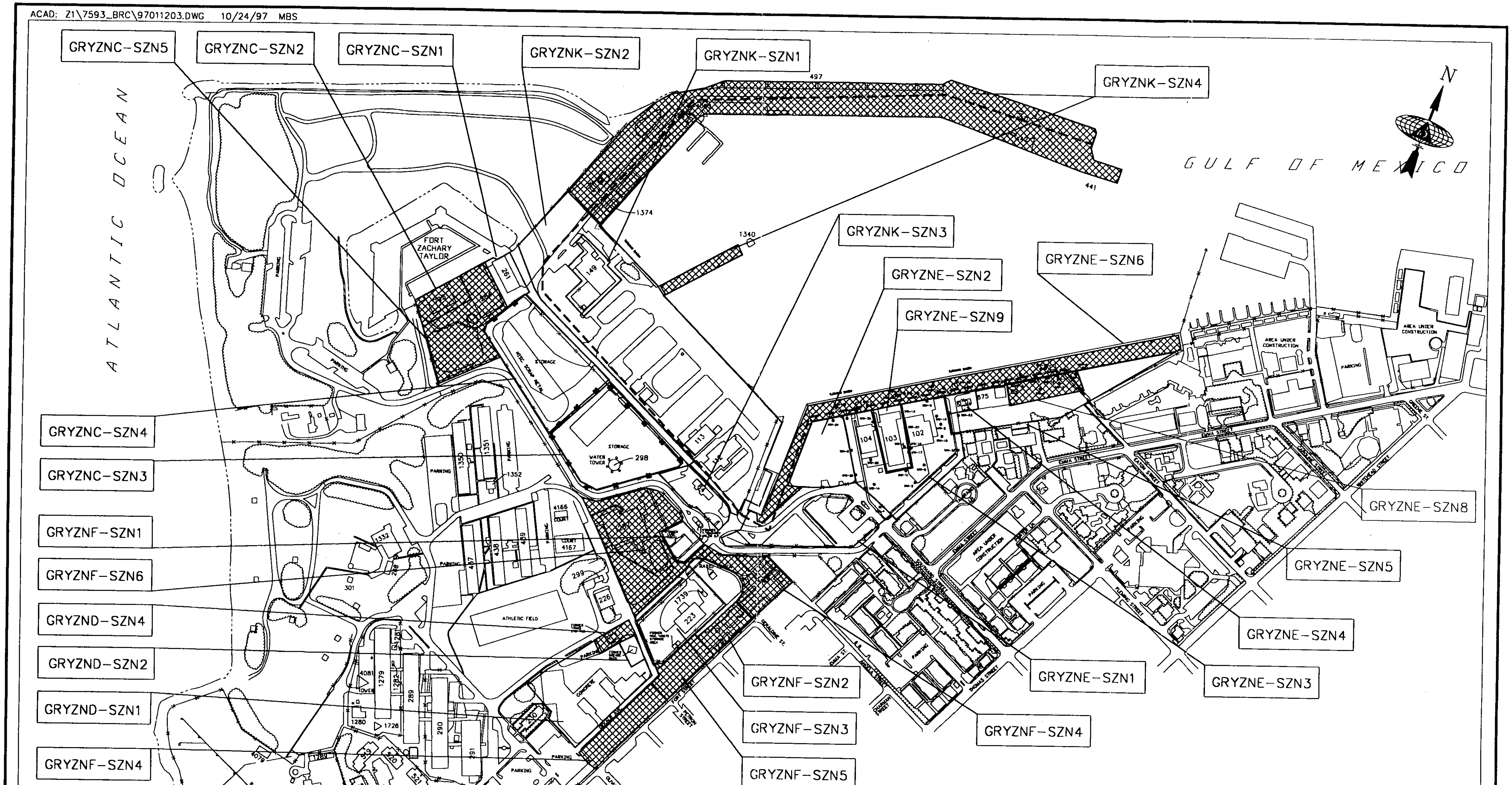
Truman Annex has had a long history as a defense facility. In 1823, after its purchase by an American citizen, the Navy was dispatched to Key West to remove pirates inhabiting most of the island. The Navy then occupied the northernmost portion of the west end of Key West. The Army acquired land on the western end of Key West in 1845 to build Fort Zachary Taylor, which provided support during the Mexican-American War. Seminole Battery was constructed to carry out defenses during the Civil War. Much of the land consisted of salt ponds limiting further construction. The United States conducted landfill operations on the northern portion of the island in the area from the Army pier to the Naval Station from 1909 to 1919.

Gradually, the Navy assumed control of the entire western tip of Key West. As early as 1918, and particularly during the 1940s through the early 1970s, submarines were berthed at eight finger piers in the turning basin. Most of the buildings along the quay were used in support of schools, units, and activities relating to submarines. The majority of the support buildings were demolished after 1982.

Buildings 102, 103, and 104; the Defense Reutilization and Marketing Office (DRMO) Waste Storage Area; Seminole Battery; Building 223; and the Waterfront Maintenance Facilities are all Truman Annex BRAC properties. These five Truman Annex BRAC Zones make up a contiguous land parcel on the southwest end of Key West (Figure 2-3). The area is flat terrain that slopes gently to the southwest. Information pertaining to the current and past operations on these properties is limited since the EBSs for the Truman Annex properties are in draft.

2.2.1.1 Zone C (DRMO Waste Storage Area)

Zone C includes Buildings 795, 284, and 261 and two large areas that house the DRMO. The DRMO receives excess government materials. In the recent past, Building 261 stored hazardous materials and Building 795 stored inert materials. A cleared area in front of Building 795, known as IR 2, has been investigated for polychlorinated biphenyl (PCB) contamination under the Navy's Installation Restoration (IR) Program. The PCBs were the result of PCB-contaminated oil used for dust suppression in the area. The investigation recommended no further action for the site based on sampling and risk assessment



NOTE:

GRYZNC-SZN6 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE C)
GRYZND-SZN3 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE D)
GRYZNE-SZN7 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE E)
GRYZNF-SZN7 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE F)
GRYZNK-SZN5 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE K)
GRYZNE-SZN10 – FORMER FUEL PIPELINE (AREA NOT OF CONCERN)
GRYZNK-SZN6 – FORMER FUEL PIPELINE (AREA NOT OF CONCERN)

LEGEND:

AREA NOT OF CONCERN

FORMER FUEL PIPELINE (AREA NOT OF CONCERN)

SITE MANAGER: CMB	CHECKED BY: DSF
DRAWN BY: TCB/MBS	DRAWING DATE: 9/15/97
SURVEYED BY:	SURVEY DATE:
SCALE: 1"=400'	
CAD DWG. NO.: 97011203.DWG	

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FIGURE 2-3.

ZONE C, D, E, F, & K TRUMAN ANNEX SUBZONES

NAVAL AIR STATION KEY WEST, FLORIDA

results. The two large storage areas have primarily stored metal debris. In addition, motors, vehicles, boats, refugee debris, and fuel trucks have been stored in those areas. Currently, metal debris including some machinery with motors is present (B&R Environmental, 1997a). A review of maps from the 1940s and 1950s also indicated the presence of oil racks within the storage areas.

2.2.1.2 Zone D (Seminole Battery)

Zone D includes the Seminole Battery and an adjacent area known to include a former fueling area and grease rack that operated in the 1940s and 1950s (B&R Environmental, 1996). The battery was constructed during the Civil War, and a modern battery addition was added to the existing structure in the 1950s. The addition was similar in construction to the East Martello Battery. Both structures are currently unused, and entry is restricted. The materials used while the batteries were in operation are unknown. The old portion of the battery has the remnants of a generator exhaust system.

The former fueling area known as 248 Tanks A&B is located to the west of Seminole Battery. The fueling island and the tanks were removed in August 1995. The area is now covered in asphalt. The Underground Storage Tank (UST) Closure Report recommends a study of groundwater in the area. To the northeast of the former tank location, concrete slabs are present from former grease racks used to lubricate and service vehicles. No visible stains are present on or near the slabs (B&R Environmental, 1996).

2.2.1.3 Zone E (Buildings 102, 103, and 104)

Zone E includes the area known as the Inner Mole Pier. The area has served as a naval docking and support facility for over a century. Most records of the area date to the period of World War II. In the late 1980s, the Inner Mole Pier waterfront was refurbished along with the Outer Mole Pier (e.g., Zone K).

Building 102 (former Torpedo Overhaul and Storehouse), Building 103 (former Central Power Plant), and Building 104 (former Battery Overhaul and Storage) are still standing but are out of service. Knowledge of the operations in these buildings is limited to activities supporting naval submarines. Hazardous materials, specifically volatiles, semivolatiles, and inorganics, are believed to have been used in each of the buildings. PCBs are known to have been present in transformers at Building 103. In the mid 1980s, these transformers were removed from the building. A petroleum Contamination Assessment Report (CAR) was prepared for the area around the three buildings. The CAR recommended the preparation of a Remedial Action Plan (RAP) that was approved in April 1995 by FDEP (USN-NFEC, 1992a, 1993a).

Building 189 (former Liquor Store) is adjacent to an area discovered to have been impacted by a petroleum leak from an underground pipeline that serviced the docks. The pipeline enters the Zone from Eaton Street and runs along the waterfront across Zone E and Zone K ending on Outer Mole Pier. A petroleum CAR was prepared for the area north of Building 189. The CAR recommended the preparation of a RAP that was approved in November 1995 by FDEP (USN-NFEC, 1992b, 1993b).

Former Building 136 (Shipfitters and prior to 1951 the Plate and Moldshop) was demolished and the debris was buried in and around the building's footprint. According to base personnel, the debris in the area was later removed for disposal and is known to have failed Toxicity Characteristic Leaching Procedure (TCLP) testing for lead. The area around the former Building 136 is currently level graded limestone. Buildings in the Zone that have been razed include the following:

- 26 - Cistern (distilled water)
- 59 - Storehouse
- 60 - Boiler Shop
- 79 - Electrical Shop
- 100 - Cold Storage
- 101 - Submarine General Shops and Offices
- 115 - Diesel Oil Storage Tank
- 116 - Steam Plant
- 117 - Fuel Oil Storage
- 118 - Battery Water Storage Tank
- 122 - Fire Station
- 123 - Public Works Maintenance Office, Garage, and Shops
- 136 - Shipfitters/former Plate and Mold Shop (pre-1951)
- 147 - Sound School Shop and Laboratory
- 148 - Fresh Water Tank
- 156 - Submarine Storage Shed
- 157 - Equipment Shed
- 160 - Ordnance Warehouse/former Anti-Aircraft Trainer (pre-1951)
- 168 - Storage Building
- 169 - General Storage
- 171 - Storehouse
- 172 - Women Accepted for Volunteer Emergency Service (WAVES) Officers' Quarters
- 173 - WAVES Officers' Quarters
- 174 - Cistern

2.2.1.4 Zone F (Building 223)

Building 223 (Equipment Repair Shop) is currently used as storage for Port Services. Little is known about the activities in the building; however, the name implies that naval support equipment was repaired at the building. A closed hazardous waste storage area is present to the south of Building 223. Building 1287 is a closed galley facility that operated during the 1960s. Adjacent to Building 1287 was a motor pool area that operated during the 1950s.

2.2.1.5 Zone K (Waterfront Maintenance Facilities)

Zone K currently includes Buildings 84, 112, 113, and 149. Building 113 is a Special Forces Operations Center (former Paint and Oil Storage). Building 149 is the NAS Key West Port Operations (Port Ops) Building (former Gear and Spare Parts Storage). Port Ops provides and maintains boats (less than 60 feet) to support naval activities for NAS Key West. The building also includes an active hazardous waste storage area. Building 84 is currently vacant, but it was most recently the site of a Naval Convenience Store and formerly a Transportation Pool. Building 112 is currently a Public Works Warehouse and formerly was used as a Submarine Spare Parts Building. Former buildings in the Zone that have been razed include the following:

- 111 - Paint Shop/former Marine Railway Utilities (pre 1951)
- 137 - Outside Machine Shop/former Fitting Out Shop (pre 1951)
- 138 - Central Tool Room/former Galvanizing Shop (pre 1951)
- 139 - Pipe and Copper Shop
- 140 - Boiler Shop
- 141 - Foundry
- 143 - Lumber Shed
- 144 - Public Work Warehouse
- 145 - Patrol Craft (PC) Boat Shop
- 146 - Experimental Lab
- 150 - Echo Repeater Shop/former Paint Shop (pre 1951)
- 153 - Rigger's Shop/former Cafeteria Annex (pre 1951)

2.2.2 Trumbo Point

The two Trumbo Point BRAC Zones make up a contiguous land parcel on the northwest end of Key West (Figure 2-4). The area is flat terrain that slopes gently to the southeast. Piers D1 and D3 extend out into

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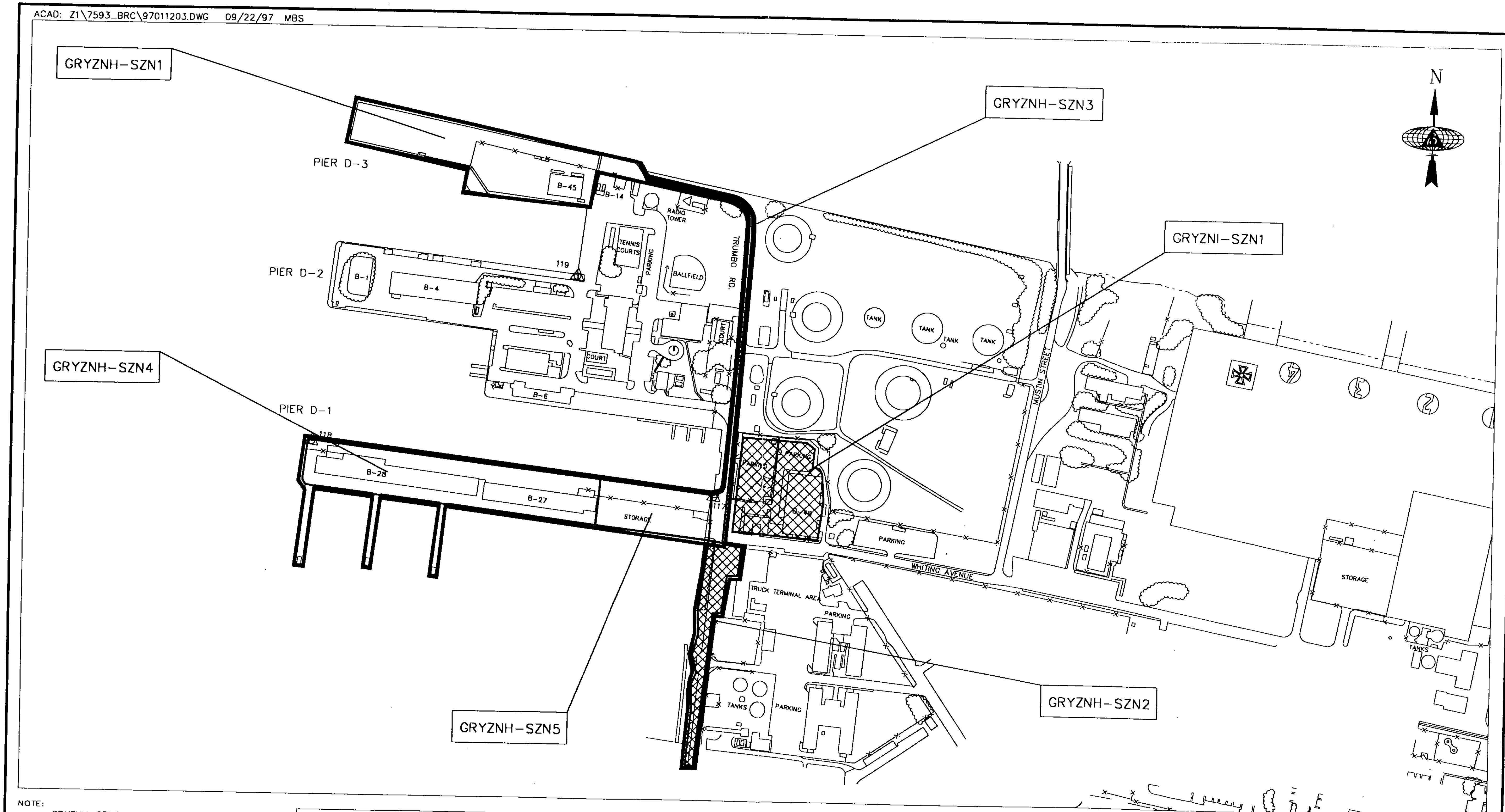

NOTE:
GRYZNH-SZN6 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE H)
GRYZNI-SZN2 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE I)

LEGEND:
AREA NOT OF CONCERN

SITE MANAGER: CMB	CHECKED BY: DSF
DRAWN BY: TCB/MBS	DRAWING DATE: 9/15/97
SURVEYED BY:	SURVEY DATE:
SCALE: 1"=300'	
CAD DWG. NO.: 97011203.DWG	

BROWN & ROOT ENVIRONMENTAL

FIGURE 2-4.
ZONE H & I
TRUMBO POINT SUBZONES

NAVAL AIR STATION
KEY WEST, FLORIDA

the Gulf of Mexico. Three of the buildings currently present on BRAC properties at Trumbo Point (B-27, B-28, and B-48) were originally constructed as ordnance facilities. B-27 and B-28 were used as shop and maintenance facilities for ordnance, while B-48 was used as a classroom and training facility.

The City of Key West, the Monroe County School District, and the U.S. Coast Guard (USCG) own parcels of land adjacent to the Navy BRAC properties located on Trumbo Point. The parcel owned by the City of Key West was previously used to generate electrical power for the surrounding Keys. The power station was coal-fueled, creating tar pits on the property that were subsequently cleaned up by the City of Key West. The City of Key West was also granted an easement for sewer lines that travel through naval property on Trumbo Point and discharge to the Key West Bight. The lines are no longer used, are capped, and are severely rusted and pitted on the visible portions of discharge piping. The Monroe County School District uses its parcel of land as a garage, maintenance facility, and administrative complex. Three aboveground storage tanks (ASTs) used for gasoline, diesel fuel, and oil storage are located on the school district's property. In 1976, ownership of Pier D-2, located on Trumbo Point, was transferred from the Navy to the USCG. The USCG currently holds approximately 13 acres on Trumbo Point. Ship refueling and hazardous waste storage are among the activities performed at these USCG facilities.

2.2.2.1 Zone H (Piers D1 and D3)

Piers D1 and D3 are two of three original harbor terminal piers constructed in 1914 by the Florida East Coast Railroad Company. The piers were used by the railroad and P.O. Steamship Company as part of an overseas railroad freight car ferry system. The piers were abandoned in 1935 due to severe hurricane damage. Some time later Pier D3 was used as an oil dock by Orange State Oil Company. In August 1942, Pier D1 was purchased by the Navy from Trumbo Point Properties, Inc. Pier D3 was purchased from Orange State Oil Company in December 1942. The Navy used the property in support of various ship and craft operations until the late 1980s. A chain link fence has been installed along the length of Pier D1. The USCG uses the north side of the pier and the Naval Air Warfare Center uses the south side (including all buildings and structures). The Navy does not use Pier D3, but the USCG uses a fenced portion of the pier, including Building 45.

The EBS (USN-SUPSHIP, 1996b) documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site.

- Although the storage of hazardous or petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed.

- No stains were observed on site soils, although numerous small stains that appear to be paint- or petroleum-related were noted throughout the site facilities.

- Two oily water flow-through process tanks are located at the northern corner of Pier D1. The tanks are not used by the present tenant.

- Pier D3 contains two USTs -- a 550-gallon waste-oil tank and a 250-gallon oily-waste tank. Both tanks have been abandoned. The fueling operations and associated piping have also been abandoned.

- The presence of PCBs is not suspected at Piers D1 or D3. Transformers at Pier D3 have been identified as non-PCB.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- Based on the 1995 inspection performed by the Navy Public Works Center, both lead-based paint (LBP) and asbestos containing building materials (ACBMs) are present in Pier D1 buildings. Pier D3 appears to contain numerous areas of LBP, but no ACBMs are associated with current facilities, although it is likely that ACBMs have been used and handled there in the past.

2.2.2.2 Zone I (Building B-48)

Building B-48 is a two-story structure constructed in 1955. The building has been identified as an ordnance and training facility. The south end of the second floor has been used as a photographic laboratory since 1962. Known uses of the building include: office space, machining operations, handling fuels, hydraulic equipment repair, electronic gear repair, ordnance handling/maintenance, emergency shelter, and training. Currently, a large portion of Building B-48 is being used by the USCG for storage of manuals associated with Alien Migration Intradiction Operations.

The EBS (USN-SUPSHIP, 1996) documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site.

- Although the storage of hazardous and/or petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed. The hazardous waste collection site on Trumbo Point, located behind Building B-48 is officially closed for the collection of hazardous waste.

- No stains were observed on site soils, although numerous small stains, apparently petroleum-related, were noted in air conditioning rooms and in the compressor room.

- Based on investigations and observations, it does not appear that any storage tanks were associated with Building B-48.

- The presence of PCBs is not suspected at Building B-48. Transformers at the site have been identified as non-PCB.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- Based on the 1995 inspection performed by the Navy Public Works Center, both LBP and ACBMs are present in Building B-48.

2.2.3 Key West Interior

The three Key West Interior BRAC Zones are made up of three divided land parcels on the eastern end of Key West. Each Zone is characterized as having flat terrain with a surface-water body located nearby. A portion of each Zone drains to its respective surface-water body.

2.2.3.1 Zone A [Hawk Missile Site (KW 65)]

Based on historical maps and aerial photographs, the land for the Hawk Missile Site was previously salt ponds that were filled by the U.S. Army in order to adapt the area for use as a missile site (Figure 2-5). This facility was built in 1964 as a defense site to repel an expected Cuban and Russian assault as a result of the Cuban Missile Crisis. It was used for coastal defense until the early 1980s, at which time it was transferred to the Navy. The Navy did not use the property but allowed its use as a refuge for homeless veterans in 1994 and 1995. During the 10 months in which Vietnam veterans occupied the site, wastewater from showers and washing machines was discharged into the surrounding wetlands.

The Hawk Missile Site is bordered to the south by Key West International Airport, where petroleum products are stored and used. The northern border is bounded by Flagler Canal, a man-made canal connected to the Atlantic Ocean. The canal is used by private boats and appears to overflow onto the site at times. Woodlands and wetlands border the property to the east and west.

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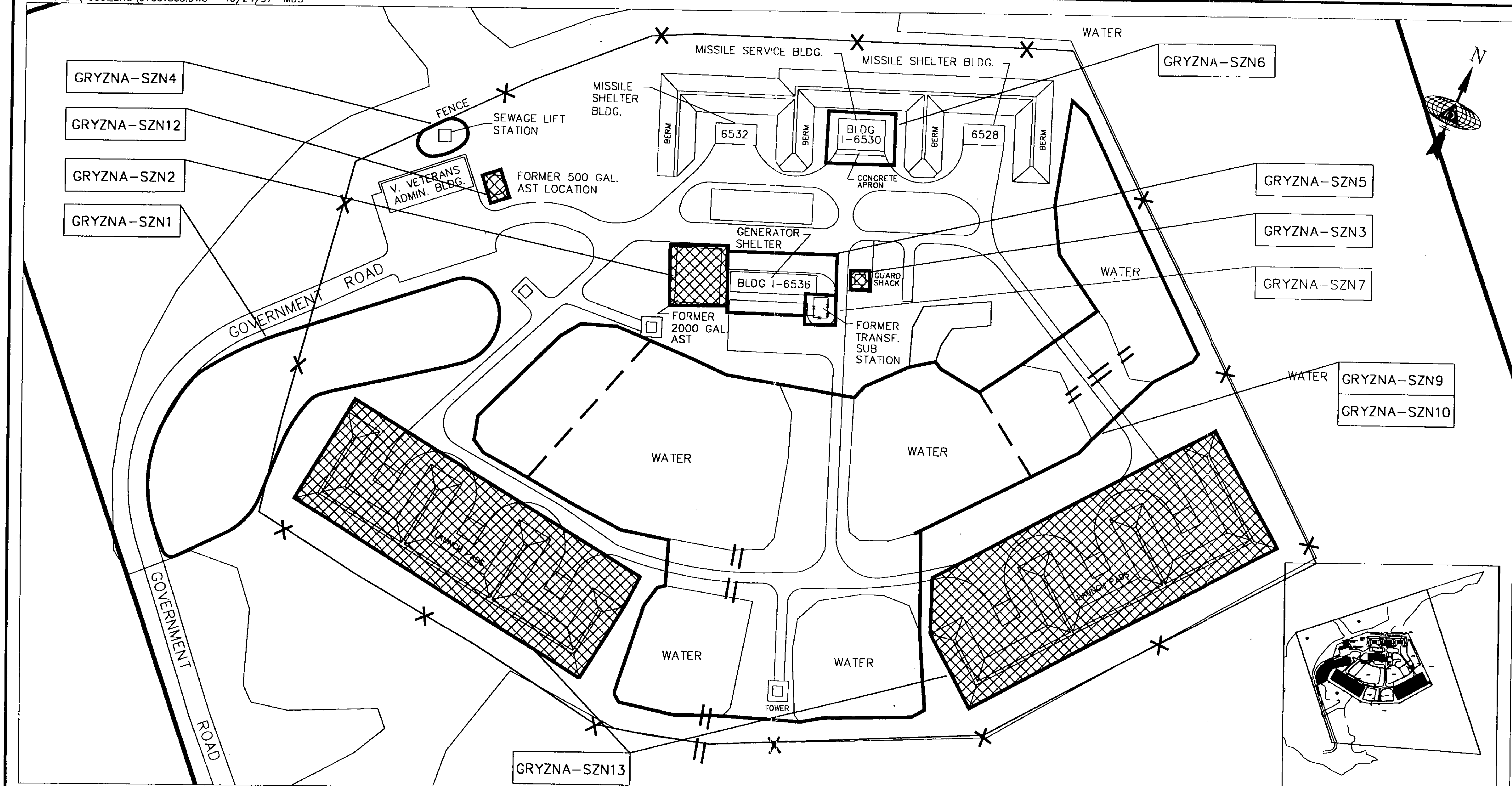

NOTE:
GRYZNA-SZN8 – REMAINDER OF ZONE A (SOIL IS NOT OF CONCERN)
GRYZNA-SZN9 – SEDIMENT SUBZONE (INCLUDES ALL WATER WITHIN THE FENCE LINE AT ZONE A)
GRYZNA-SZN10 – SURFACE WATER SUBZONE (INCLUDES ALL WATER WITHIN THE FENCE LINE AT ZONE A)
GRYZNA-SZN11 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE A)

LEGEND:
AREA NOT OF CONCERN

SITE MANAGER: CMB	CHECKED BY: DSF
DRAWN BY: TCB/MBS	DRAWING DATE: 8/21/97
SURVEYED BY:	SURVEY DATE:
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BROWN & ROOT ENVIRONMENTAL

FIGURE 2-5.
ZONE A
HAWK MISSILE SITE SUBZONES

NAVAL AIR STATION
KEY WEST, FLORIDA

The EBS (USN-SUPSHIP, 1996) documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site.

- Although the storage of hazardous or petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed.

- No stains were observed on site soils, although old stains of an indeterminate nature were found on the floors of several site facilities.

- At one time, two ASTs in bermed foundations were used for fuel oil and/or diesel storage. Both of these ASTs have since been removed, although there are currently several other empty ASTs located at site. Two of these tanks, located north of Building I-6504, contained water. Two other empty tanks, sitting on the asphalt drive, were apparently moved from an unknown location by Vietnam veterans.

- Vandalism of three on-site transformers, abandoned by the Army, resulted in a small PCB spill. Initial testing by the Navy showed very low PCB concentrations in soil, and subsequent tests did not indicate any PCB contamination.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- A water storage tank and sewage pumping station are located on-site, but have not been operable for many years.

- Based on the 1995 inspection performed by the Navy Public Works Center, both LBP and ACBMs are present in the Hawk Missile Site facilities and infrastructure.

2.2.3.2 Zone B (East Martello Battery)

The U.S. Army built East Martello Battery in the early 1940s for use as a Coastal Defense Battery. It was used as such until the property was transferred to the Navy in 1950 (Figure 2-6). The Navy developed the property in the early 1950s to accommodate 100 trailers to be used as housing. The trailer housing project also included two laundry facilities, but no dry cleaning operations were known to have been conducted. The trailer project was deactivated in 1956, and all trailers and buildings were removed from the site. Monroe County Civil Defense used the bunker from 1985 until 1992 as an administrative

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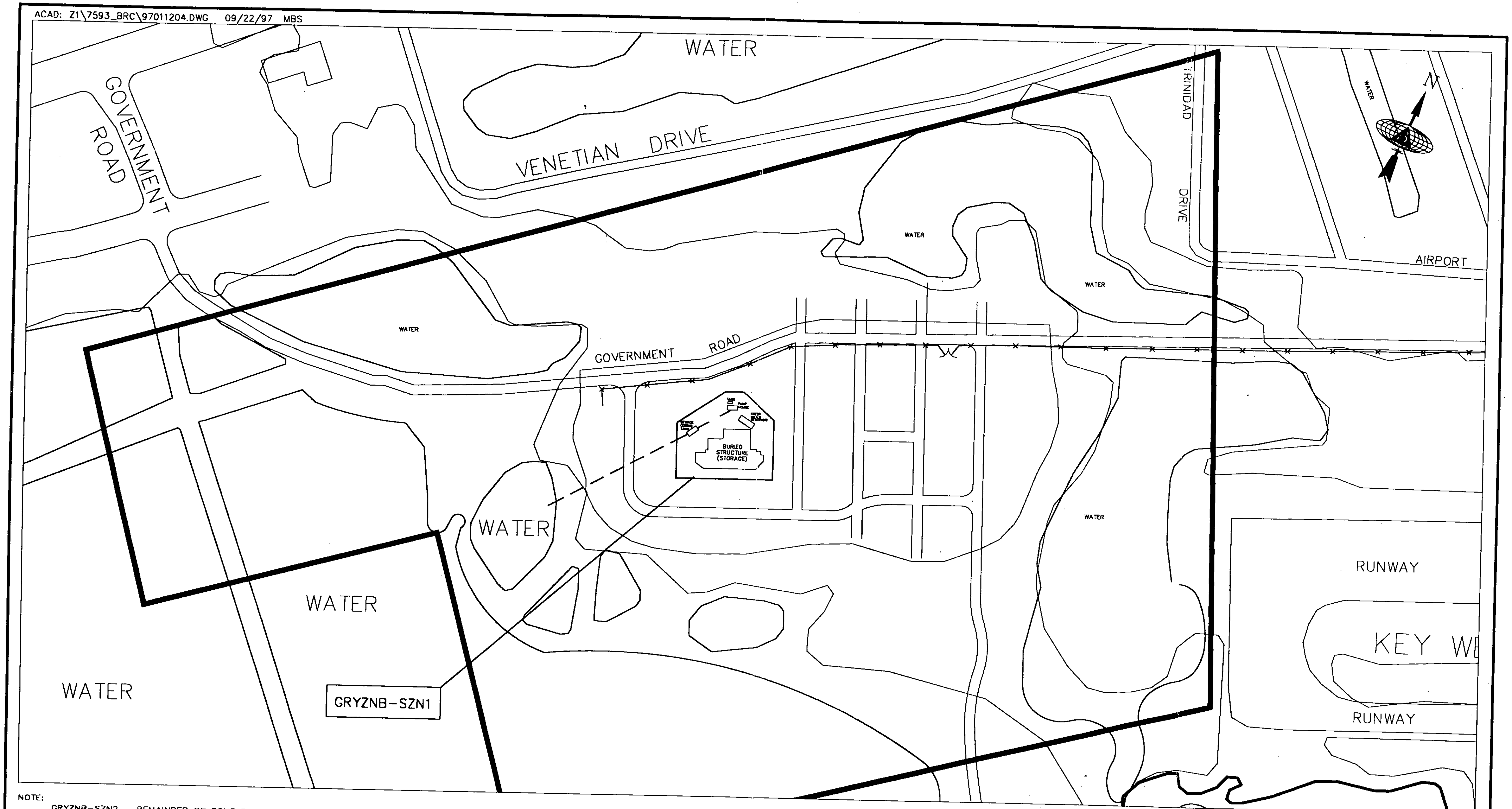

NOTE:
GRYZNB-SZN2 – REMAINDER OF ZONE B (SOIL IS NOT OF CONCERN)
GRYZNB-SZN3 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE B)

SITE MANAGER: CMB	CHECKED BY: DSF
DRAWN BY: MBS	DRAWING DATE: 9/15/97
SURVEYED BY:	SURVEY DATE:
SCALE: 1"=200'	
CAD DWG. NO.: 97011204.DWG	

BROWN & ROOT ENVIRONMENTAL

FIGURE 2-6.
ZONE B
EAST MARTELLO BATTERY SUBZONES

NAVAL AIR STATION
KEY WEST, FLORIDA

command post. The county has placed yard and tree cuttings on the property to dry prior to mulching and replacing.

East Martello Battery is located on the western border of Key West International Airport, at the end of the runaway. The airport stores and uses petroleum products. The northern border is bounded by old residential communities, while the southern and western borders are saltwater ponds and undeveloped woodlands.

The EBS (USN-SUPSHIP, 1996) documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site.

- Although the storage of hazardous or petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed.

- No stains were observed on site soils, although old stains of an indeterminate nature were found on the floors of several site facilities.

- A freshwater tower and tank were previously located at the site, but have been removed.

- Concrete freshwater storage and sewage dosing tanks are located in the northeast and northwest corners of Zone B, but appear to have been out of service for many years.

- A septic drain field is located on the southwest portion of the property, but it has not been used since the 1950s, when the sanitary waste dosing station ceased operation.

- There is no reason to suspect PCB contamination at this facility.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

Based on the 1995 inspection performed by the Navy Public Works Center, both LBP and suspected ACBMs are present in East Martello Battery facilities and infrastructure.

2.2.3.3 Zone G (Poinciana Housing)

Poinciana housing is situated on 36 acres on the east end of Key West near the Naval Regional Medical Clinic (Figure 2-7). The property is bounded on three sides by Duck Avenue, 19th Street, and Donald

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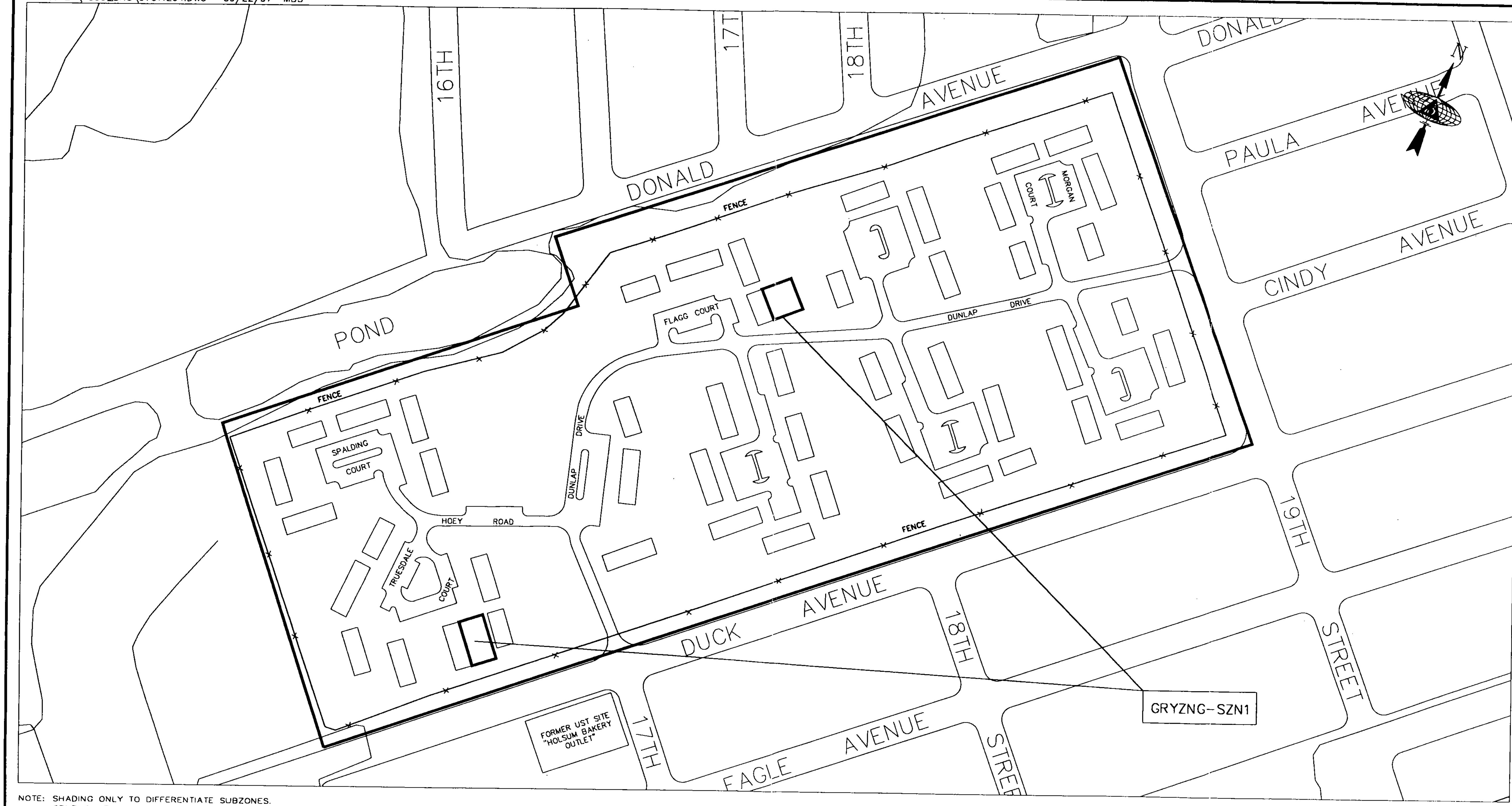

NOTE: SHADING ONLY TO DIFFERENTIATE SUBZONES.
GRYZNG-SZN2 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE G)

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DRAWN BY: MBS	DRAWING DATE: 9/15/97
SURVEYED BY:	SURVEY DATE:
SCALE: 1"=200'	
CAD DWG. NO.: 97011204.DWG	

BROWN & ROOT ENVIRONMENTAL

FIGURE 2-7.
ZONE G
POINCIANA PLAZA HOUSING SUBZONES
NAVAL AIR STATION
KEY WEST, FLORIDA

Avenue. The fourth side is bounded by single-family residences. This housing park consists of 212 townhouse-type units constructed in 1966. Since 1942, the property has been used as residential housing. No industrial activities have taken place at the site since its acquisition by the Navy in 1947.

The parcel is located in a residential neighborhood/commercial area. Recreational areas are nearby, including boating, a sports complex, malls, etc.

The EBS (USN-NFEC, 1996a) and the Lead and Asbestos Survey (USN-NPWC, 1995; CAPE, 1997) documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site.

- Hazardous substances and petroleum products were stored and used in the housing area, but quantities and strengths were no greater than those normally found in private residences.
- No gas station was maintained on this parcel.
- No storage tanks or oil/water separators were maintained at this site.
- No stains were observed on site grass or soils. Stains attributable to automotive oil and fluid leaks were noted in the parking area.
- There is no reason to suspect PCB contamination, as PCB transformers are not present on the site.
- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.
- Based on the 1995 inspection performed by the Navy Public Works Center, both LBP and ACBMs are present in Poinciana Housing structures. Lead was also detected in soil samples collected in the Zone.

2.3 BASE ENVIRONMENTAL SETTING

Key West is approximately 4 miles long and 1.5 miles wide. Boca Chica Key is approximately 3 miles wide and 3 miles long. The City of Key West is the county seat for Monroe County. The principal industry of tourism in Key West brings about 1,225,000 tourists annually. Tourism, fishing, wholesale and retail trade, services, construction, finance, insurance, real estate, Federal government, state and local government, and transportation industries make up the major sources of employment in Key West.

The following subsections present a summary of existing conditions common to all sites located at NAS Key West.

2.3.1 Climate and Meteorology

Of the Florida Keys, the lower Keys have the least rainfall with an average annual rainfall of 39.4 inches. Temperature is fairly uniform across the Florida Keys with a July average temperature of 84 degrees Fahrenheit (°F), a January average temperature of 64 to 70°F, and an average annual temperature of 76.3°F. Freezing temperatures are rare in the Florida Keys due to their proximity to the Gulf Stream and the Gulf of Mexico, both of which modify advancing cold fronts. Freezes, when they occur, have the long-lasting effect of killing cold-sensitive species that might otherwise become established. Easterly tradewinds and sea breezes suppress summer heat from June to September (IT Corporation, 1994).

Hurricanes normally form in the warm, moist air over the tropical seas around the Lesser Antilles and occasionally in the Caribbean. They tend to move in a westerly to northwesterly direction, gradually turning northward and eastward. Most hurricanes that approach Key West do so from the south and east. Severe hurricanes have struck Key West from each direction. Tidal flooding causes an estimated 75 percent of all damage that occurs during a hurricane (IT Corporation, 1994).

Dry and wet seasons characterize Key West. From December through May, the Keys receive approximately 20 to 25 percent of their annual precipitation total. Approximately 75 to 80 percent of the annual rainfall occurs from June through November. Rainfall usually occurs in advance of a cold front in the form of a few heavy showers, occasionally five to eight light showers per month. Overland flow or storm drains that drain approximately 50 percent of the island's surface area carry rainfall runoff from Key West to the tidal waters; however, much of the rainfall percolates directly into the subsurface (IT Corporation, 1994).

2.3.2 Topography

The NAS Key West Complex lies in the southeastern Coastal Plain physiographic province. A series of ancient marine reefs, formed during the Pleistocene period when the sea level was higher than it is at present, control the topography of the Coastal Plain in southern Florida (ABB, 1995).

Ground elevations in the Key West area average between 4 and 5 feet above msl, and the highest point on Key West is approximately 18 feet above msl. The Key West area is characterized by a sparse veneer of residual soil and surface vegetation overlying eroded limestone. The topography of the lower Keys, generally smooth and flat in the center of the key, slopes gently toward the shoreline. With the exception of central Key West, most areas are within the 100-year floodplain (ABB, 1995).

2.3.3 Surface-Water Hydrology

The surrounding saltwater bodies, the Atlantic Ocean and the Gulf of Mexico, dominate the surface-water regime in the Florida Keys. FDEP classifies surface water in the Florida Keys as Class G-III Waters - Recreational, Propagation, and Management of Fish and Wildlife. In the immediate area of NAS Key West are the Great White Heron National Wildlife Refuge and the Key West National Wildlife Refuge, which FDEP classifies as Outstanding Florida Waters to receive the highest degree of protection by the State. The residents of Florida consider these waters of exceptional recreational and ecological significance (ABB, 1995).

Freshwater recharge in the lower Keys occurs directly through rainfall. The nearly flat topography and porous nature of exposed limestone allows much of the rainfall to infiltrate to shallow groundwater tables, forming freshwater lenses. Overland flow or storm drains in most of the more developed areas carry remaining rainfall to tidal waters. Accelerated runoff and increased saltwater intrusion from canals, housing, dewatering (as a mosquito control measure), and marinas decrease the freshwater lens on the Florida Keys, shorten the period that residents can draw on freshwater supplies, and affect water quality. During the dry season, freshwater tends to disappear quickly by seepage to the sea and evaporation. Evaporation exerts an important effect on the Florida Keys' hydrologic budget, with transpiration affecting a more localized and confined area on individual islands (ABB, 1995).

2.3.4 Geology and Soil

The lower Keys, which are within the southern or distal geomorphic division of Florida, were formed during the Pleistocene era. Commonly referred to as the "Oolite Keys," they are underlain by the Oolitic Member (Miami Oolite) of the Miami Limestone. The Oolitic Member consists of variably sandy, fossiliferous limestone composed primarily of ooids (spherical calcareous grains 0.25 to 2.0 mm in diameter) that were created through eustatic elevation of the limestone. In the lower Keys, the Oolitic Member consists of the Ooid Calcarenite and the Oomoldic-recrystalline lithofacies. The Ooid Calcarenite lithofacies consists of very fine to coarse sand-size, spherical carbonate grains concentrically laminated around a silt-size to fine-sand-size nucleus. The Oomoldic-recrystalline lithofacies consists of slightly sandy to very sandy well- to moderately well-consolidated micritic calcite. The Miami Oolite overlies the Key Largo Limestone, a geologic unit consisting of light grey to light yellow coralline limestone comprised of coral heads encased in a matrix of calcarenite.

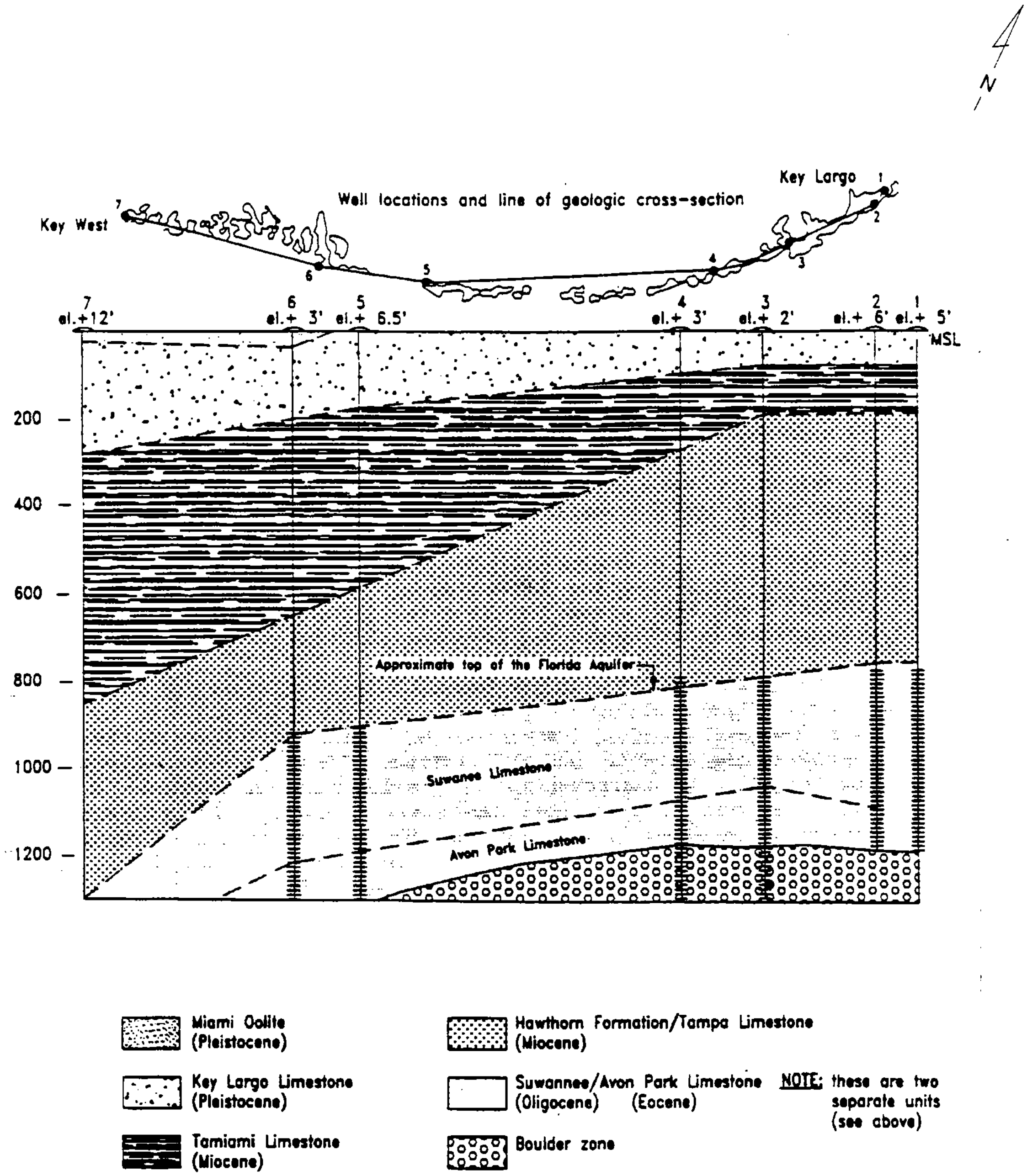
In the Supplemental RFI/RI Workplan, ABB Environmental Services, Inc. (ABB) reported that the Miami Oolite is 27 feet thick and that the Key Largo limestone is greater than 270 feet thick in the western portion of Key West. The Key Largo Limestone is generally more porous than the Miami Oolite, but it contains only saltwater. Figure 2-8 shows a geologic cross-section of the Florida Keys (ABB, 1995).

Undisturbed soil in the Keys consists of shallow marl over limestone with the substrate rock outcropping at the surface. Many areas of the Florida Keys, such as Fleming Key, have been filled and graded. The soils on Boca Chica Key are primarily rockland with some filled areas and mangrove swamps. Other major soil groups on Boca Chica Key consist of gravely sand and marl, and marl and weathered bedrock (ABB, 1995).

2.3.5 Hydrogeology

The surficial aquifer system that occurs in the lower Keys consists of the Oolitic Member, which is very porous and highly permeable due to the dissolution of carbonate by groundwater as it recharges the aquifer system. The aquifer is tidally controlled and fluctuates constantly. It is extremely porous, and solution holes and caverns are ubiquitous. The Tamiami Formation lies below the Key Largo Limestone unit, between 300 and 900 feet below land surface (bls). The formation contains mineralized water that does not meet Florida drinking water standards. Underlying the Tamiami Formation are the Hawthorn and Tampa Formations, which together act as an aquiclude confining the underlying limestone units. Below the confining units of the Hawthorn and Tampa Formations is the Suwannee Limestone, a fossiliferous limestone representing the top of the water-producing zone in the Florida Keys. The water is of adequate quality for drinking after treatment. The Avon Park Limestone is 1,300 feet bls and, although it has a higher transmissivity than the Suwannee Limestone and supplies large quantities of drinking water in central Florida, is of poor quality in the Florida Keys (ABB, 1995).

The unconfined surficial aquifer consists of the highly permeable, porous, solution-riddled Miami Oolite, which allows recharge from rainfall to seep quickly to the ocean and saltwater to intrude easily to the aquifer. The surficial aquifer is the principal aquifer of concern in Key West because of its reported use as a potable water resource to a limited extent (although not at NAS Key West) and because of its groundwater-to-surface-water contaminant migration route (ABB, 1995). The water table ranges in depths from 0.8 to 2.4 feet below msl at the center of Key West and from 0.4 to 2.2 feet below msl near the coast. The water table fluctuates diurnally because of tidal effects. Head differentials associated with tidal



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0 16 32
SCALE IN MILES (APPROXIMATE)

FIGURE 2-8. GEOLOGIC CROSS-SECTION OF THE FLORIDA KEYS

NAS KEY WEST — KEY WEST, FLORIDA

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variations near the shore can further accelerate groundwater movement in the area. A reconnaissance water-quality sampling study completed in 1990 by the U.S. Geological Survey in cooperation with the South Florida Water Management District indicates that the freshwater lens contains non-potable water (ABB, 1995). The State of Florida classifies groundwater in unconfined aquifers that have a total dissolved solids content of 10,000 milligrams per liter (mg/L) or greater as Class G-III (non-potable water). No freshwater public or registered domestic wells are in use on NAS Key West (ABB, 1995); however, domestic residences on Boca Chica and Key West are reported to use surficial aquifer wells for non-potable uses such as flushing water. The City Engineer of Key West also reports that water from some of these types of wells might be used for drinking after treatment such as reverse osmosis. The freshwater lens averages 5 feet in thickness below the center of the western half of Key West. The lens contains between 20 and 30 million gallons of fresh water, depending on the season. Underlying the freshwater lens is a 40-foot transition zone of brackish water (ABB, 1995).

2.3.6 Potable Water Supply

Potable water is supplied to all the Florida Keys. The Florida Keys Aqueduct Authority (FKAA) operates and maintains the Florida Keys Aqueduct that supplies potable water throughout the Florida Keys. The water is drawn from wells near Florida City in southeastern Dade County and pumped 130 miles through a water main that parallels U.S. Highway No. 1 and terminates in Key West. Water is distributed along the length of the main. In 1984, the FKAA supplied the City of Key West with an average flow of 11.7 million gallons per day (mgd). The Navy received 14.35 percent of the average flow (ABB, 1995). In some instances, potable water is also obtained by rainwater catchment (the only source prior to the construction of the pipeline in the 1940s).

Alternative sources of potable and non-potable water used in the Florida Keys include private cisterns, private wells, home desalination systems, and bottled water. The Monroe County Health Department recognizes the public water supply as the only potable water source available on Key West. In addition to managing the centralized public water supply system, the FKAA has the authority to regulate all potable water supplies in the Keys, including alternative sources of water such as those mentioned above. Those residences using a dual system of private and public water are required to use a reduced-pressure valve to prevent water from back-flowing into the water supply system. The FKAA does, however, report that private wells in the freshwater lens in the Surficial Aquifer may be used for both potable and non-potable purposes (ABB, 1995). The number of people who use water from private wells in Key West for drinking or non-potable domestic purposes is unknown. The best estimate of the number of people using local groundwater for non-potable domestic purposes is less than 500 people (IT Corporation, 1994).

2.3.7 Population and Land Use

The City of Key West has a residential population of approximately 24,800 (USCBS, 1990). The principal industry is tourism with about 1,225,000 tourists visiting annually. The Monroe County population is approximately 78,000, and the average age is approximately 39 years (USCBS, 1990). The average household size is 2.3 persons. The median cost of housing is $164,000. Key West has five elementary schools, two parochial elementary schools, one public high school, the Florida Keys Community College, and May Sands Exceptional Center. Monroe County has 33 churches, one synagogue, and two Florida Health System Hospitals (east and west). Land use in the City of Key West consists primarily of commercial and residential areas. Boca Chica Key is almost totally a military-use area.

2.3.8 General Area Ecology

The NAS Key West complex includes areas that have been developed by the Navy and retain little natural resource value; however, undeveloped areas still support high-quality natural communities and provide important habitats for rare species. Five non-marine natural community types have been identified within the NAS Key West study area (FNAI, 1994); however, of the 10 BRAC Zones, the seven Truman Annex and Trumbo Point BRAC Zones are considered fill areas with no natural communities. The remaining three Key West Interior BRAC Zones have elements of mangrove swamps or coastal rock barren. These two natural community types are described below.

2.3.8.1 Natural Communities

In areas of minimal topographic relief, natural communities often form a continuum that lacks distinct boundaries. As a rule, the boundaries change gradually along some environmental gradient, where dominant species become co-dominant and yield to species better adapted to the new conditions along the gradient. Depending on their species ecological tolerances, some plant species will range over several distinct community types. Natural communities cover approximately 20 percent of NAS Key West (FNAI, 1994).

2.3.8.1.1 Mangrove Swamp

Approximately 75 percent of the natural communities at NAS Key West can be classified as mangrove swamp, also known as tidal swamp (FNAI, 1994). Four plant species dominate these areas: red mangrove (*Rhizophora mangle*), black mangrove (*Avidennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erecta*). The relative abundance of each species varies greatly from area to area as do the density, average height, degree of canopy closure, and diversity of associated herbaceous species. Extremes in variation include hyposaline, shallow marl sites supporting 0.5 to 1.5-meter (m)-tall "spider" red mangroves; hypersaline dwarf black mangrove associations; and euryhaline tidal areas on deep peat soils supporting well-developed mixed assemblages of red/black/white mangroves with closed canopies 10 to 12 m tall and trees with 20-centimeter (cm)-diameters at breast height (DBH) (FNAI, 1994).

Most of the mangrove vegetation at NAS Key West falls well between these extremes. The classic zone pattern of red mangrove to black mangrove to white mangrove to buttonwood along a seaward-to-landward elevational and salinity gradient is evident in some areas but absent in others. Mixed mosaics of mangrove species make up the majority of mangrove swamps at NAS Key West, which vary continuously over a given area with regard to dominance.

Many terrestrial and aquatic vertebrate species are associated with mangrove swamp habitats. At least 220 species of fish, 24 reptile and amphibian species, 18 mammal species, and 181 bird species (guilds include 18 wading birds, 25 probing shore birds, 29 floating and diving water birds, 14 aerially searching birds, 20 birds of prey, and 71 arboreal birds) inhabit mangrove swamp habitats in Florida (Myers and Ewel, 1990).

A mangrove swamp appears to exist on the eastern half of the Hawk Missile Site property. A narrow fringe of mangrove swamp habitat occurs along the water's edge on the southern and eastern portion of the East Martello Battery property.

2.3.8.1.2 Coastal Rock Barren

Approximately 8 to 10 percent of the natural vegetation at NAS Key West can be classified as coastal rock barren (FNAI, 1994). Coastal rock barrens are generally characterized as flat rocklands with much exposed and eroded limestone, sparsely vegetated with stunted, xeric, and halophytic shrubs, cacti, algae, and herbs. Buttonwood in some form often dominates this community. It can vary from bonsai-like sprawling shrubs less than 30 cm in height growing with two or three other stunted halophytes on essentially bare rock pavement to erect, multi-trunked 10-m-tall trees growing on deeper marls and associated with a rich variety of xerophytic shrubs, trees, cacti, graminoids, and forbs. Typical species include saffron plum (*Bumelia celastrina*), Christmas berry (*Lycium carolinana*), cat's claw (*Pithecellobium keyense*), erithalis (*Erithalis fruticosa*), bay cedar (*Suriana maritima*), indigo berry (*Randia aculeata*), wild dilly (*Manilkara bahamensis*), poisonwood (*Metopium toxiferum*), seagrape (*Coccoloba uvifera*), joewood (*Jacquinia keyensis*), rhacoma (*Crossopetalum rhacoma*), Spanish stopper (*Eugenia myrtoides*), saltgrass (*Distichlis spicata*), fimbristylis (*Fimbristylis castanea*), and Porter's broom spurge (*Chamaesyce* *porteriana var. scoparia*). In these sites, the coastal rock barren becomes a relatively dense thorn scrub thicket of sclerophyllous vegetation that typically includes epiphytic bromeliads and orchids.

At NAS Key West, coastal rock barren occurs in both the open pavement rockland form and in the deeper marl thicket form. A wide range of forms of this community type at NAS Key West supports populations of various vascular plants and vertebrates.

Remnants of this habitat appear to exist on the northwestern portion of the Hawk Missile Site property beyond the site fence line and on the northwestern portion of the East Martello Battery property although it has been impacted by the invasion of Australian pine.

2.3.8.2 Wildlife

As expected, wildlife species at NAS Key West vary considerably depending on habitat. Developed areas of the base limit wildlife species primarily to birds associated with urbanized areas. A variety of species, however, use the relatively undisturbed habitats (particularly mangrove swamps and lagoons).

An 11-month field study observed 126 species of birds at NAS Key West (FNAI, 1994). As many as 300 species of birds might use habitats on the base either as migrants or as residents (Schuetz, 1996). Biologists observed four snake and three lizard species during the Florida Natural Areas Inventory (FNAI) study: the black racer (*Coluber constrictor*), red rat snake (*Elaphe guttata guttata*), Eastern diamondback rattlesnake (*Crotalus adamanteus*), rough green snake (*Opheodrys aestivus*), Florida Keys mole skink (*Eumeces egregius egregius*), Carolina anole (*Anolis carolinensis*), and brown Cuban anole (*A. sagrei*) (FNAI, 1994). Biologists previously observed the endangered Eastern indigo snake (*Drymarchon corais couperi*) (FNAI, 1994); this and other reptiles and amphibians undoubtedly occur on the base.

Very few mammal species occur on NAS Key West and in the lower Florida Keys. Only three native mammal species were observed during the FNAI study: the Lower Keys marsh rabbit (*Sylvilagus palustiris hefneri*), the raccoon (*Procyon lotor*), and the opossum (*Didelphis virginianus*) (FNAI, 1994). Raccoons are abundant and widespread on the base, while opossums are uncommon.

Relatively harsh natural ecological conditions in the Keys (i.e., poor soils, scarcity of fresh water) likely ensure a low species diversity of mammals. In addition, humans have extensively altered or destroyed natural habitats, so remaining natural habitats occur in small isolated patches. Exotic species such as Australian pine have invaded and thus significantly altered many natural areas.

Carnivorous mammals at NAS Key West are limited to raccoons and feral cats. No moles and shrews live on the base, and few rodent species occur there. Neither the eastern harvest mouse (*Reithrodontomys humulis*) nor the cotton mouse (*Peromyscus gossypinus*), both common in most of Florida, occur on the base. Native terrestrial mammals on the base appear to be limited to raccoons, marsh rabbits, opossums, and cotton rats (*Sigmodon hispidus*). Silver rice rats (*Oryzomys argentatus*) have been recorded on Saddlebunch Key but not on Boca Chica Key or Key West, in spite of extensive trapping efforts (FNAI, 1994). Three exotic rodents also occur on the base: the Norway rat (*Rattus norvegicus),* black rat (*Rattus rattus*), and house mouse (*Mus musculus*) (Frank, 1996; Schuetz, 1996).

2.3.8.3 Threatened and Endangered Species

Tables 2-1 and 2-2 present Federal and State-listed threatened and endangered species recorded at NAS Key West (FNAI, 1994). A few listed threatened and endangered species not recorded on Tables 2-1 and 2-2 undoubtedly occur on the base, but have not been reported to FNAI. For example, several listed sea turtle species occasionally use beaches in the Key West area (IT Corporation, 1994). The Florida tree snail (*Liguus fasciatus*), listed as a Species of Special Concern (SSC) by the Florida Game and Fresh Water Fish Commission (FGFWFC), the Stock Island tree snail (*Orthalicus reses*) listed as endangered by the FGFWFC and threatened by the United States Fish and Wildlife Service (FWS), and the mangrove rivulus (*Rivulus marmoratus*), listed as SSC by FGFWFC, might occur in the area (Deyrup and Franz, 1994; Gilbert, 1992).

B&R Environmental biologists observed several threatened and endangered species during field activities associated with the Supplemental RFI/RI. For example, biologists observed an active bald eagle nest approximately 0.5 mile west of SWMU 5, AIMD Building A-990, on Boca Chica Key. Wading birds, including little blue herons, snowy egrets, tricolored herons, reddish egrets, and white ibis, were observed foraging in lagoons and ditches. During field activities, biologists observed white crowned pigeons in flight at various locations. Biologists have observed ospreys and recorded three nesting pairs on the base (FNAI, 1994).

TABLE 2-1

ENDANGERED AND THREATENED ANIMAL SPECIES KNOWN TO OCCUR AT NAS KEY WEST (FNAI, 1994) NAS KEY WEST

Common Name	Scientific Name	Designated Status	
		FGFWFC	US FWS
ish			
ey silverside	*Menidia conchorum*	T	-
eptiles			
astern indigo snake	*Drymarchon corais couperi*	T	T
ed rat snake	*Elaphe guttata guttata*	SSC	-
lorida Keys mole skink	*Eumeces egregius egregius*	SSC	-
irds			
hite crowned pigeon	*Columba leucocephala*	T	-
ittle blue heron	*Egretta caerulea*	SSC	-
eddish egret	*Egretta rufescens*	SSC	-
nowy egret	*Egretta thula*	SSC	-
ricolored heron	*Egretta tricolor*	SSC	-
Vhite ibis	*Eudocimus albus*	SSC	-
ald eagle	*Haliaeetus leucocephalus*	T	T
sprey	*Pandion haliaetus*	SSC	-
rown pelican	*Pelecanus occidentalis*	SSC	-
east tern	*Sterna antillarum*	T	-
oseate tern	*Sterna dougallii*	T	T
lammals			
ilver rice rat	*Oryzomys argentatus*	E	E
ower Keys marsh rabbit	*Sylvilagus palustris hefneri*	E	E
lorida manatee	*Trichechus manatus*	E	E

Notes: E = Endangered
T = Threatened
SSC = Species of special concern
- = Not Listed
FGFWFC = Florida Game and Fresh Water Fish Commission
US FWS = U.S. Fish and Wildlife Service

TABLE 2-2

**ENDANGERED AND THREATENED PLANT SPECIES KNOWN TO OCCUR AT NAS KEY WEST (FNAI, 1994)
NAS KEY WEST**

Common Name	Scientific Name	Designated Status	
		FDA	US FWS
Blodgett's wild mercury	*Argythamnia blodgettii*	E	-
Locustberry	*Byrsonima Lucida*	E	-
Porter's spurge	*Chamaesyce porteriana*	E	-
Geiger tree	*Cordia sebestena*	E	-
Rhacoma	*Crossopetalum rhacoma*	E	-
Wild cotton	*Gossypium hirsutum*	E	-
Manchineel	*Hippomane mancinella*	E	-
Joewood	*Jacquinia keyensis*	T	-
Bahama brake	*Pteris bahamensis*	E	-
West Indies mahogany	*Swietenia mahogani*	E	-
Brittle thatch palm	*Thrinax morrissi*	E	-
Florida thatch palm	*Thrinax radiata*	E	-
Banded wild pine	*Tillandsia flexuosa*	E	-
Worm-vine orchid	*Vanilla barbellata*	E	-

Notes: E = Endangered
T = Threatened
- = Not Listed
FDA = Florida Department of Agriculture and Consumer Services
US FWS = U.S. Fish and Wildlife Service

3.0 DATA QUALITY OBJECTIVE PROCESS

3.1 DATA QUALITY OBJECTIVE PROCESS

The Data Quality Objectives (DQO) Process (EPA, 1994) was used as a tool in determining the type, quantity, and quality of data needed to support the conclusions and recommendations for the NAS Key West BRAC properties. As a systematic planning tool based on the scientific method, the seven-step DQO process helps establish criteria for defensible decision-making at the onset of a study and develops a data-collection design based on these criteria. The steps identify such information as the goal of the investigation, the inputs needed to reach the goal and make a decision, the temporal and areal boundaries of the investigation, the level of confidence required to support a decision, and finally, a sampling design that is adequate to support the decision-making process. The steps, as identified in the EPA Guidance for the DQO process, are as follows:

Step 1: State the Problem - Concisely describe the problem to be studied. Review prior studies and existing information to gain a sufficient understanding to define the problem.

Step 2: Identify the Decision - Identify what questions the study will attempt to resolve and what actions may result.

Step 3: Identify the Inputs to the Decision - Identify the information that needs to be obtained and the measurements that need to be taken in order to resolve the decision statement.

Step 4: Define the Study Boundaries - Specify the time periods and spatial area to which decisions will apply. Determine when and where data will be collected.

Step 5: Develop a Decision Rule - Define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.

Step 6: Specify Tolerable Limits on Decision Errors - Define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.

Step 7: Optimize the Design - Evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all the DQOs.

3.2 DATA QUALITY OBJECTIVES PROCESS FOR THE BRAC SITE INVESTIGATION PROPERTIES AT NAS KEY WEST

Early in the DQO process, the 10 BRAC Zones were divided into subzones based on surface features and the individual site's previous uses. Each subzone consists of a single environmental medium (e.g., groundwater, sediment, soil, or surface water), and the subzones within a given zone are not necessarily spatially unique. For instance, a sediment subzone may overlap a surface-water subzone. Groundwater is always considered at the zone level and is never subdivided because subsurface features are generally homogeneous over a much broader area than surface features. Additionally, groundwater migration makes it difficult to isolate the area of potential groundwater contamination to a particular region of the zone. Figures 2-3 through 2-7 depict the subzones within the 10 BRAC Zones.

The planning team, consisting of Navy and B&R Environmental staff, completed all seven steps of the DQO process for each subzone in the 10 BRAC Zones at NAS Key West. Decisions needed to facilitate the process were reached jointly by members of the NAS Key West partnering team, including representatives of the Navy, B&R Environmental, Bechtel Environmental, Inc. (BEI), FDEP, and EPA Region IV. In many cases, the information addressed under each step is not unique to a particular subzone, and is either applicable to all BRAC subzones, or is dependent only on the environmental medium being sampled in a given subzone. The outcome of each step in the DQO process for the BRAC subzones is discussed below. The subzone-specific DQO process summaries are presented in Appendix B.

Step 1: The first step in the DQO process was to generate a problem statement for each subzone. In general, potential contamination was the problem. Based on existing documentation, some subzones were removed from the SI process at this point. In these cases, sufficient documentation existed to either declare that the site was "not an area of concern," that contamination was well enough characterized, or that contamination was already being addressed elsewhere (e.g., primarily by the UST program) to consider the CERCLA assessment process complete for those subzones. The 16 subzones eliminated from the DQO process in step one are presented in Table 3-1. Table 3-2 presents a summary of the subzones that have been addressed or are currently being addressed by the UST program at NAS Key West. It should be noted that several of these sites have not been eliminated from the BRAC SI process because contaminants not addressed by the UST program may have been released there.

TABLE 3-1

BRAC[1] SUBZONES ELIMINATED FROM THE DATA QUALITY OBJECTIVES PROCESS AT NAS KEY WEST
PAGE 1 OF 3

Subzone	Building/Area	Problem Statement	Rationale for Elimination
ZONE A - HAWK MISSILE SITE			
GRYZNA-SZN2	Former 2,000-gallon AST[2]	Not an area of concern	Site being addressed by UST[3] program.
GRYZNA-SZN3	Paint storage area	Not an area of concern	There was no visible staining or evidence of release.
GRYZNA-SZN8	Remainder Hawk Missile Site	Not an area of concern	Soil in this area was determined not to have been impacted by former operations at the facility.
GRYZNA-SZN12	Former 500-gallon AST[2] location	No additional investigation required	Site was closed by UST[3] program. No evidence of contamination was documented after tank removal.
GRYZNA-SZN13	Missile launch pads	Not an area of concern	GRYZNA-SZN6 was identified as the missile maintenance area, so there is no reason to believe maintenance activities were conducted at GRYZNA-SZN13.
ZONE B - EAST MARTELLO BATTERY			
GRYZNB-SZN2	Remainder of East Martello property	Not an area of concern	This property was not used for industrial purposes. It is assumed that the septic field located on the site will be addressed in the groundwater assessment of GRYZNB-SZN3 which includes the same area.
ZONE C - TRUMAN ANNEX DRMO[4] WASTE STORAGE AREA			
GRYZNC-SZN2	Building 795 and former IR 2 area	No additional investigation required	Building 795 stored only inert material. Site data from investigations of former IR 2 sufficiently characterized this area.
GRYZNC-SZN5	Remainder of zone, across from Buildings 795 and 284	Not an area of concern	The wooded area does not appear to have seen recent industrial use. This is supported by a map dated 1957. Both buildings were used for inert storage.
ZONE D - TRUMAN ANNEX SEMINOLE BATTERY			
GRYZND-SZN4	Former gas station and Army dispensing facility	Not an area of concern	Site being addressed by UST[3] program.
ZONE E - TRUMAN ANNEX BUILDINGS 102, 103, AND 104			
GRYZNE-SZN6	Inner pier waterfront	Not an area of concern	Buildings and structures are not located in this area and limited operations were associated with this area. Additionally, the pier is covered with concrete and has double retaining walls on the water.
GRYZNE-SZN8	Broken fuel transfer pipeline (north of Building 189)	No additional investigation required	Site being addressed by UST[3] program.
GRYZNE-SZN10	Fuel pipeline	Not an area of concern	Site being addressed by UST[3] program.
GRYZNE-SZN11	Oil water separator	Not an area of concern	Site being addressed by UST[3] program.

TABLE 3-1

BRAC[1] SUBZONES ELIMINATED FROM THE DATA QUALITY OBJECTIVES PROCESS AT NAS KEY WEST
PAGE 2 OF 3

Subzone	Building/Area	Problem Statement	Rationale for Elimination
ZONE F - TRUMAN ANNEX BUILDING 223			
GRYZNF-SZN2	Building 1276- former gas station	Not an area of concern	Site being addressed by UST[3] program.
GRYZNF-SZN4	Zone F-remainder	Not an area of concern	Southern tip of Zone F is not believed to have been impacted because no historic uses have been identified, other than use a parking lot on a map dating from 1957. The area around Building 1287 and the radio tower is assumed not to have been impacted based on existing information.
GRYZNF-SZN5	Zone F razed buildings	Not an area of concern	This part of Zone F is not believed to have been impacted, as buildings appear to have been limited to office and residential uses in the past.
GRYZNF-SZN6	Building 1287 galley AST	Not an area of concern	Site being addressed by UST[3] program.
ZONE H - TRUMBO POINT PIERS D-1 AND D-3			
GRYZNH-SZN1	Pier D-3	No additional investigation, pending review of ABB risk assessment	Primary contamination is assumed to be petroleum related. This will be evaluated in ABB's risk assessment under the UST program. If the risk from petroleum products is low, it will be assumed that any other contamination in negligible.
GRYZNH-SZN2	Trumbo Road area below Pier D-1	Not an area of concern	This has been identified as an area where storage, release, disposal, and/or migration of hazardous substances or petroleum products has occurred, but at concentrations that do not require a removal or remedial action.
GRYZNH-SZN3	Trumbo Road	Not an area of concern	NAS Key West Tank Management Plan is already addressing potential soil and groundwater contamination along Trumbo Road.
GRYZNH-SZN4	Pier D-1 Remainder and Buildings B-27 and B-28	No additional investigation, pending review of ABB risk assessment	Primary contamination is assumed to be petroleum related. This will be evaluated in ABB's risk assessment under the UST program. If the risk from petroleum products is low, it will be assumed that any other contamination in negligible.
GRYZNH-SZN5	Pier D-1 Storage Area	No additional investigation, pending review of ABB risk assessment	Primary contamination is assumed to be petroleum related. This will be evaluated in ABB's risk assessment under the UST program. If the risk from petroleum products is low, it will be assumed that any other contamination in negligible.

TABLE 3-1

BRAC[1] SUBZONES ELIMINATED FROM THE DATA QUALITY OBJECTIVES PROCESS AT NAS KEY WEST

Subzone	Building/Area	Problem Statement	Rationale for Elimination
ZONE I - TRUMBO POINT BUILDING B-48			
GRYZNI-SZN1	Soil	No additional investigation required	Contamination Assessment Report adequately documents the impact of petroleum contamination in this area. Historical records do not indicate any other suspected contaminant classes in this area.
GRYZNI-SZN2	Groundwater	No additional investigation required	Contamination Assessment Report adequately documents the impact of petroleum contamination in this area. Historical records do not indicate any other suspected contaminant classes in this area.
ZONE K - WATERFRONT MAINTENANCE FACILITIES			
GRYZNK-SZN4	Outer and Inner Mole Pier	Not an area of concern	Outer Mole Pier is covered with concrete and considered "capped." Additionally, available information indicates that the fuel line there was never used. Inner Mole Pier is a concrete monolith.
GRYZNK-SZN6	Fuel pipeline	Not an area of concern	Site being addressed by UST[3] program.
GRYZNK-SZN7	Oil water separator	Not an area of concern	Site being addressed by UST[3] program.

1 Base Realignment and Closure
2 Aboveground Storage Tank
3 Underground Storage Tank
4 Defense Reutilization and Marketing Office

TABLE 3-2
UST[1]/AST[2] SITES ON NAS KEY WEST BRAC[3] PROPERTIES

UST[1] or AST[2] Site	Location	Lead	Status
Building 1287 500-gallon AST	Building 1287, Zone F-Truman Annex Building 223 (GRYZNF-SZN6)	NAS Key West	Active: Tank removed and Contamination Assessment Report (CAR) sampling conducted June 1997
2,000-gallon AST	Zone A-Hawk Missile Site (GRYZNA-SZN2)	NAS Key West	Active: Tank removed and CAR sampling conducted June 1997
Oil Water Separator 4,000-gallon UST - Outer Mole Pier	Outer Mole Pier, Zone K-Truman Annex Waterfront Maintenance Facilities (GRYZNK-SZN7)	NAS Key West	Active: Tank removal and CAR needed.
Oil Water Separator 4,000-gallon UST - Inner Mole Pier	Front of Building 103, Zone E-Building 102, 103, and 104 (GRYZNE-SZN11)	NAS Key West	Active: Tank removal and CAR needed.
500-gallon AST	Vietnam Veterans Administration Building Zone A-Hawk Missile Site (GRYZNA-SZN12)	NAS Key West	Closed: Tank removal and No Further Action (NFA) April 1996
Building 103 Electric Power Plant, AST and UST	Building 103, Zone E-Building 102, 103, and 104 (GRYZNE-SZN9)	NAVFACENCOM[4]	Active: Approved Remedial Action Plan (RAP). FY 99 start
Building 189, Pipeline Leak	North of Building 189, Zone E-102, 103, and 104 (GRYZNE-SZN8)	NAVFACENCOM[4]	Active: Approved RAP. FY 99 start
Trumbo Point Fuel Farm	Zone H-Trumbo Point Piers D1 & D3 (GRYZNH)	NAVFACENCOM[4]	Active: CAR complete. Risk Assessment October 1997 and RAP in process due April 1998.
Building 1276, 2 USTs[5]	Building 1276, Zone F-Truman Annex Building 223 (GRYZNF-SZN2)	NAVFACENCOM[4]	Active: Tank removed and CAR funding needed.
Tanks 248 A&B USTs[5]	NW corner, Zone D-Truman Annex Seminole Battery (GRYZND-SZN4)	NAVFACENCOM[4]	Active: Tank removed August 1995 and CAR funding needed.
Abandoned Pipeline	Crosses Zone E to Zone K ending at Outer Mole Pier ((GRYZNE-SZN10 and (GRYZNK-SZN6)	NAVFACENCOM[4]	Active: Closure start date October 1997

1 Underground Storage Tank
2 Aboveground Storage Tank
3 Base Realignment and Closure
4 Naval Facilities Engineering Command, Southern Division
5 NAVFACENCOM acquiring funding for activities due to age of tanks

Step 2: The second step in the DQO process establishes the principal study question for each subzone and presents the various alternative actions that could result from resolving the question. The principal study question identifies the medium and parameter group that is of interest in each subzone. The parameter groups were selected based on existing analytical data for each subzone, as well as the site's history. The environmental medium of which each subzone consists, as well as the parameter groups selected for analysis at each subzone, are presented in Table 3-3.

Step 3: A number of existing sources of information were identified as potentially being of use in site characterization. Reports from previous investigations, maps, and drawings have been located for many of the subzones. In some cases, site visits were also used as information sources.

The additional information needed for decision resolution takes the form of analytical data in most subzones. Standard analytical methods have been selected to characterize each parameter group in Table 3-3. Since the individual parameters vary from method to method, specific methods were selected based on the correlation between the parameters included in the method and known or suspected contaminants on the properties. Table 3-4 identifies the parameters and the analytical methods selected to quantify them. The Laboratory SOW will require that quantitation limits be low enough to meet the action levels selected in Step 5 of the DQO process. In the event this is not technically possible with the selected method, frequency of detection may be used as the primary tool in resolving the decision, rather than a comparison with the selected action level. The partnering team will be actively involved in resolving any decisions of this nature.

A variety of Applicable, Relevant and Appropriate Requirements (ARARs) and Screening Action Levels (SALs) were considered for use as action levels in the decision-making process for the BRAC sites. These various lists of screening criteria were obtained from state agencies, Federal agencies, and research institutions. Additionally, twice the average background concentration of a subset of the data presented in the Comprehensive Background Report (Appendix F of the Supplemental RFI/RI for Eight Sites) was also considered as a potential action level. All potential action levels considered for soil, sediment, surface-water, and groundwater contaminants are included in Appendix B. The actual selection of action levels for use in resolving the decision was performed in Step 5 of the DQO process.

Step 4: The fourth step in the DQO process describes the environmental medium of interest in each subzone and identifies any potential boundaries or limitations that must be recognized and addressed prior to data collection. The spatial boundaries of each subzone are addressed, as well the temporal boundaries. Spatially, the decisions apply to the medium of interest in each subzone. Temporally, it is

TABLE 3-3

PARAMETER GROUPS AND MEDIA OF INTEREST IN THE BRAC[1] SUBZONES AT NAS KEY WEST
PAGE 1 OF 2

Subzone	Building/Area	Medium	Number of Samples	Parameter Group: VOCs	SVOCs	Inorganics	PCBs	Pesticides
Zone A - Hawk Missile Site								
GRYZNA-SZN1	Drainage Area	SO	4	X	X	X		
GRYZNA-SZN4	Sewage Lift Station	SO	4	X	X	X		
GRYZNA-SZN5	Generator Building I-6536	SO	4	X	X	X		
GRYZNA-SZN6	Burnt Building I-6530 - Former Missile Maintenance Bay	SO	4	X	X	X		
GRYZNA-SZN7	Former Transformer Storage Area	SO	4		X	X	X	
GRYZNA-SZN9	Ponds	SD	6	X	X	X		X
GRYZNA-SZN10	Ponds	SW	7		X	X		
GRYZNA-SZN11	Groundwater	GW	12	X	X	X		
Zone B - East Martello Battery								
GRYZNB-SZN1	East Martello Battery	SO	4	X	X	X		
GRYZNB-SZN3	Groundwater	GW	12	X	X	X		
Zone C - Truman Annex Defense Reutilization and Marketing Office (DRMO) Waste Storage Area								
GRYZNC-SZN1	Building 261 Hazardous Material Storage (Former DRMO)	SO	4	X	X	X		X
GRYZNC-SZN3	Former Oil Container (Pre-1942) and Scrap Metal and Refugee Item Storage Areas	SO	4	X	X	X		
GRYZNC-SZN4	Former Scrap Metal Storage Area (Former DRMO)	SO	4			X		
GRYZNC-SZN6	Groundwater	GW	12	X	X	X		
Zone D - Truman Annex Seminole Battery								
GRYZND-SZN1	Seminole Battery	SO	4	X	X	X		
GRYZND-SZN2	Former Grease Racks	SO	4	X	X	X		
GRYZND-SZN3	Groundwater	GW	7	X	X	X		

TABLE 3-3

PARAMETER GROUPS AND MEDIA OF INTEREST IN THE BRAC[1] SUBZONES AT NAS KEY WEST PAGE 2 OF 2

Subzone	Building/Area	Medium	Number of Samples	Parameter Group				
				VOCs	SVOCs	Inorganics	PCBs	Pesticides
Zone E - Truman Annex Buildings 102, 103, and 104								
GRYZNE-SZN1	Former Building Sites South End of Zone E	SO	4	X	X	X		
GRYZNE-SZN2	Former Building 136	SO	4	X	X	X		
GRYZNE-SZN3	Buildings 102, 103, and 104	SO	5	X	X	X		
GRYZNE-SZN4	Transformer Site near Building 675	SO	4		X	X	X	
GRYZNE-SZN5	Former Building Sites North End of Zone E	SO	4	X	X	X		
GRYZNE-SZN7	Groundwater	GW	16	X	X	X		
GRYZNE-SZN9	Building 103	SO	4	X	X	X	X	
Zone F - Truman Annex Building 223								
GRYZNF-SZN1	Former Lube Area	SO	4	X	X	X		
GRYZNF-SZN3	Building 223 Equipment Repair Shop	SO	4	X	X	X		
GRYZNF-SZN7	Groundwater	GW	12	X	X	X		
Zone G - Poinciana Housing								
GRYZNG-SZN1	Poinciana Plaza Housing	SO	4			X		
GRYZNG-SZN2	Groundwater	GW	12	X	X	X		
Zone H - Trumbo Point Piers D-1 and D-3								
GRYZNH-SZN6	Groundwater	GW	4	X		X		
Zone K - Water Front Maintenance Facilities								
GRYZNK-SZN1	Building 149 Port Operations and Hazardous Waste Storage Area	SO	4	X	X	X		
GRYZNK-SZN2	Remainder Public Works Maintenance Facilities	SO	4	X	X	X		
GRYZNK-SZN3	Building 84	SO	4			X		
GRYZNK-SZN5	Groundwater	GW	13	X	X	X		

1 Base Realignment and Closure

TABLE 3-4

PARAMETERS AND ANALYTICAL METHODS FOR BRAC[1] SITE INVESTIGATION AT NAS KEY WEST
PAGE 1 OF 2

Parameters	SW-846 Method
INORGANICS	
Aluminum	6010a/6010b and 7000a
Antimony	6010a/6010b and 7000a
Arsenic	6010a/6010b and 7000a
Barium	6010a/6010b and 7000a
Beryllium	6010a/6010b and 7000a
Cadmium	6010a/6010b and 7000a
Calcium	6010a/6010b and 7000a
Chromium	6010a/6010b and 7000a
Cobalt	6010a/6010b and 7000a
Copper	6010a/6010b and 7000a
Iron	6010a/6010b and 7000a
Lead	6010a/6010b and 7000a
Magnesium	6010a/6010b and 7000a
Manganese	6010a/6010b and 7000a
Mercury	6010a/6010b and 7000a
Nickel	6010a/6010b and 7000a
Potassium	6010a/6010b and 7000a
Selenium	6010a/6010b and 7000a
Silver	6010a/6010b and 7000a
Sodium	6010a/6010b and 7000a
Thallium	6010a/6010b and 7000a
Tin	6010a/6010b and 7000a
Vanadium	6010a/6010b and 7000a
Zinc	6010a/6010b and 7000a
POLYCHLORINATED BIPHENYLS	
Aroclor-1016	8081/8082
Aroclor-1221	8081/8082
Aroclor-1232	8081/8082
Aroclor-1242	8081/8082
Aroclor-1248	8081/8082
Aroclor-1254	8081/8082
Aroclor-1260	8081/8082
PESTICIDES	
4,4'-DDD	8081/8081a
4,4'-DDE	8081/8081a
4,4'-DDT	8081/8081a
Aldrin	8081/8081a
alpha-BHC	8081/8081a
alpha-chlordane	8081/8081a
beta-BHC	8081/8081a
delta-BHC	8081/8081a

Parameters	SW-846 Method
Dieldrin	8081/8081a
Endosulfan I	8081/8081a
Endosulfan II	8081/8081a
Endosulfan sulfate	8081/8081a
Endrin	8081/8081a
Endrin aldehyde	8081/8081a
Endrin ketone	8081/8081a
gamma-BHC (lindane)	8081/8081a
gamma-chlordane	8081/8081a
Heptachlor	8081/8081a
Heptachlor epoxide	8081/8081a
Methoxychlor	8081/8081a
Toxaphene	8081/8081a
SEMIVOLATILE ORGANIC COMPOUNDS	
1,2,4-trichlorobenzene	8270b/8270c
1,2-dichlorobenzene	8260a/8260b
1,3-dichlorobenzene	8260a/8260b
1,4-dichlorobenzene	8260a/8260b
2,4,5-trichlorophenol	8270b/8270c
2,4,6-trichlorophenol	8270b/8270c
2,4-dichlorophenol	8270b/8270c
2,4-dimethylphenol	8270b/8270c
2,4-dinitrophenol	8270b/8270c
2,4-dinitrotoluene	8270b/8270c
2,6-dinitrotoluene	8270b/8270c
2-chloronaphthalene	8270b/8270c
2-chlorophenol	8270b/8270c
2-methyl-4,6-dinitrophenol	8270b/8270c
2-methylnaphthalene	8270b/8270c
2-methylphenol	8270b/8270c
2-nitroaniline	8270b/8270c
2-nitrophenol	8270b/8270c
3 & 4-methylphenol	8270b/8270c
3,3'-dichlorobenzidine	8270b/8270c
3-nitroaniline	8270b/8270c
4-bromophenyl phenyl ether	8270b/8270c
4-chloro-3-methylphenol	8270b/8270c
4-chloroaniline	8270b/8270c
4-chlorophenyl phenyl ether	8270b/8270c
4-nitroaniline	8270b/8270c
4-nitrophenol	8270b/8270c

TABLE 3-4

PARAMETERS AND ANALYTICAL METHODS FOR BRAC[1] SITE INVESTIGATION AT NAS KEY WEST
PAGE 2 OF 2

Parameters	SW-846 Method
Acenaphthene	8270b/8270c
Acenaphthylene	8270b/8270c
Anthracene	8270b/8270c
Benzo(a)anthracene	8270b/8270c
Benzo(a)pyrene	8270b/8270c
Benzo(b)fluoranthene	8270b/8270c
Benzo(g,h,i)perylene	8270b/8270c
Benzo(k)fluoranthene	8270b/8270c
Bis(2-chloroethoxy)methane	8270b/8270c
Bis(2-chloroethyl)ether	8270b/8270c
Bis(2-ethylhexyl)phthalate	8270b/8270c
Butyl benzyl phthalate	8270b/8270c
Carbazole	8270b/8270c
Chrysene	8270b/8270c
Di-n-butyl phthalate	8270b/8270c
Di-n-octyl phthalate	8270b/8270c
Dibenzo(a,h)anthracene	8270b/8270c
Dibenzofuran	8270b/8270c
Diethyl phthalate	8270b/8270c
Dimethyl phthalate	8270b/8270c
Fluoranthene	8270b/8270c
Fluorene	8270b/8270c
Hexachlorobenzene	8270b/8270c
Hexachlorobutadiene	8270b/8270c
Hexachlorocyclopentadiene	8270b/8270c
Hexachloroethane	8270b/8270c
Indeno(1,2,3-cd)pyrene	8270b/8270c
Isophorone	8270b/8270c
n-nitrosodiphenylamine	8270b/8270c
Naphthalene	8270b/8270c
Nitrobenzene	8270b/8270c
Pentachlorophenol	8270b/8270c
Phenanthrene	8270b/8270c
Phenol	8270b/8270c
Pyrene	8270b/8270c
VOLATILE ORGANIC COMPOUNDS	
1,1,1-trichloroethane	8260a/8260b
1,1,2,2-tetrachloroethane	8260a/8260b
1,1,2-trichloroethane	8260a/8260b
1,1-dichloroethane	8260a/8260b
1,1-dichloroethene	8260a/8260b

Parameters	SW-846 Method
1,2-dichloroethane	8260a/8260b
1,2-dichloropropane	8260a/8260b
2-butanone	8260a/8260b
2-hexanone	8260a/8260b
4-methyl-2-pentanone	8260a/8260b
Acetone	8260a/8260b
Benzene	8260a/8260b
Bis(2-chloroisopropyl)ether	8270b/8270c
Bromodichloromethane	8260a/8260b
Bromoform	8260a/8260b
Bromomethane	8260a/8260b
Carbon disulfide	8260a/8260b
Carbon tetrachloride	8260a/8260b
Chlorobenzene	8260a/8260b
Chloroethane	8260a/8260b
Chloroform	8260a/8260b
Chloromethane	8260a/8260b
cis-1,2-dichloroethene	8260a/8260b
cis-1,3-dichloropropene	8260a/8260b
Dibromochloromethane	8260a/8260b
Ethylbenzene	8260a/8260b
Methylene chloride	8260a/8260b
Styrene	8260a/8260b
Tetrachloroethene	8260a/8260b
Toluene	8260a/8260b
trans-1,2-dichloroethene	8260a/8260b
trans-1,3-dichloropropene	8260a/8260b
Trichloroethene	8260a/8260b
Vinyl chloride	8260a/8260b
Xylenes, total	8260a/8260b

1 Base Realignment and Closure

assumed that any analytical data obtained to facilitate the decision-making process are representative of current site conditions. Any constraints on data collection are also addressed in this step. The constraints generally relate to the increased costs that may result from specialized equipment required under certain sampling conditions. For example, a direct-push unit or drill rig may be required for groundwater or soil sampling, and a boat or boat and dredge may be needed in order to obtain surface-water and sediment samples in deep water.

Step 5: This step states the decision rule for each subzone and addresses the elements that contributed to decision rule development. The decision at each site will be based on a comparison of analytical results with action levels. If the comparison is favorable (i.e., mean parameter concentrations are less than the selected action level), then the subzone will be considered "clean" based on the comparison to action levels and a decision of no further action will be made. If the comparison is not favorable (i.e., mean parameter concentrations are greater than the selected action level), then further action in the form of additional sampling, a Remedial Investigation/Feasibility Study (RI/FS), an Interim Remedial Action (IRA) with an RI/FS, or an emergency removal with an RI/FS will be considered.

In order to ultimately resolve the decision, it is necessary to select a media-specific action level for each parameter. Various sources of action levels were evaluated, and six medium-specific tables (shown in Appendix B) were generated depicting the results of the evaluation. For each parameter in a given medium, the selected action level and the source of that value are identified in the final two columns of the tables. Several considerations contributed to the selection process. Legally binding action levels, guidance values, and potentially applicable guidance values from other media were all evaluated as part of the selection process. For inorganics and pesticide compounds, both commonly found in background samples from the vicinity of NAS Key West, twice the average background concentration was also considered as an action level. The decision logic used to compare these various values and to select the action levels is shown in Figure 3-1.

In subzones where action levels are exceeded, consistent and appropriate recommendations must be made. The options include no further action, additional SI work, an RI/FS, an IRA, or an emergency removal. Where risk values are available for the compound(s) in question from the Supplemental RFI/RI investigations performed at NAS Key West during 1996, these values will be used as a basis for determining the appropriate path forward. Where risk values are not available, the path forward will be dictated by the basis of the action level and various site-specific and guidance-specific considerations. The decision logic for this process is outlined in Figure 3-2.

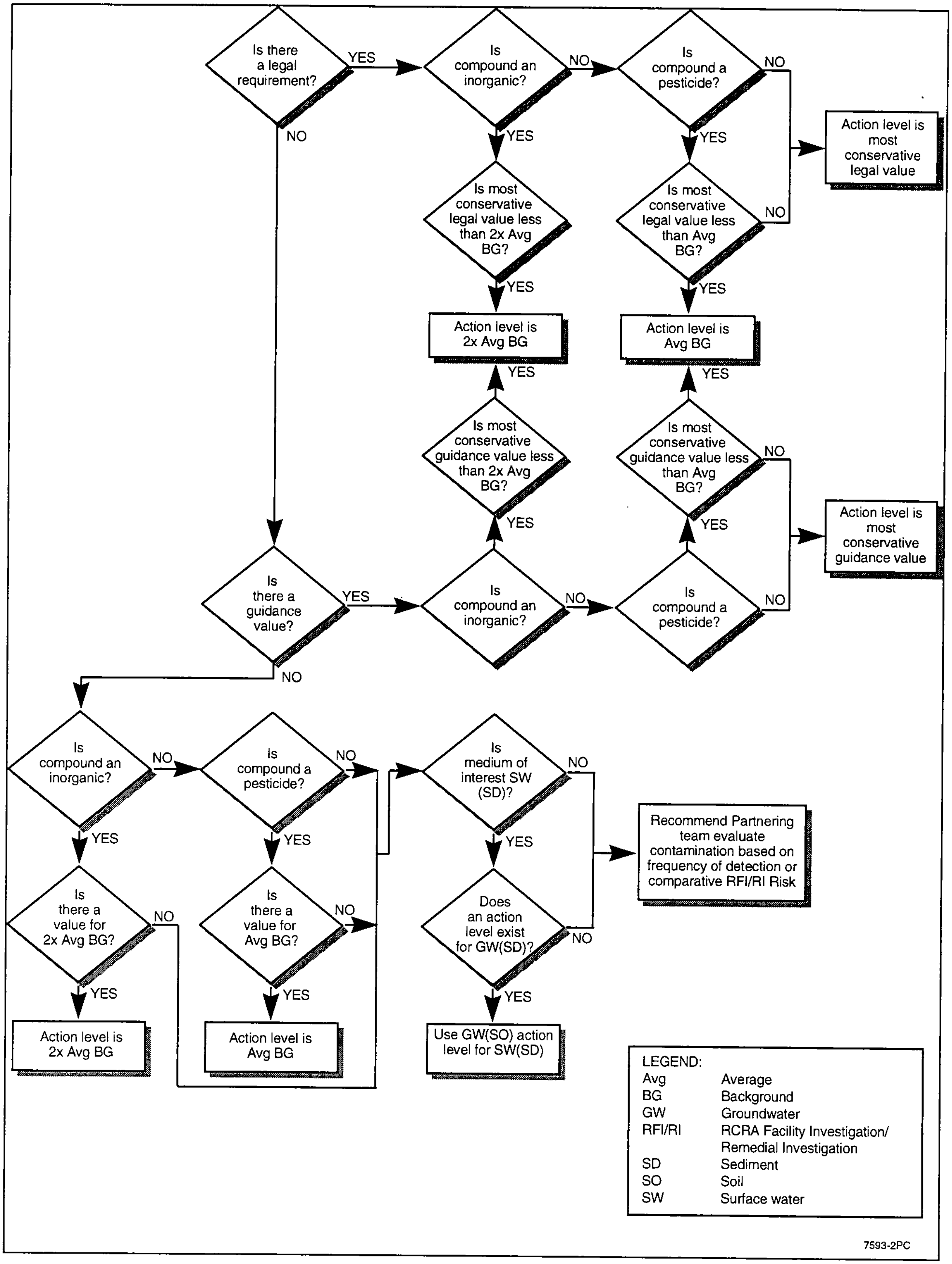

FIGURE 3-1. DECISION LOGIC FOR ACTION LEVEL SELECTION

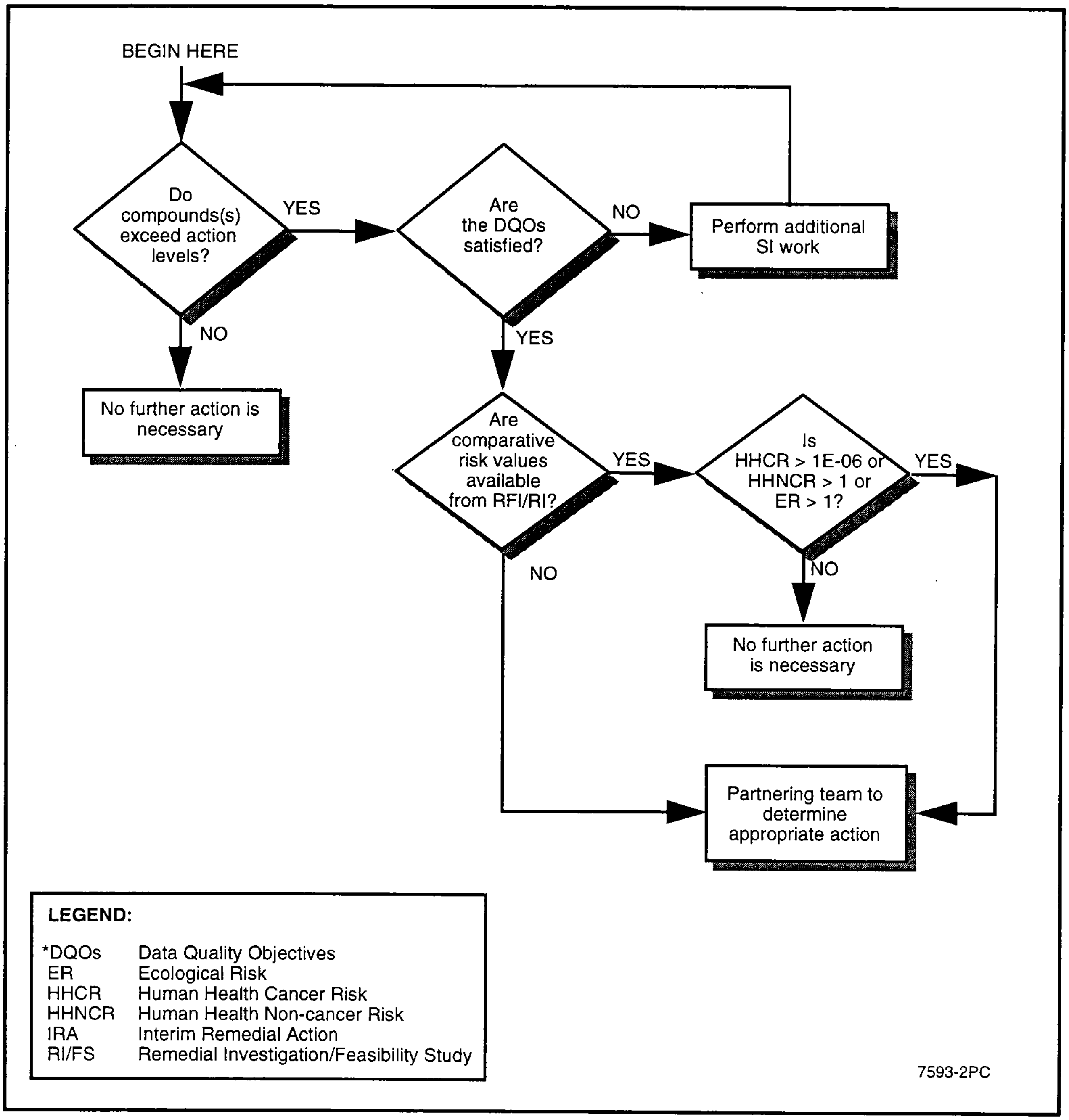

FIGURE 3-2. DECISION LOGIC FOR ESTABLISHING RECOMMENDATIONS AND CONCLUSIONS

Step 6: The sixth step in the DQO process quantifies the level of confidence that is necessary in the decisions resulting from the BRAC SI. The planning team determined that any decisions must have a confidence level of 95 percent. This is the confidence level that is used in the statistical calculations relating to the sample collection process. Additionally, the planning team selected a "grey region" of 1.5 times the selected action level for soil and sediment, which have no legally binding action levels. Statistically speaking, the average parameter concentration may sometimes be greater than the action level and still represent data from a site with an acceptable levels of chemicals. Concentrations that fall within the "grey region" may still be considered representative of uncontaminated data. This provides a greater degree of certainty in any decision to pursue further action in a subzone. No grey area was established for the screening of surface-water or groundwater contamination because both media have legally binding action levels.

Step 7: The seventh and final step in the DQO process uses the information from the preceding steps to choose the optimal design for data collection. A combination of simple random and biased sampling was the data collection design of choice. Simple random sampling will be used on subzones with little or no previous information, and biased sampling will be used for subzones with existing information.

The formula for determining the sample size for each medium was based on this data collection design and the hypothesis test. As a recommendation in EPA's DQO Process Guidance (1994), the Gilbert's equation was selected as the standard formula to select the optimal sample size. The equation was selected because it allowed for the selection of an acceptable error rate and a margin of error. Therefore, the partnering team selected an acceptable error rate of 5 percent or a confidence level of 95 percent. It selected a grey region 1.5 times the selected action level for soil and sediment and no grey region for the screening of surface-water or groundwater contamination, since both media have legally binding action levels. The equation also utilizes the variance for parameters from a subset of the NAS Key West background data (B&R Environmental, 1997b). The data subset includes data from 1996 B&R Environmental and 1995 BEI sampling efforts at NAS Key West. The subset of background data is found in Appendix B.

The computations performed utilizing the Gilbert equation involved Student's t-test performed for multiple iteration rather than the less vigorous z-score approximation. As a result, more realistic optimum sample numbers could be generated for the subzones. Based on the equation, the optimal number of soil, sediment, surface-water, and groundwater samples is four, six, seven, and two, respectively. The results of the Gilbert's equation computations are found in Appendix B. Since at least three samples are needed in order to perform statistical analyses on a group of data, three groundwater samples will be taken in each groundwater subzone. Each sample from a given subzone will be tested for the parameter groups specified in Table 3-3, under the methods specified in Table 3-4.

4.0 SAMPLING AND ANALYSIS PLAN

4.1 SAMPLING OBJECTIVES

The analytical results from environmental samples collected in the 10 BRAC Zones during the SI will support the evaluation of the human health or environmental threats that may be posed by the BRAC properties. In order to facilitate the decision-making process, the 10 BRAC Zones were divided into subzones based on the site's history of use and the environmental media present. As a part of the DQO process discussed in Section 3.0, all subzone boundaries were reviewed, discussed and agreed upon by the regulators and the Navy as part of the Partnering effort for NAS Key West. Ultimately, sample results will be used to determine whether further study and characterization, possibly leading to a remedial action, are needed in each given subzone.

4.2 SAMPLE TYPES AND FREQUENCY

The 10 BRAC Zones are divided into subzones based on the site's history of use and the environmental media present there. As discussed under the DQO process, the base sample size for each environmental medium was determined statistically in order to provide a mathematical basis for conclusions. The initial samples in each subzone will be biased when information is known about the subzone or random when no information is known about the subzone. When the results of these initial samples indicate a need, additional biased samples may be collected in order to better characterize specific areas. Table 3-3 presents a summary of all subzones where samples are to be collected, including the total number of samples and the analyses that have been selected.

4.2.1 Soil

Soil is by far the most prevalent medium in the 10 BRAC Zones. Twenty-three soil subzones will require sampling and analysis under the BRAC SI. In order to provide a statistically significant basis for conclusions, at least 4 soil samples will be collected within each soil subzone, yielding at least 92 soil samples.

4.2.2 Sediment

A single sediment subzone will require sampling and analysis under the BRAC SI. This subzone (GRYZNA-SZN9) includes the ponds at the Hawk Missile Site and corresponds with GRYZNA-SZN10, which addresses surface water in the same area. In order to provide a statistically significant basis for conclusions, at least six sediment samples will be collected from the ponds at the Hawk Missile Site.

4.2.3 Surface Water

A single surface-water subzone requiring sampling and analysis under the BRAC SI has been identified. This subzone (GRYZNA-SZN10) includes the ponds at the Hawk Missile Site and corresponds with the single sediment subzone, as discussed above. In order to provide a statistically significant basis for conclusions, at least seven surface-water samples will be collected from the ponds at the Hawk Missile Site.

4.2.4 Groundwater

Due to the generally homogeneous nature of subsurface features and the propensity for contaminant migration, groundwater is always considered at the zone level. Therefore, the nine groundwater subzones that have been identified for sampling and analysis under the BRAC SI correspond geographically to their respective zones. Groundwater screening samples will be collected from each groundwater subzone in order to facilitate the future placement of three permanent monitoring wells that are required in order to provide a statistical basis for conclusions in each groundwater subzone. The screening sample results will be reviewed by the partnering team and used to locate the permanent monitoring wells at each site. Since FDEP does not accept conclusions based on data from temporary well points, the data from the screening samples will be used only as a tool in the placement of permanent monitoring wells, not in making recommendations and conclusions in the SI. Samples were generally placed on a 200 foot by 200 foot grid, resulting in an average of nine screening samples per subzone. The screening samples were sited in order to achieve geographical coverage of the groundwater subzones, thus larger areas may require more than nine samples, while smaller areas may require fewer than nine. The screening samples will include groundwater samples from direct push sample points, drilled temporary well points (if necessary), and existing permanent monitoring wells. The direct push method of groundwater sampling is preferable, but where the geologist determines that field conditions preclude this method, temporary well points will be drilled instead. A total of 72 groundwater screening samples will be collected, and 28 permanent monitoring wells will be sampled.

4.3 SAMPLE LOCATIONS

B&R Environmental used either a biased sampling approach or a stratified random sampling approach in order to locate the environmental samples within each subzone. The biased sampling approach placed samples in the subzone when there was information available indicating the likely location of contaminated media. The stratified random sampling approach placed samples in a random fashion when no information or indication of contaminated media was available. The design for both approaches requires that the BRAC Zones be divided into geographical subzones that are expected to yield statistically similar results. Based on the DQO process for the Site Investigation Workplan, as discussed under Sections 3.2 and 4.0, a total of 37 subzones have been identified for investigation as part of this field effort. When the stratified random sampling approach was used, soil, sediment, and surface-water samples were placed using a numbered grid, a map of applicable subzones, and Microsoft Excel's random number generator. Groundwater screening samples were placed throughout each Zone based on a grid no larger than 200 feet by 200 feet. In areas where a building, a road, or a concrete structure would preclude sample collection, the sample location grid was drawn around these features. In cases where such a feature was not considered in sample placement and interferes with the collection of a sample as specified in this Workplan, professional judgment will be used to relocate the sample to the nearest non-obstructed location within the subzone. The locations of the subzones and the associated environmental samples are discussed below, on a zone-by-zone basis.

4.3.1 <u>Truman Annex (Five Zones)</u>

Five Zones are located within Truman Annex-- Zone C (DRMO Waste Storage Area), Zone D (Seminole Battery), Zone E (Buildings 102, 103, and 104), Zone F (Building 223), and Zone K (Waterfront Maintenance Buildings). Figure 2-3 provides an overview of the Truman Annex BRAC sites. Subzones that require sampling and analysis under the BRAC SI are shown, as well as subzones that were determined, based on existing information, either not to be areas of concern or not to require further investigation under the BRAC SI. A separate discussion of each zone is presented below. Since groundwater is interconnected between adjacent zones, a map showing the relationship of all groundwater screening samples at Truman Annex is provided in Figure 4-1. For greater detail, the zone-specific groundwater figures in Sections 4.3.1.1 through 4.3.1.5 should be referenced.

4.3.1.1 Zone C (Truman Annex DRMO Waste Storage Area)

Four subzones within Zone C require sampling and analysis under the BRAC SI. GRYZNC-SZN1 [Building 261 Hazardous Material Storage (Former DRMO)], GRYZNC-SZN3 [Former Oil Container (Pre-1942) and Scrap Metal and Refugee Item Storage Areas], and GRYZNC-SZN4 [Former Scrap Metal Storage Area (Former DRMO)] were identified as soil subzones, and the four sample locations within each subzone are shown on Figures 4-2 through 4-4, respectively. The placement of screening samples in the groundwater subzone, GRYZNC-SZN6, is shown on Figure 4-5.

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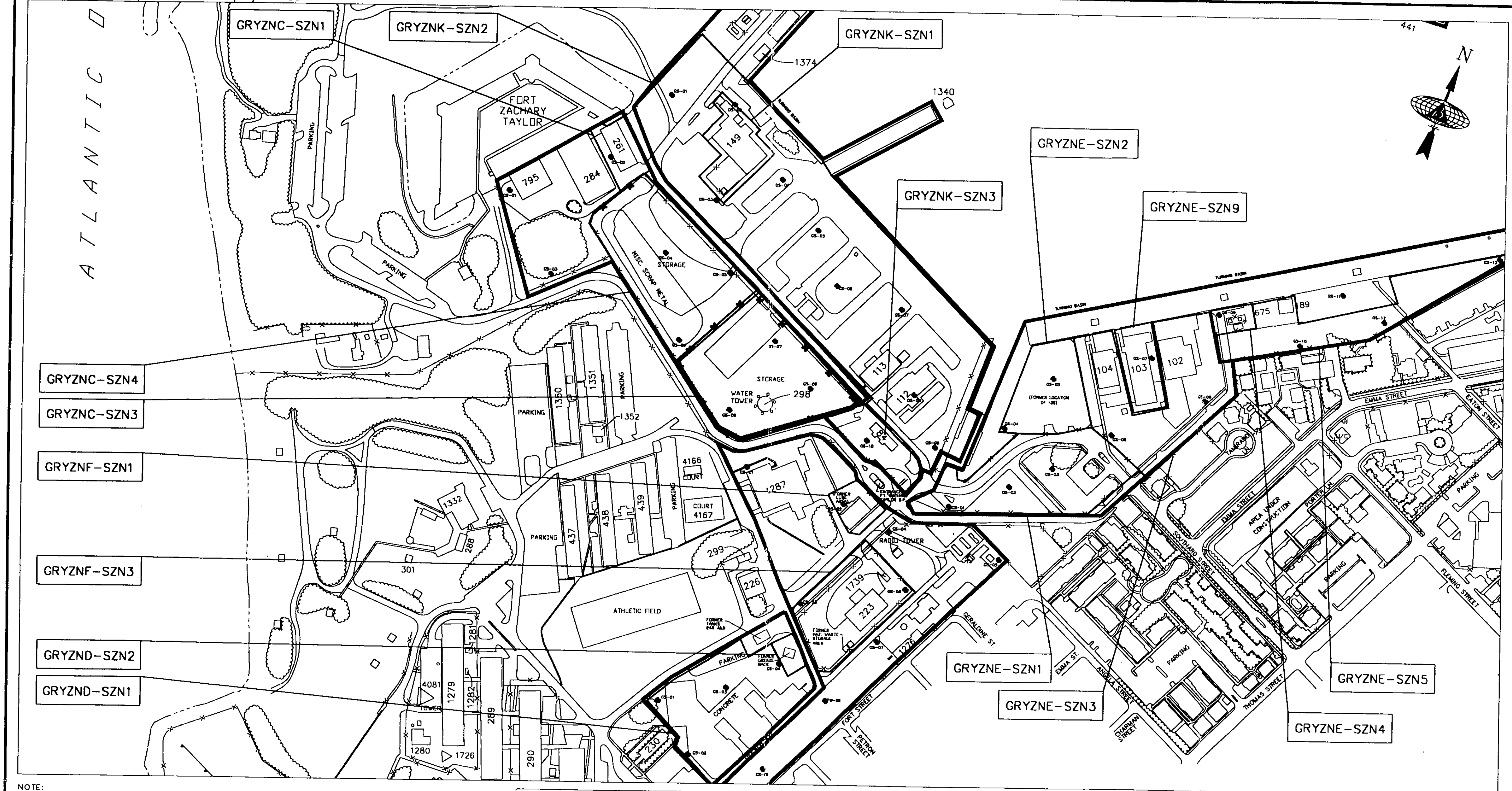

NOTE:

GRYZNC-SZN6 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE C)
GRYZND-SZN3 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE D)
GRYZNE-SZN7 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE E)
GRYZNF-SZN7 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE F)
GRYZNK-SZN5 – GROUNDWATER SUBZONE (INCLUDES ALL OF ZONE K)
GRYZNE-SZN10 – FORMER FUEL PIPELINE (AREA NOT OF CONCERN)
GRYZNK-SZN6 – FORMER FUEL PIPELINE (AREA NOT OF CONCERN)

LEGEND:

- GROUNDWATER SCREENING SAMPLE LOCATIONS
- FORMER FUEL PIPELINE (AREA NOT OF CONCERN)

SITE MANAGER: CMB	CHECKED BY: DSF
DRAWN BY: TCB/MBS	DRAWING DATE: 9/15/97
SURVEYED BY:	SURVEY DATE:
SCALE: 1"=200'	
CAD DWG. NO.: 97011202.DWG	

BROWN & ROOT ENVIRONMENTAL

FIGURE 4-1.
ZONE C, D, E, F, & K TRUMAN ANNEX
GROUNDWATER SCREENING SAMPLES

NAVAL AIR STATION
KEY WEST, FLORIDA

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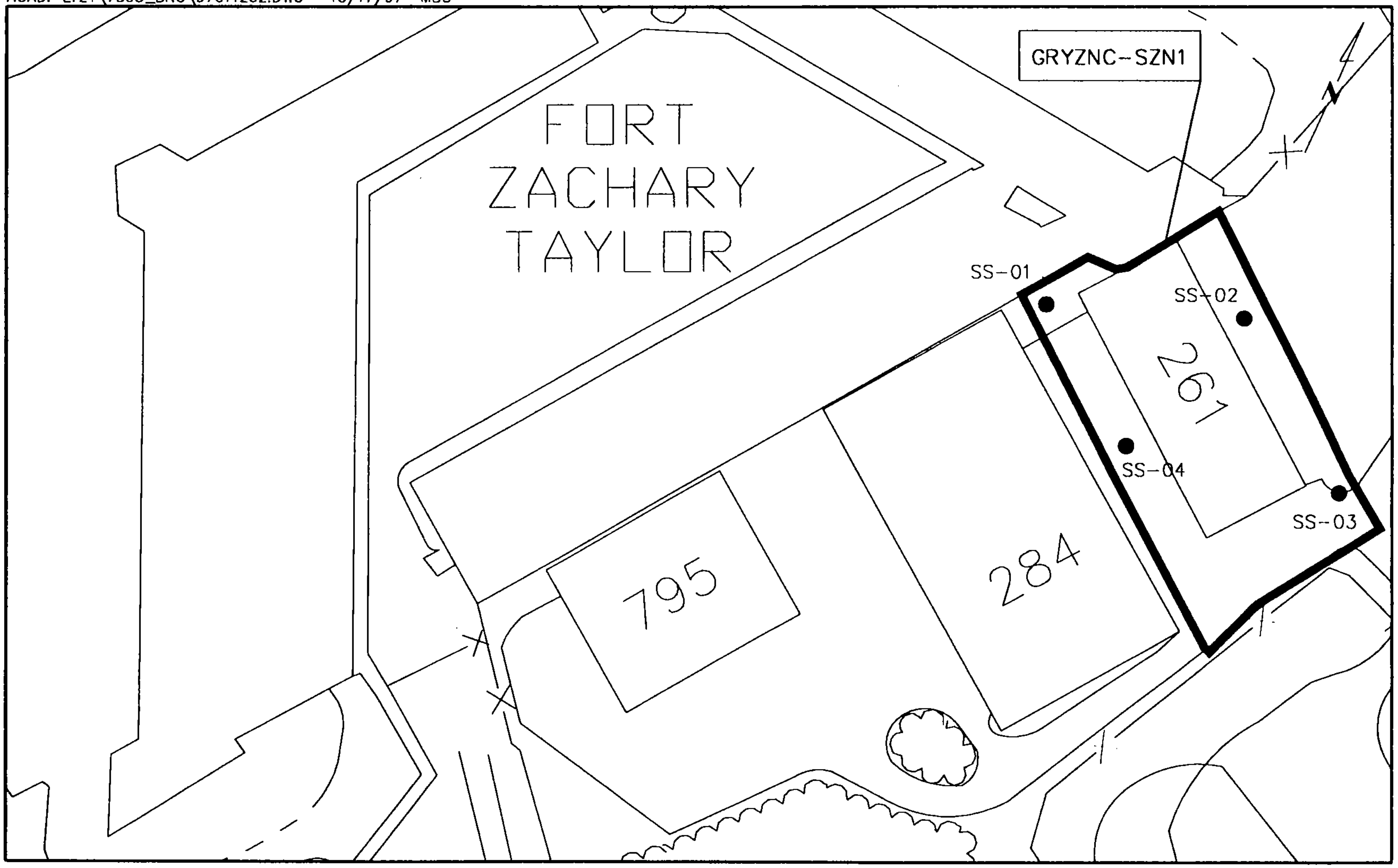

BROWN & ROOT ENVIRONMENTAL

0 40 80 120
SCALE IN FEET (APPROX.)

LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-2. TRUMAN ANNEX
ZONE C - SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

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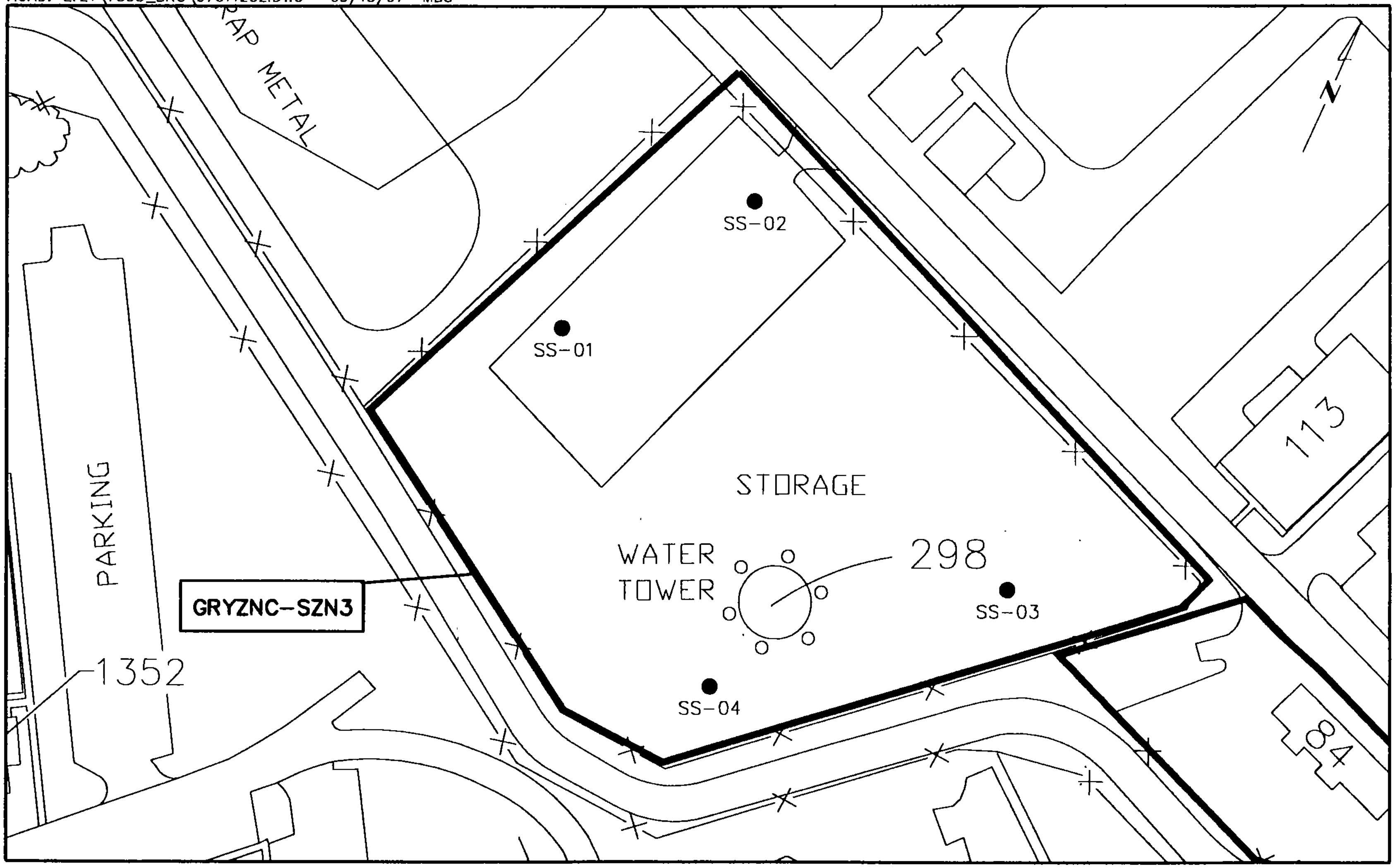

BROWN & ROOT ENVIRONMENTAL

0 50 100 150
SCALE IN FEET (APPROX.)

LEGEND
- ● SOIL-BORING SAMPLE LOCATION
- ▬ SUBZONE BOUNDARY

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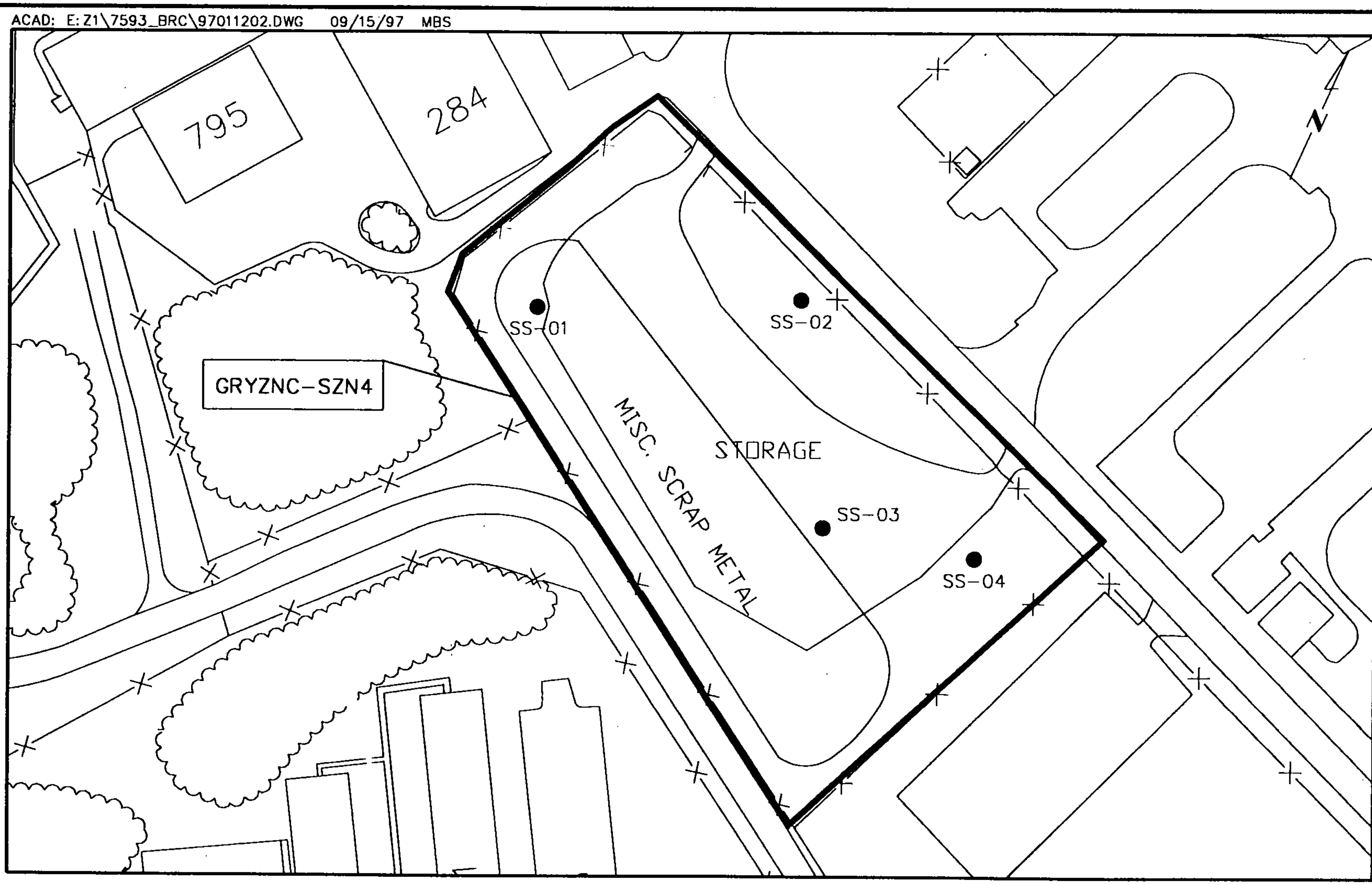
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 09/12/97 REV.: 0
FILE NAME: 97011202.DWG

FIGURE 4-3. TRUMAN ANNEX
ZONE C – SOIL SUBZONE 3

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

AIK-97-0124



BROWN & ROOT ENVIRONMENTAL

0 60 120 180

SCALE IN FEET (APPROX.)

LEGEND

● SOIL-BORING SAMPLE LOCATION

▬ SUBZONE BOUNDARY

DRAWN BY: MDB

CHECKED BY: DK

SCALE: AS SHOWN

DATE: 09/12/97 REV.: 0

FILE NAME: 97011202.DWG

FIGURE 4-4. TRUMAN ANNEX ZONE C – SOIL SUBZONE 4

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

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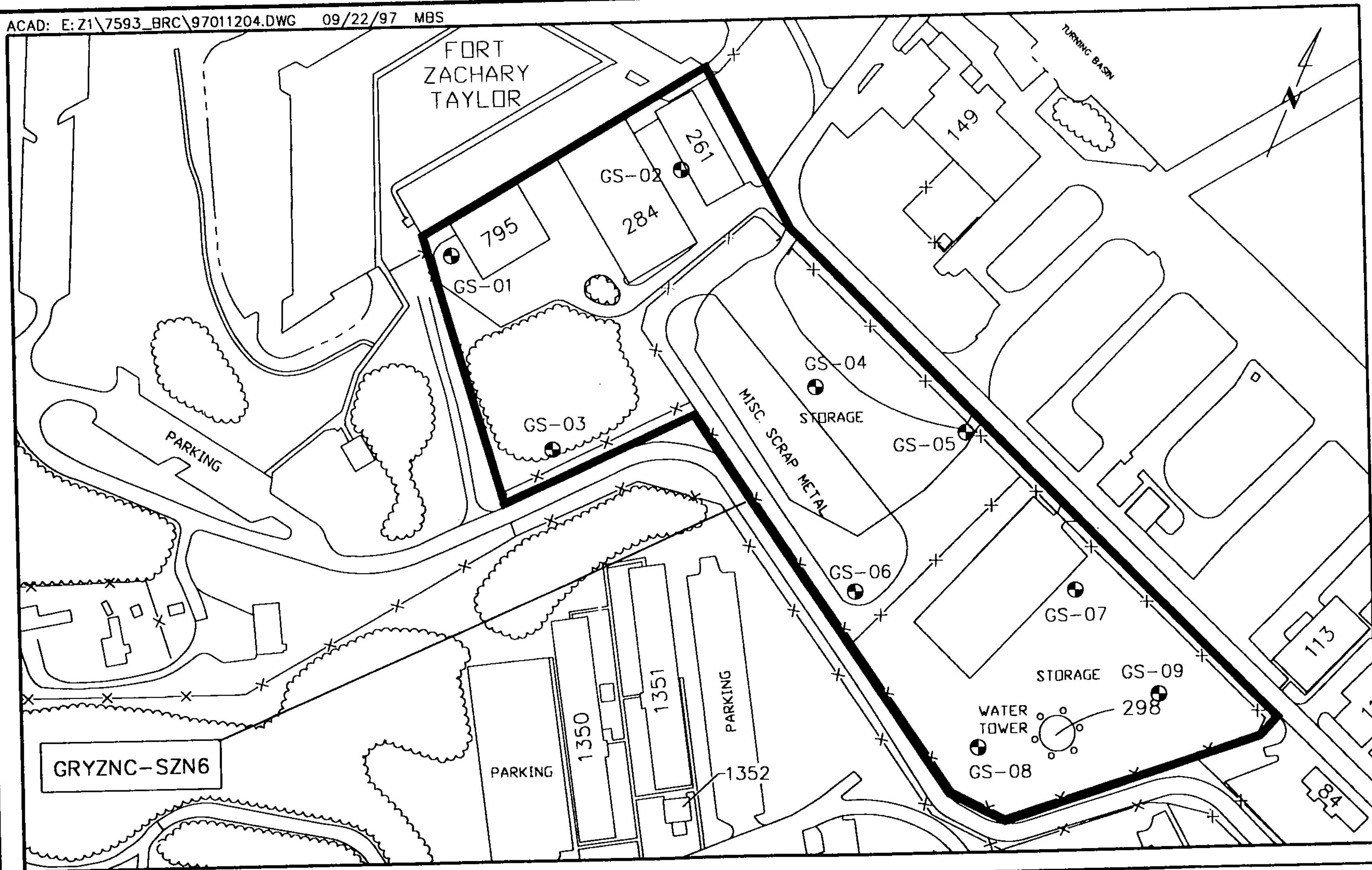

BROWN & ROOT ENVIRONMENTAL

0 100 200 300

SCALE IN FEET (APPROX.)

LEGEND

GROUNDWATER SCREENING SAMPLE LOCATIONS

SUBZONE BOUNDARY

DRAWN BY: MDB

CHECKED BY: DK

SCALE: AS SHOWN

DATE: 08/12/97 REV.: 0

FILE NAME: 97011204.DWG

FIGURE 4-5. TRUMAN ANNEX ZONE C - GROUNDWATER SUBZONE 6

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

4.3.1.2 Zone D (Truman Annex Seminole Battery)

Three subzones within Zone D require sampling and analysis under the BRAC SI. GRYZND-SZN1 (Seminole Battery) and GRYZND-SZN2 (Former Grease Racks) were identified as soil subzones, and the four sample locations within each subzone are shown on Figures 4-6 and 4-7, respectively. The placement of screening samples in the groundwater subzone, GRYZND-SZN3, is shown on Figure 4-8.

4.3.1.3 Zone E (Truman Annex Buildings 102, 103, and 104)

Seven subzones within Zone E require sampling and analysis under the BRAC SI. GRYZNE-SZN1 (Former Building Sites South End of Zone E), GRYZNE-SZN2 (Former Building 136), GRYZNE-SZN3 (Buildings 102, 103, and 104), GRYZNE-SZN4 (Transformer Site Near Building 675), GRYZNE-SZN5 (Former Building Sites North End of Zone E), and GRYZNE-SZN9 (Building 103) were identified as soil subzones, and the four sample locations within each subzone are shown on Figures 4-9 through 4-12. The placement of screening samples in the groundwater subzone, GRYZNE-SZN7, is shown on Figure 4-13.

4.3.1.4 Zone F (Truman Annex Building 223)

Three subzones within Zone F require sampling and analysis under the BRAC SI. GRYZNF-SZN1 (Former Lube Area) and GRYZNF-SZN3 (Building 223 Equipment Repair Shop) were identified as soil subzones, and the four sample locations within each subzone are shown on Figures 4-14 and 4-15, respectively. The placement of screening samples in the groundwater subzone, GRYZNF-SZN7, is shown on Figure 4-16.

4.3.1.5 Zone K (Water Front Maintenance Facilities)

Four subzones within Zone K require sampling and analysis under the BRAC SI. GRYZNK-SZN1 (Building 149, Port Operations and Hazardous Waste Storage Area), GRYZNK-SZN2 (Remainder Waterfront Maintenance Facilities), and GRYZNK-SZN3 (Building 84) were identified as soil subzones, and the four sample locations within each subzone are shown on Figures 4-17 through 4-19, respectively. The placement of screening samples in the groundwater subzone, GRYZNK-SZN5, is shown on Figure 4-20.

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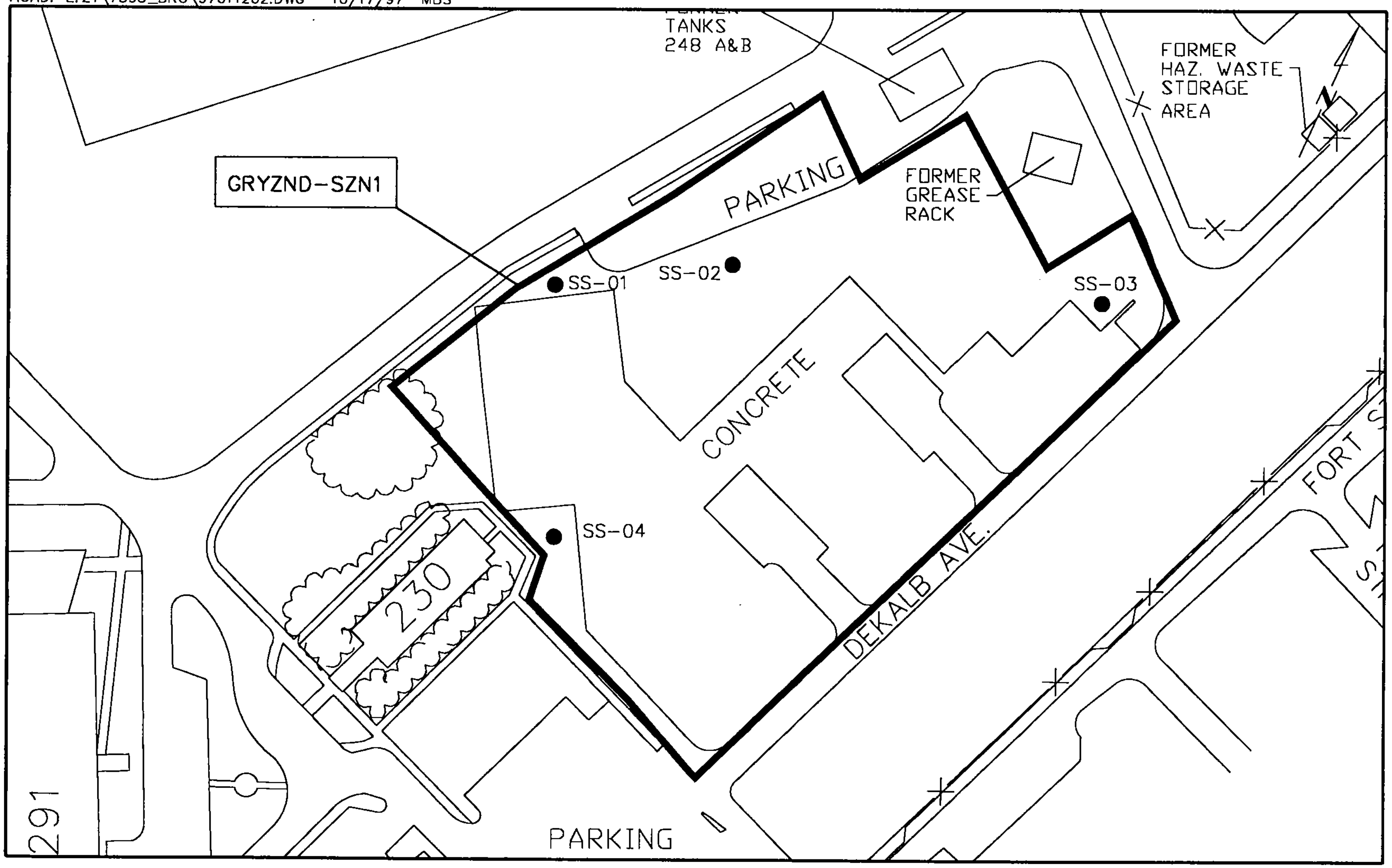

BROWN & ROOT ENVIRONMENTAL

0 50 100 150
SCALE IN FEET (APPROX.)

LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

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SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4–6. TRUMAN ANNEX ZONE D – SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

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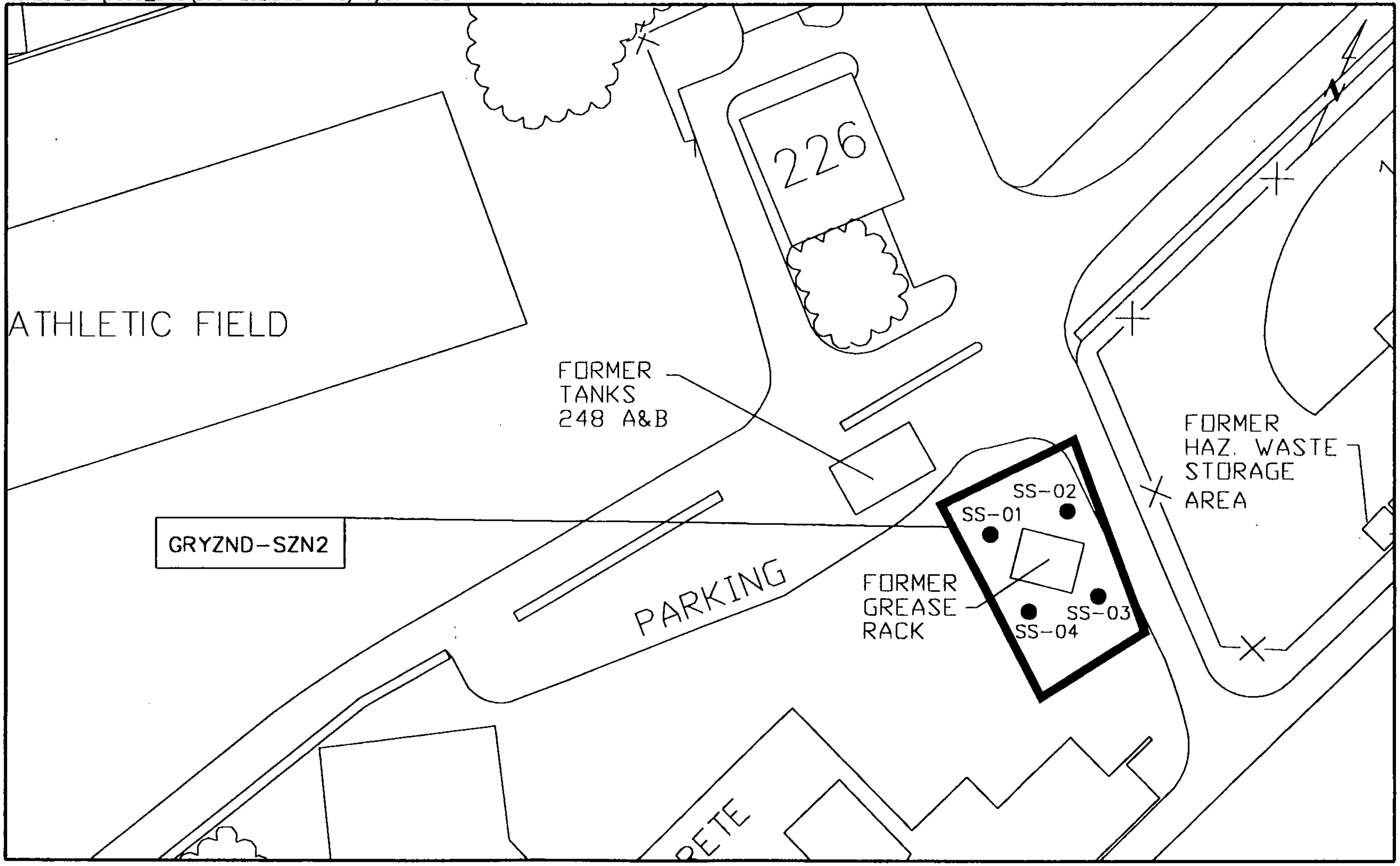

BROWN & ROOT ENVIRONMENTAL

0 60 120 180
SCALE IN FEET (APPROX.)

LEGEND

● SOIL-BORING SAMPLE LOCATION

▬ SUBZONE BOUNDARY

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DATE: 09/12/97	REV.: 0
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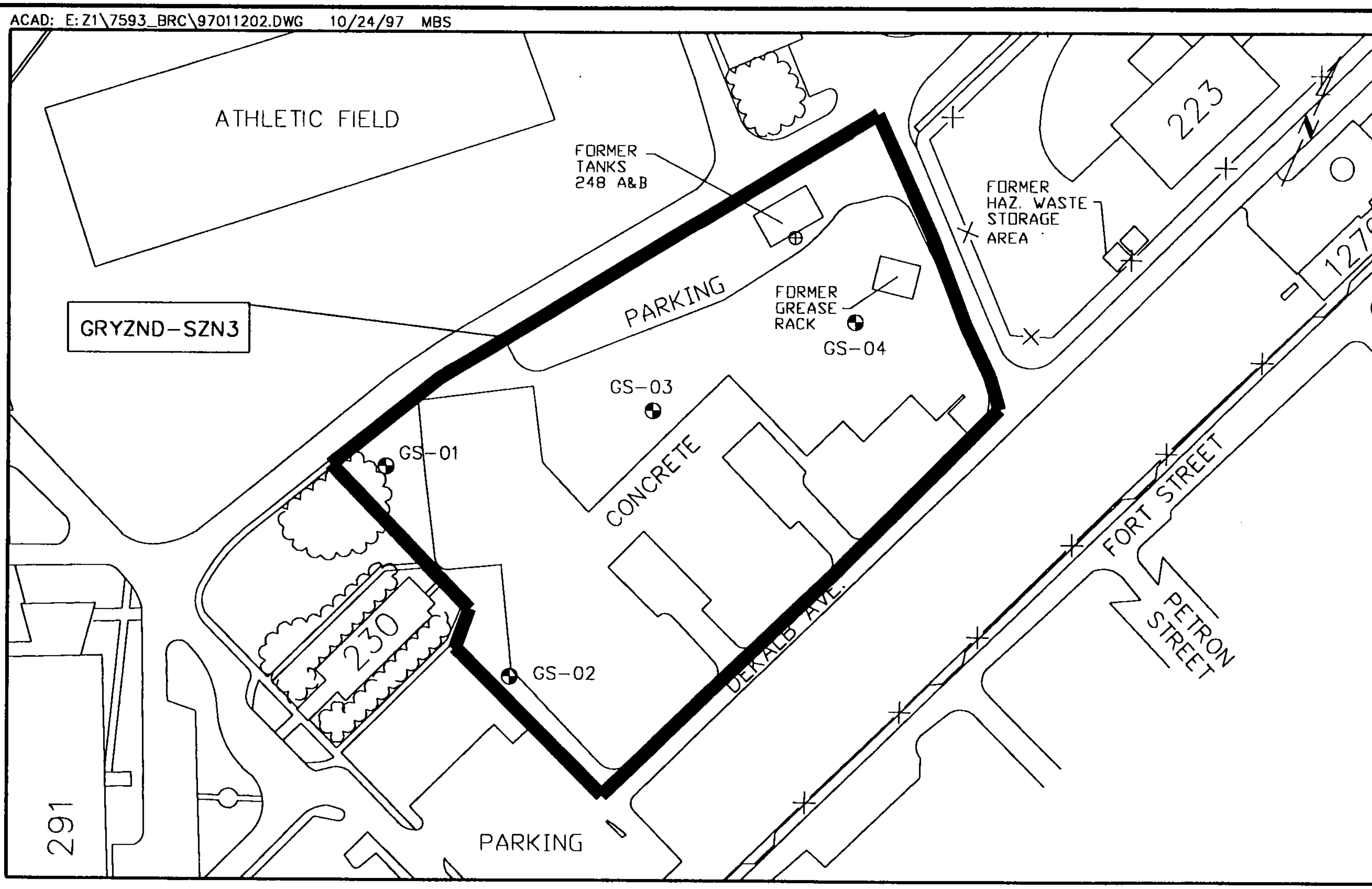
FIGURE 4-7. TRUMAN ANNEX ZONE D - SOIL SUBZONE 2

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL



BROWN & ROOT ENVIRONMENTAL

0 50 100 150
SCALE IN FEET (APPROX.)

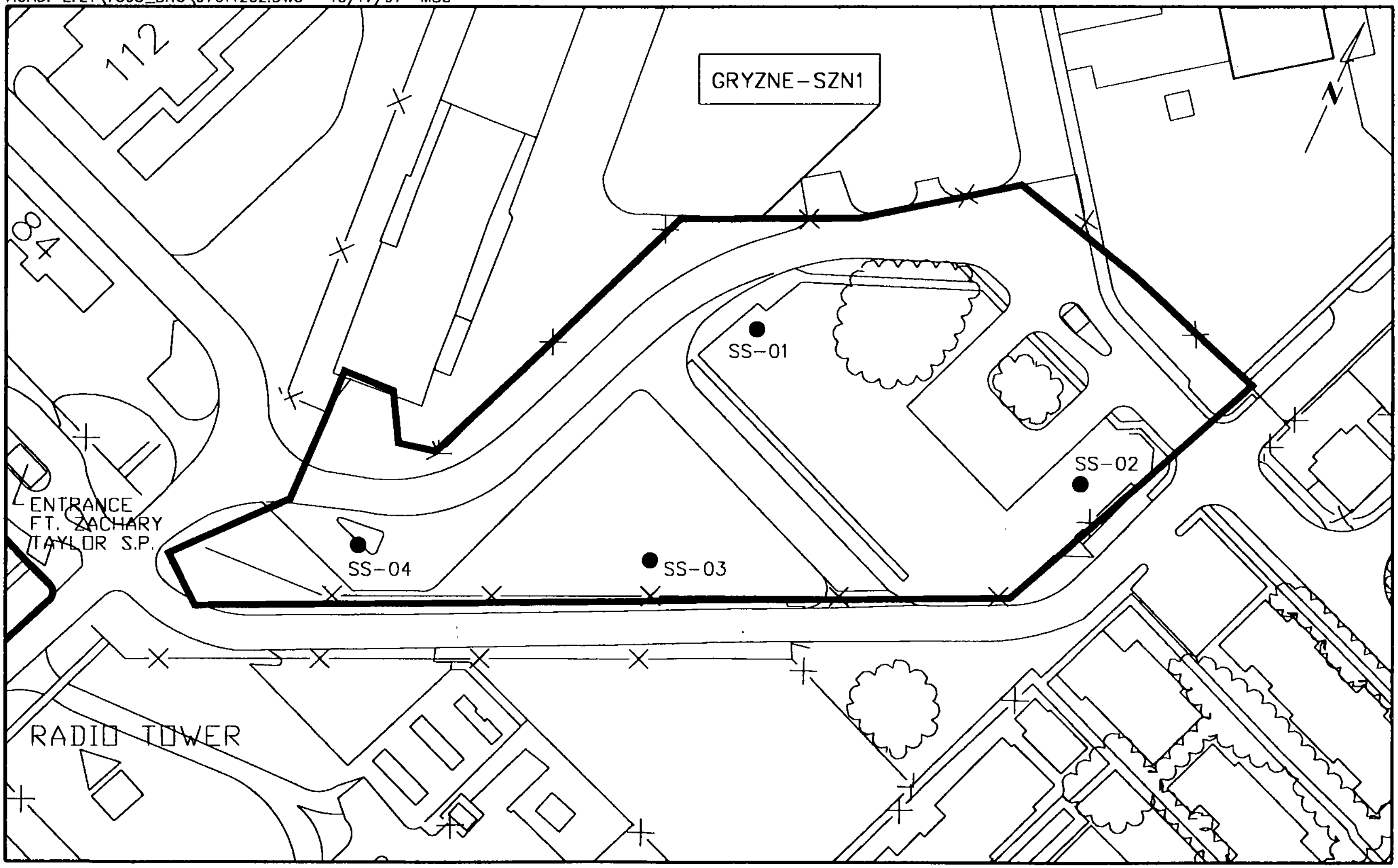
LEGEND
- GROUNDWATER SCREENING SAMPLE LOCATIONS
- EXISTING MONITORING WELLS
- SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 08/12/97	REV.: 0
FILE NAME: 97011204.DWG	

FIGURE 4-8. TRUMAN ANNEX ZONE D - GROUNDWATER SUBZONE 3

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/17/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 50 100 150
SCALE IN FEET (APPROX.)

LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

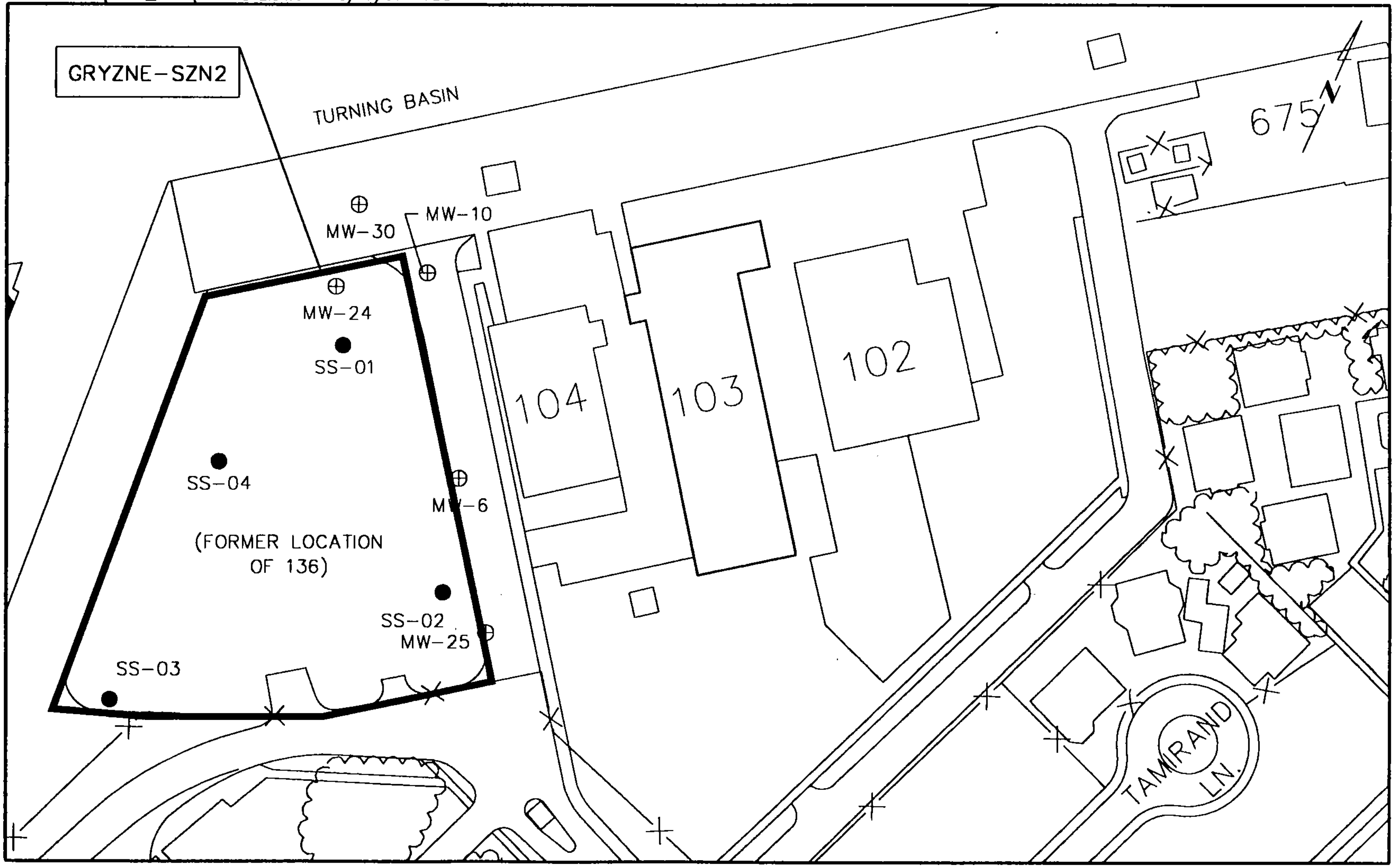
DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-9. TRUMAN ANNEX
ZONE E - SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

AIK-97-0124

ACAD: E:Z1\7593_BRC\97011202.DWG 10/17/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 50 100 150
SCALE IN FEET (APPROX.)

LEGEND
- ● SOIL-BORING SAMPLE LOCATION
- ⊕ EXISTING MONITORING WELLS
- ▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-10. TRUMAN ANNEX
ZONE E - SOIL SUBZONE 2

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

CTO 0032

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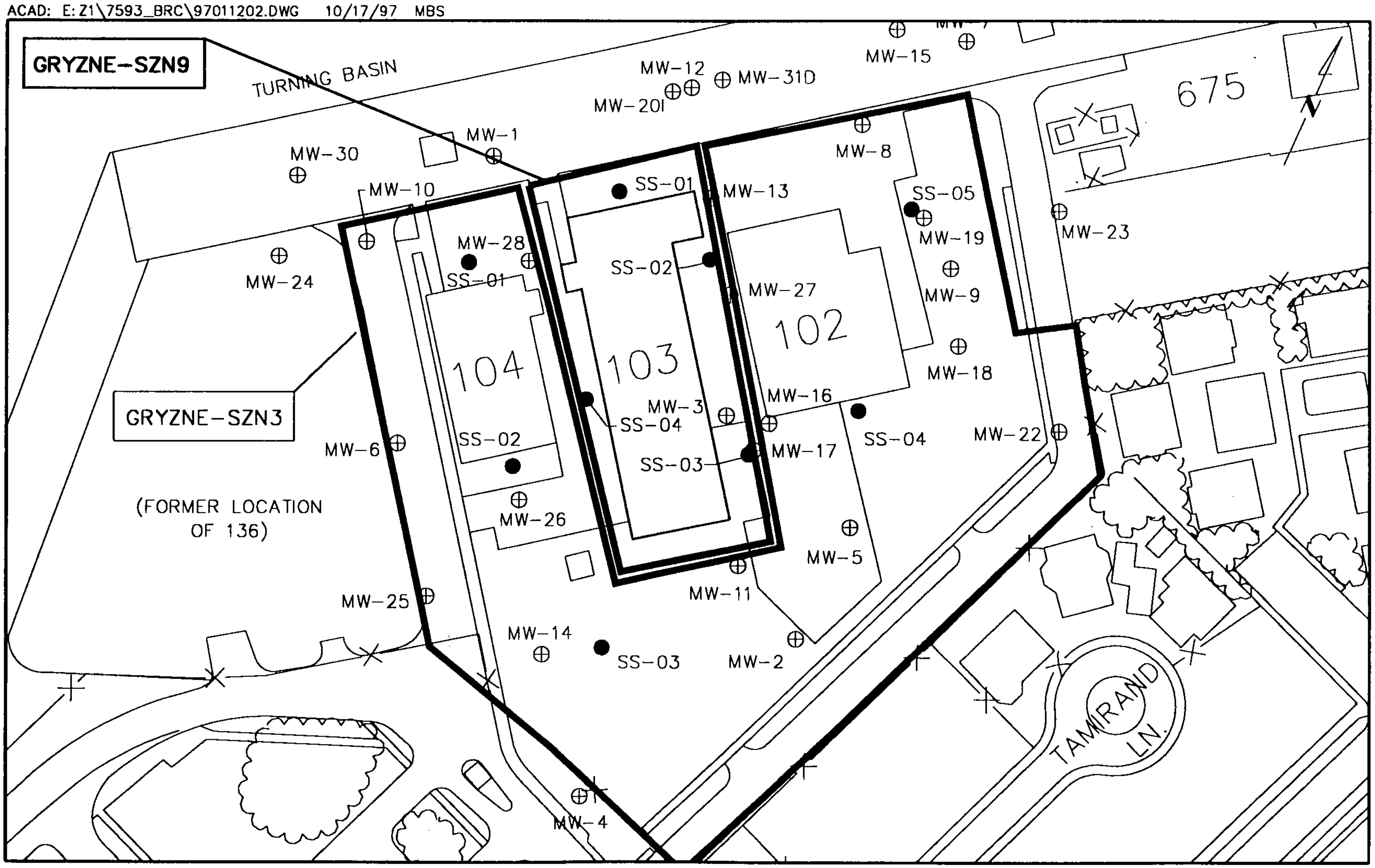
11/05/97

ACAD: E:Z1\7593_BRC\97011202.DWG 10/17/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 60 120 180
SCALE IN FEET (APPROX.)

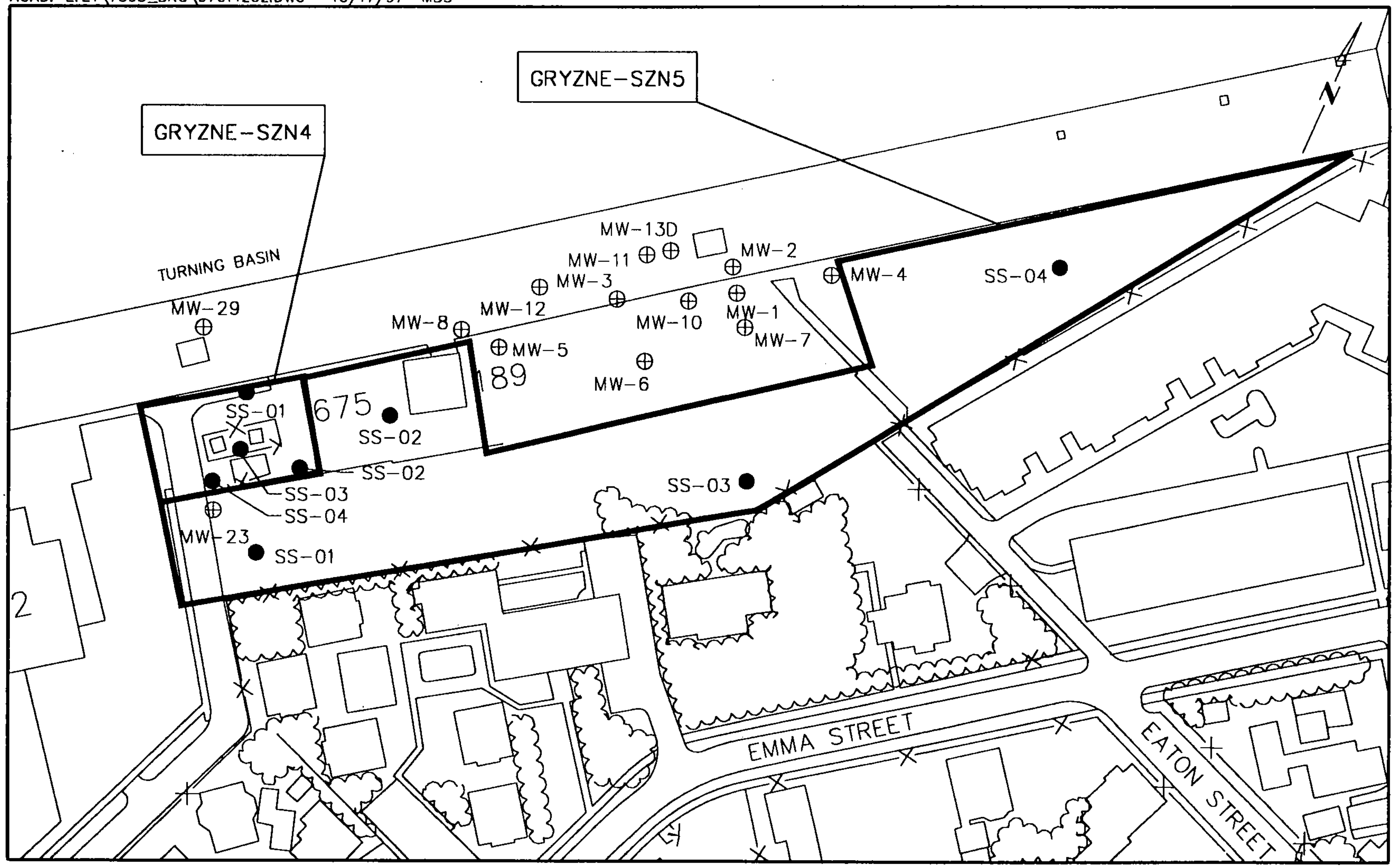
LEGEND
- ● SOIL-BORING SAMPLE LOCATION
- ⊕ EXISTING MONITORING WELLS
- ▬ SUBZONE BOUNDARY

DRAWN BY: MDB
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 09/12/97 REV.: 0
FILE NAME: 97011202.DWG

FIGURE 4-11. TRUMAN ANNEX ZONE E – SOIL SUBZONE 3 & 9

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/17/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 60 120 180
SCALE IN FEET (APPROX.)

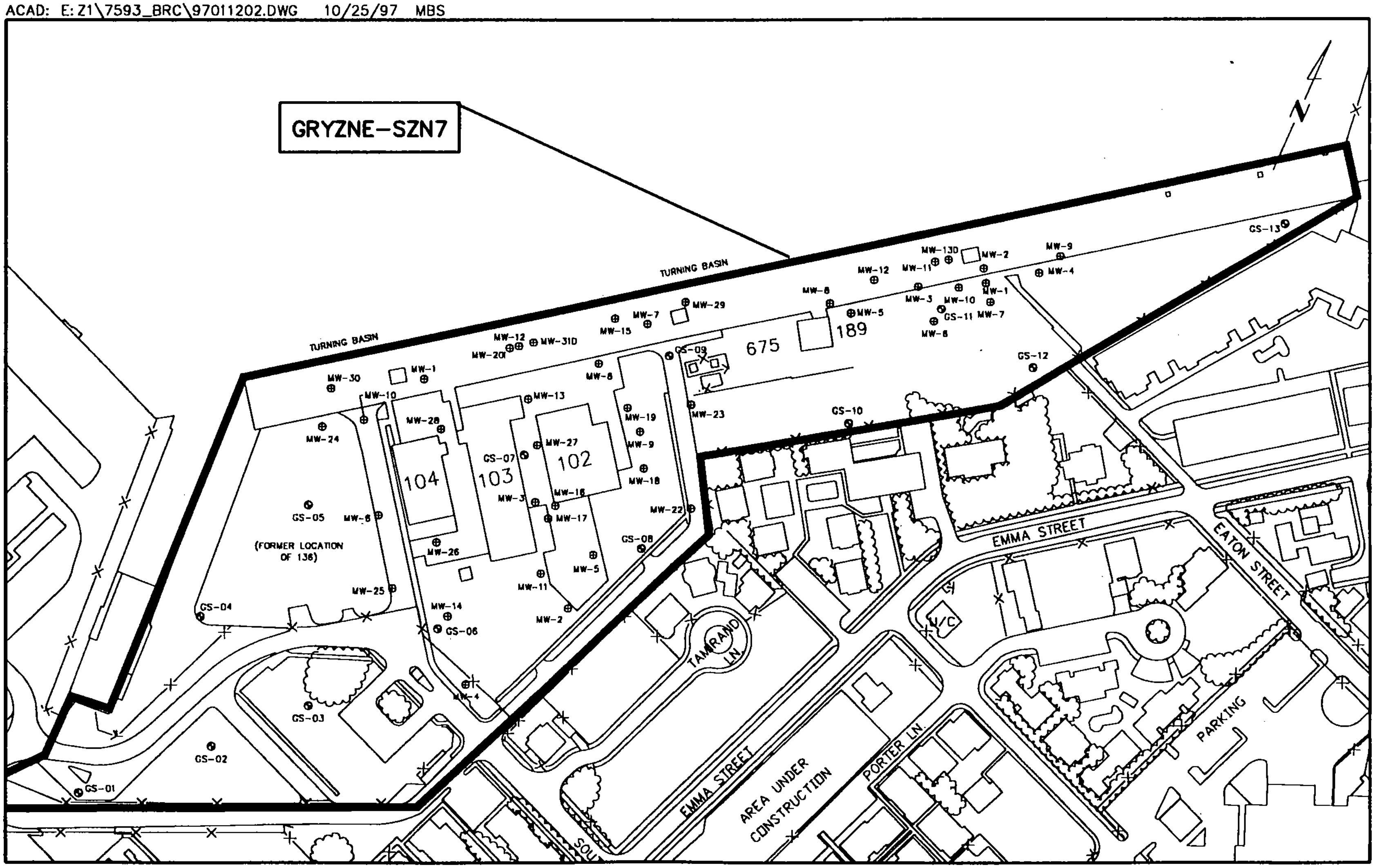
LEGEND
● SOIL-BORING SAMPLE LOCATION
⊕ EXISTING MONITORING WELLS
▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-12. TRUMAN ANNEX
ZONE E - SOIL SUBZONE 4 & 5

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/25/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 100 200 300
SCALE IN FEET (APPROX.)

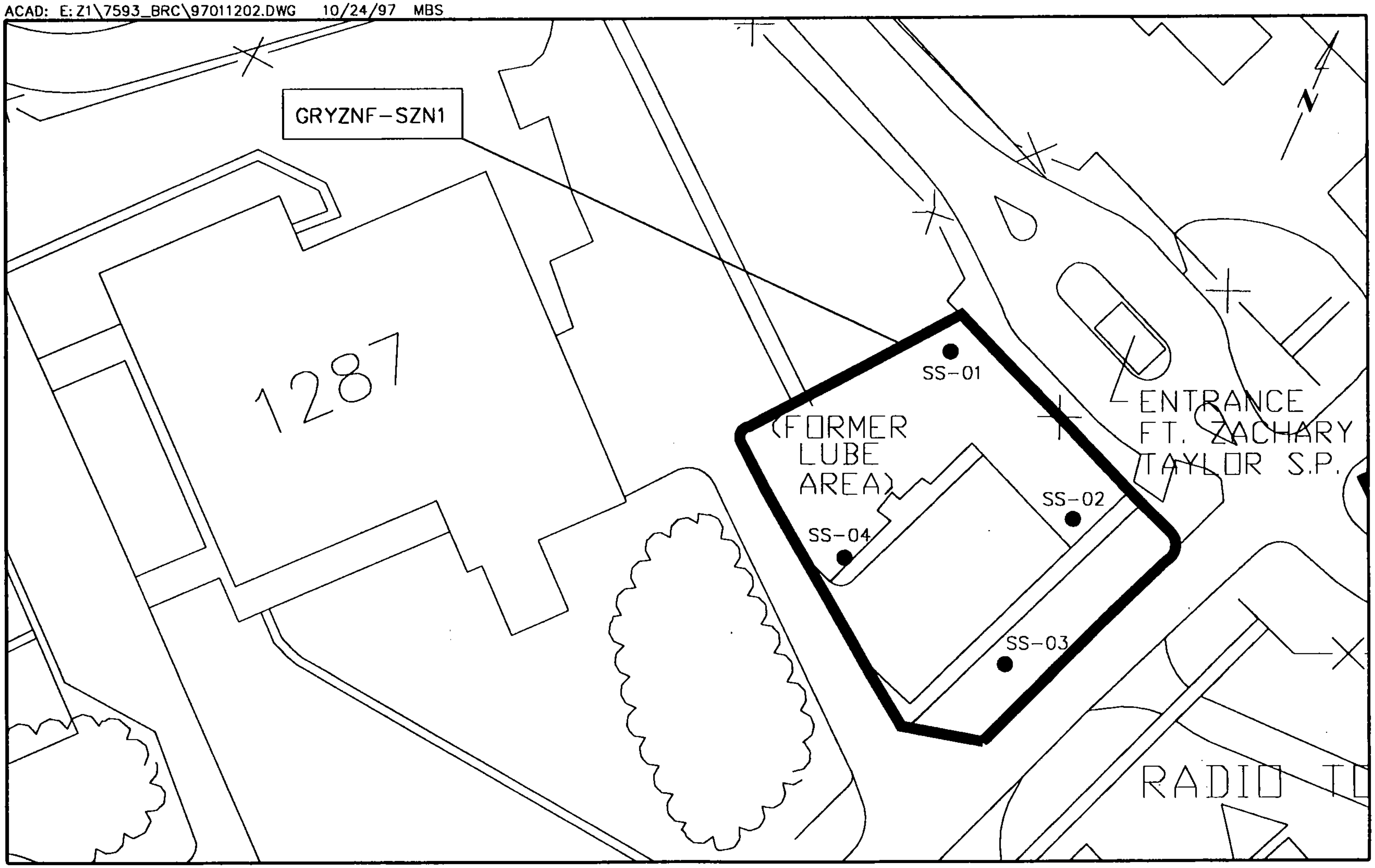
LEGEND
- GROUNDWATER SCREENING SAMPLE LOCATIONS
- EXISTING MONITORING WELLS
- SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 08/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-13. TRUMAN ANNEX
ZONE E - GROUNDWATER SUBZONE 7

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/24/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 30 60 90
SCALE IN FEET (APPROX.)

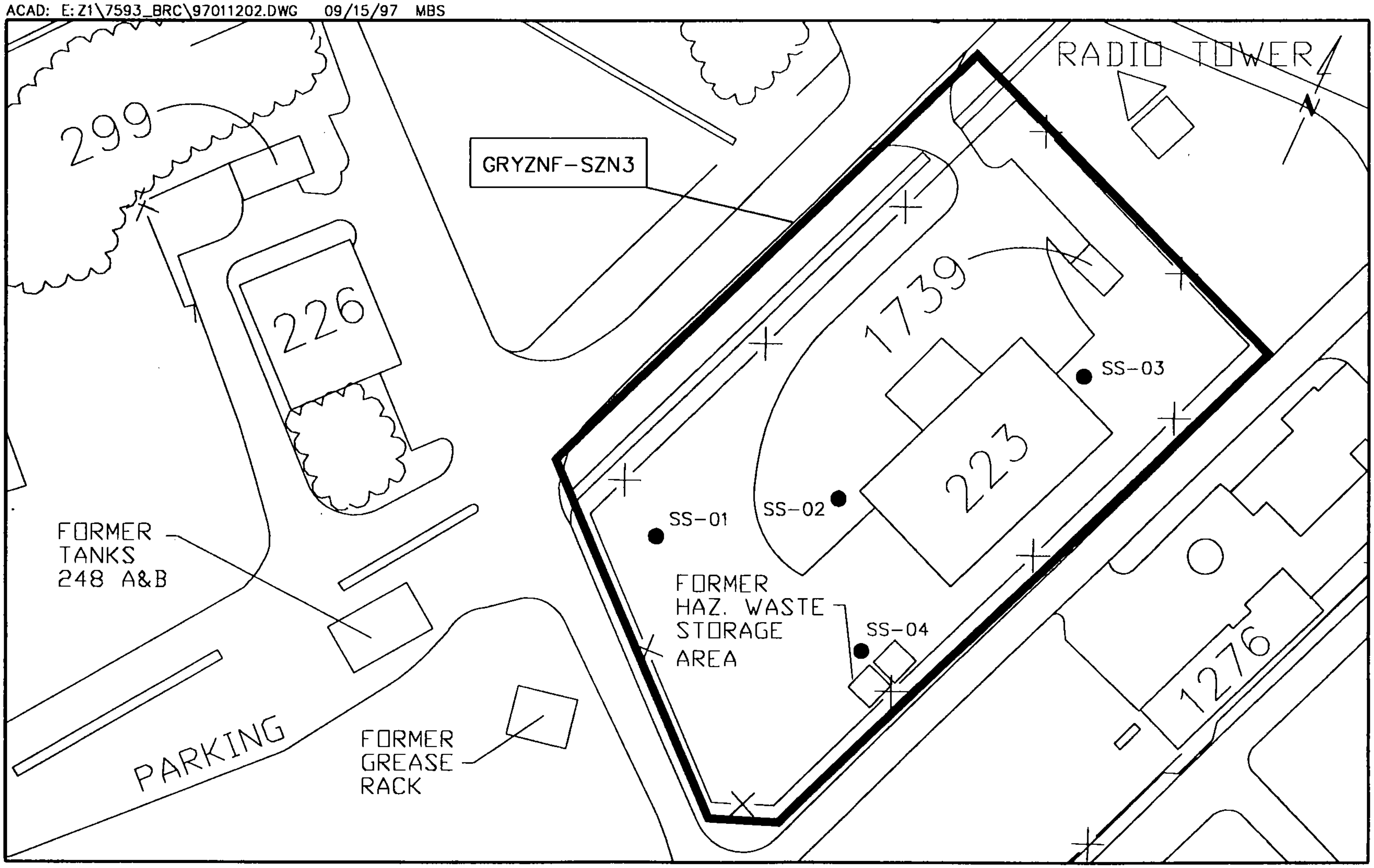
LEGEND
- ● SOIL-BORING SAMPLE LOCATION
- ▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-14. TRUMAN ANNEX
ZONE F – SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 09/15/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 40 80 120
SCALE IN FEET (APPROX.)

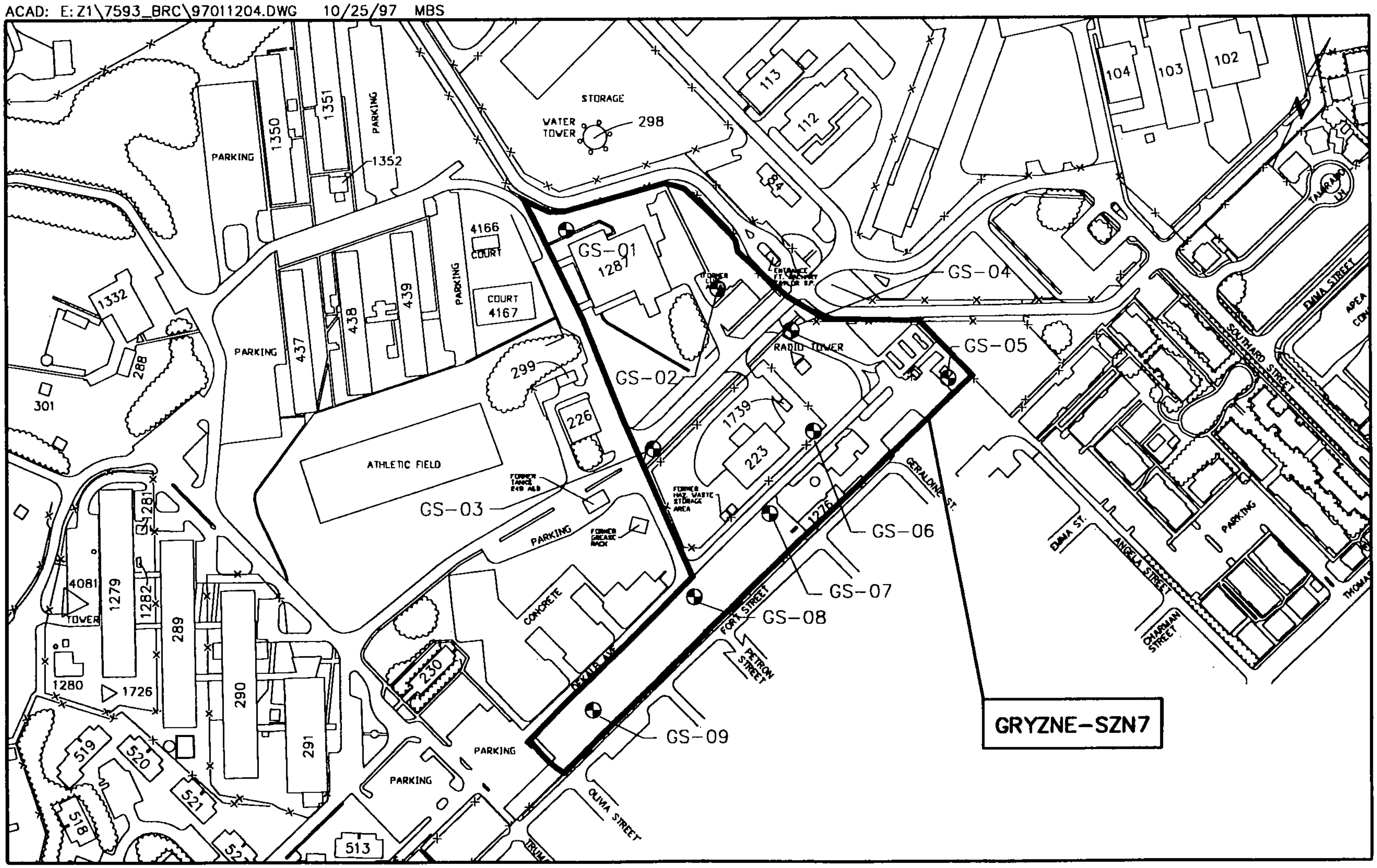
LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-15. TRUMAN ANNEX ZONE F - SOIL SUBZONE 3

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011204.DWG 10/25/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 150 300 450

SCALE IN FEET (APPROX.)

LEGEND

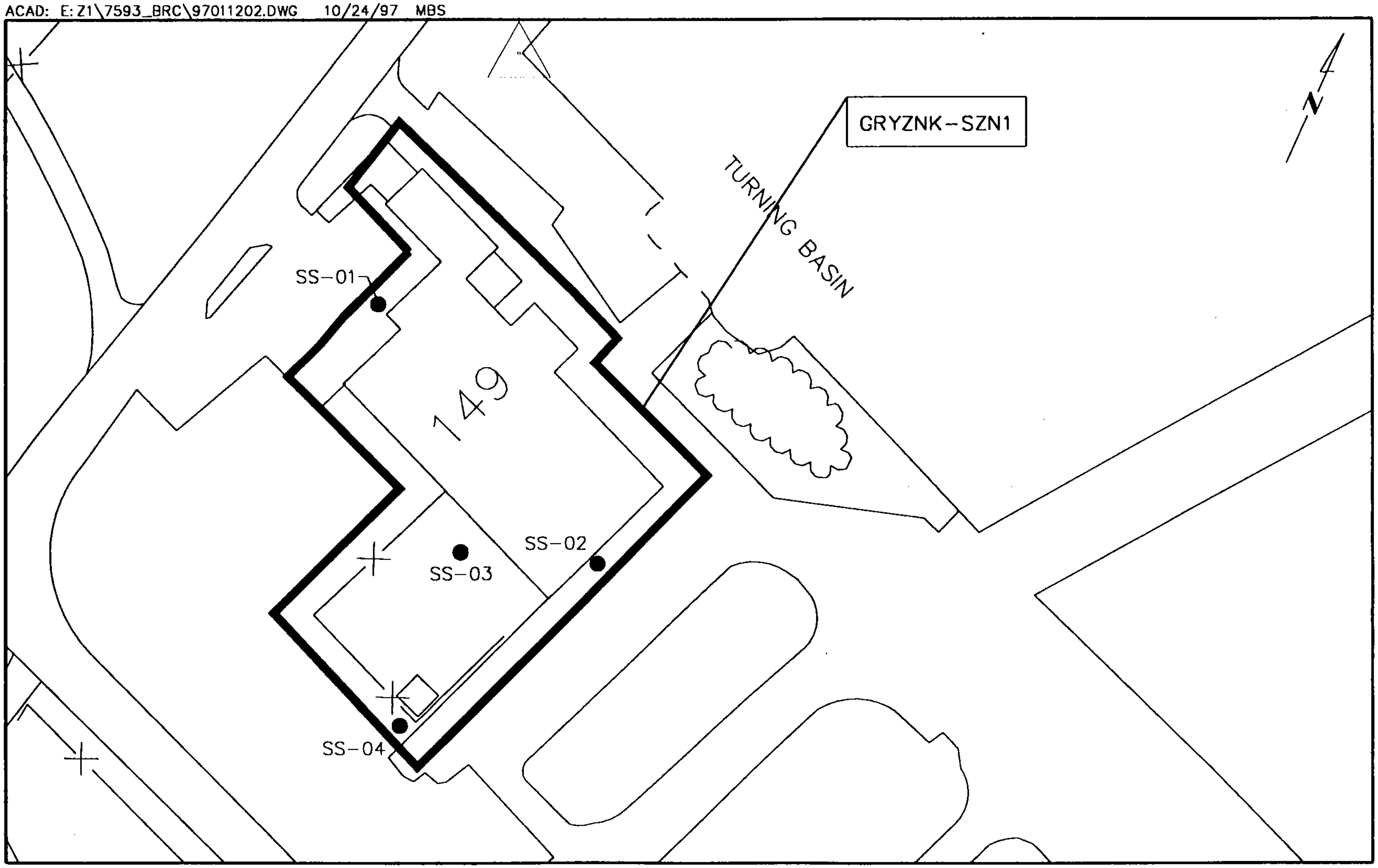
- GROUNDWATER SCREENING SAMPLE LOCATIONS
- SUBZONE BOUNDARY

DRAWN BY: MDB
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 08/12/97 REV.: 0
FILE NAME: 97011204.DWG

FIGURE 4-16. TRUMAN ANNEX ZONE F – GROUNDWATER SUBZONE 7

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/24/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 40 80 120
SCALE IN FEET (APPROX.)

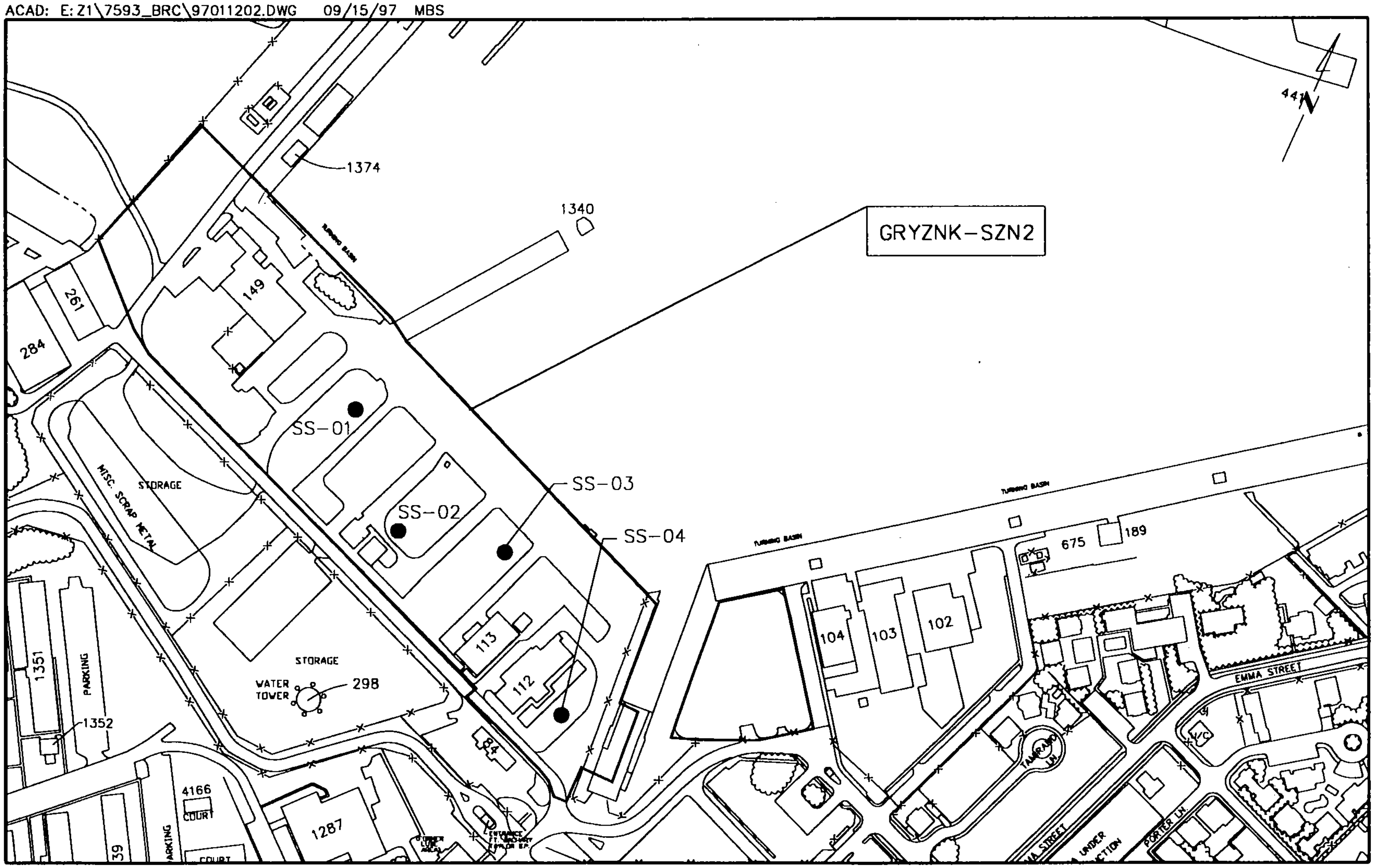
LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-17. TRUMAN ANNEX
ZONE K - SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 09/15/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 150 300 450

SCALE IN FEET (APPROX.)

LEGEND

● SOIL-BORING SAMPLE LOCATION

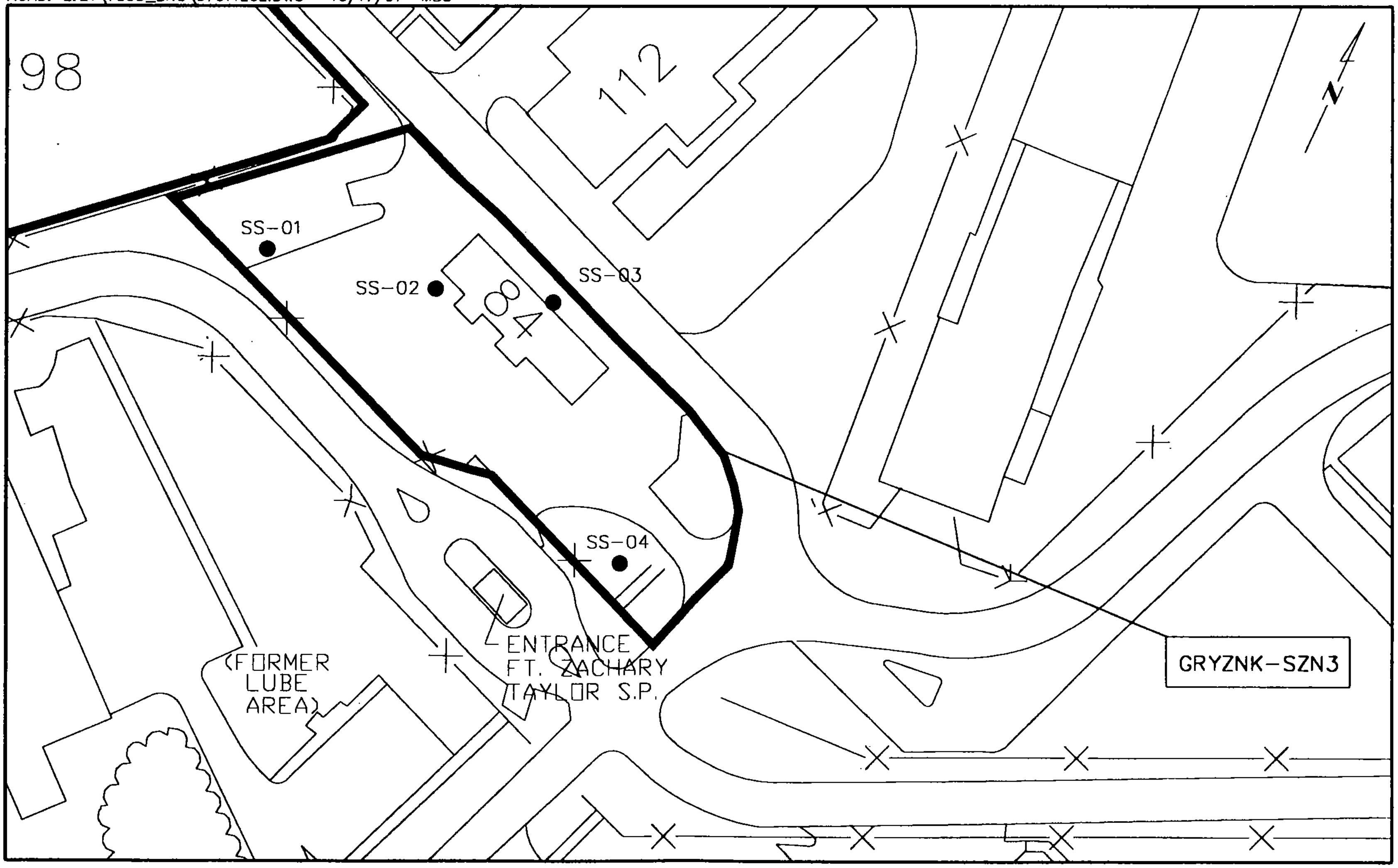
▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011202.DWG	

FIGURE 4-18. TRUMAN ANNEX ZONE K – SOIL SUBZONE 2

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/17/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 40 80 120
SCALE IN FEET (APPROX.)

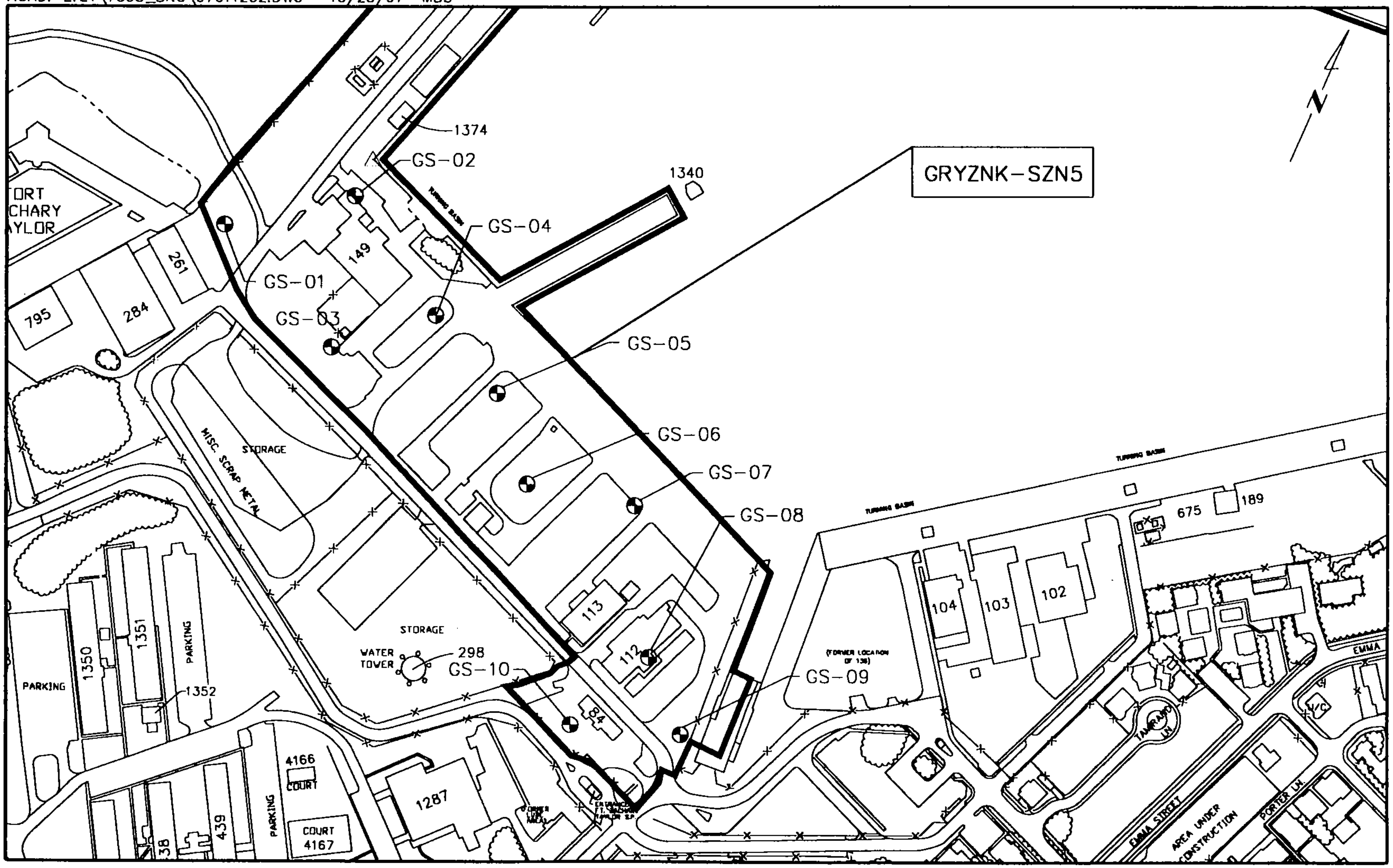
LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 09/12/97 REV.: 0
FILE NAME: 97011202.DWG

FIGURE 4-19. TRUMAN ANNEX ZONE K – SOIL SUBZONE 3

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011202.DWG 10/25/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 150 300 450

SCALE IN FEET (APPROX.)

LEGEND

GROUNDWATER SCREENING SAMPLE LOCATIONS

SUBZONE BOUNDARY

DRAWN BY: MDB

CHECKED BY: DK

SCALE: AS SHOWN

DATE: 08/12/97 REV.: 0

FILE NAME: 97011202.DWG

FIGURE 4-20. TRUMAN ANNEX
ZONE K – GROUNDWATER SUBZONE 5

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

4.3.2 Trumbo Point (Two Zones)

Two zones are located at Trumbo Point-- Zone H (Trumbo Point Piers D-1 & D-3) and Zone I (Trumbo Point Building B-48). Figure 2-4 provides an overview of the Trumbo Point BRAC sites. Subzones that require sampling and analysis under the BRAC SI are shown, as well as subzones that were determined, based on existing information, either not to be areas of concern or not to require further investigation under the BRAC SI.

4.3.2.1 Zone I (Trumbo Point Building B-48)

Two subzones were initially identified in Zone I; neither were found to require additional sampling under the BRAC SI.

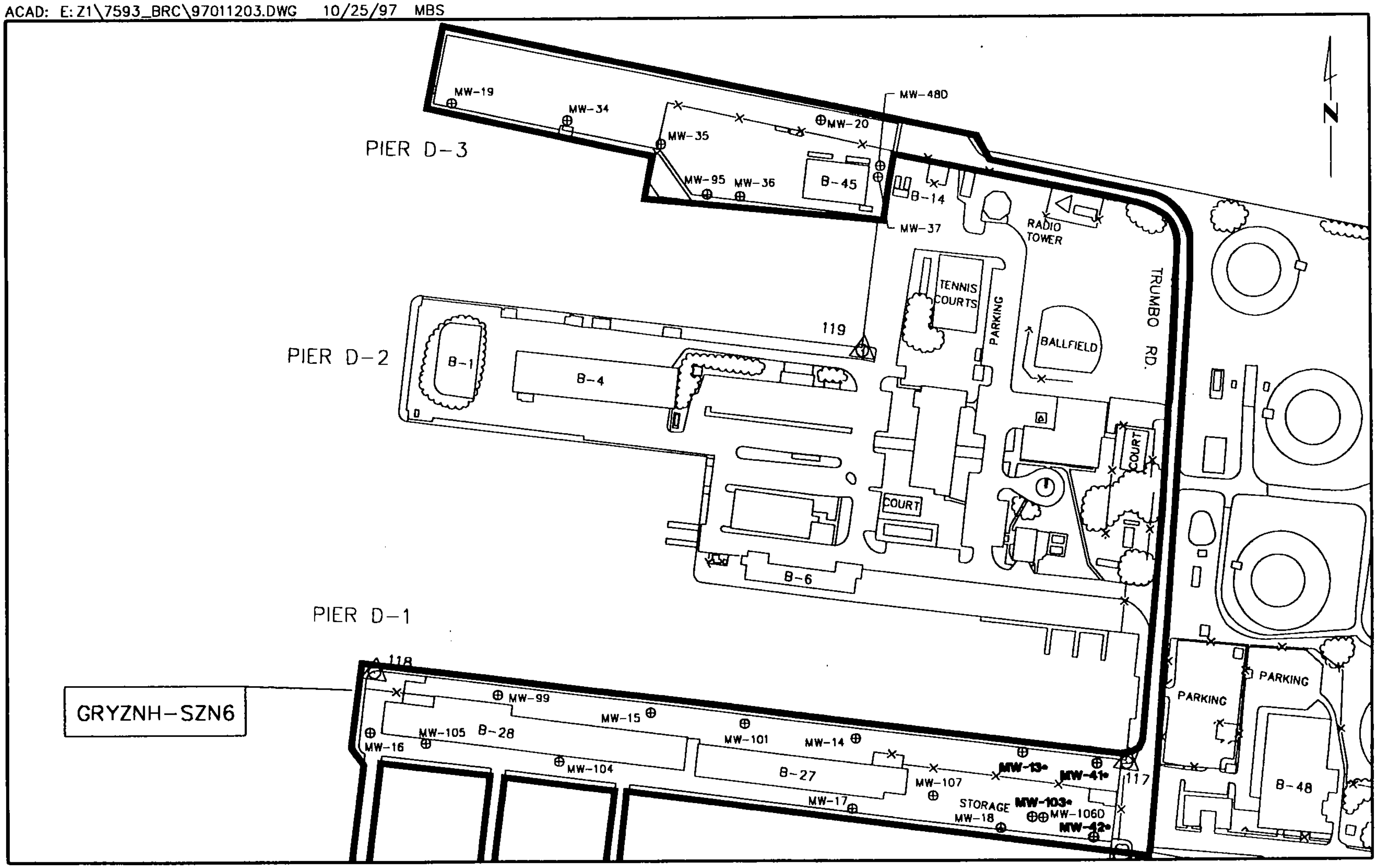
4.3.2.2 Zone H (Trumbo Point Piers D-1 and D-3)

One subzone (GRYZNH-SZN6) within Zone H requires sampling and analysis under the BRAC SI at this time. Three other subzones (see Table 3-1) have been eliminated pending results from the ABB risk assessment of Zone H. Groundwater samples at Zone H have been biased in order to target the area that may contain non-petroleum contamination, based on site history indicating a potentially leaky bilge line. Since the location of the suspected leaky bilge line is well-defined and monitoring wells already exist in the area, no screening samples are necessary. Samples will be collected from four existing monitoring wells and the results will be used in decision-making. All existing wells, including the locations where samples will be collected in the groundwater subzone, GRYZNH-SZN6, are shown on Figure 4-21.

4.3.3 Key West Interior (Three Zones)

Three Zones are located within the interior region of Key West: Zone A (Hawk Missile Site), Zone B (East Martello Battery), and Zone G (Poinciana Housing). Figures 2-5 through 2-7 provide an overview of the Key West interior BRAC sites. Subzones that require sampling and analysis under the BRAC SI are shown, as well as subzones that were determined, based on existing information, either not to be areas of concern or not to require further investigation under the BRAC SI. A separate discussion of each zone is presented below.

ACAD: E:Z1\7593_BRC\97011203.DWG 10/25/97 MBS



BROWN & ROOT ENVIRONMENTAL 0 100 200 300 SCALE IN FEET (APPROX.)	LEGEND ⊕• GROUNDWATER SAMPLE LOCATIONS ⊕ EXISTING MONITORING WELLS ▬ SUBZONE BOUNDARY	DRAWN BY: MDB CHECKED BY: DK SCALE: AS SHOWN DATE: 08/12/97 REV.: 0 FILE NAME: 97011203.DWG

FIGURE 4-21. TRUMBO POINT
ZONE H – GROUNDWATER SUBZONE 6

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

4.3.3.1 Zone A (Hawk Missile Site)

Eight subzones within Zone A require sampling and analysis under the BRAC SI. GRYZNA-SZN1 (Drainage Area), GRYZNA-SZN4 (Sewage Lift Station), GRYZNA-SZN5 (Generator Building I-6536), GRYZNA-SZN6 (Burnt Building I-6530-Former Missile Maintenance Bay), and GRYZNA-SZN7 (Former Transformer Storage Area) were identified as soil subzones. Four soil samples have been randomly placed in each subzone, and the sample locations within the each subzone are shown on Figures 4-22 through 4-25. Zone A is the only BRAC Zone that requires sediment or surface-water sampling under this investigation. Figure 4-26 shows the placement of the six sediment samples in GRYZNA-SZN9 (Ponds), as well as the placement of three surface-water samples in the same area [GRYZNA-SZN10 (Ponds)]. The placement of screening samples in the groundwater subzone, GRYZNA-SZN11, is shown on Figure 4-27.

4.3.3.2 Zone B (East Martello Battery)

Two subzones within Zone B require sampling and analysis under the BRAC SI. The random placement of soil samples in GRYZNB-SZN1 (East Martello Battery) is shown in Figure 4-28, while the placement of groundwater screening samples in GRYZNB-SZN3 is shown in Figure 4-29.

4.3.3.3 Zone G (Poinciana Housing)

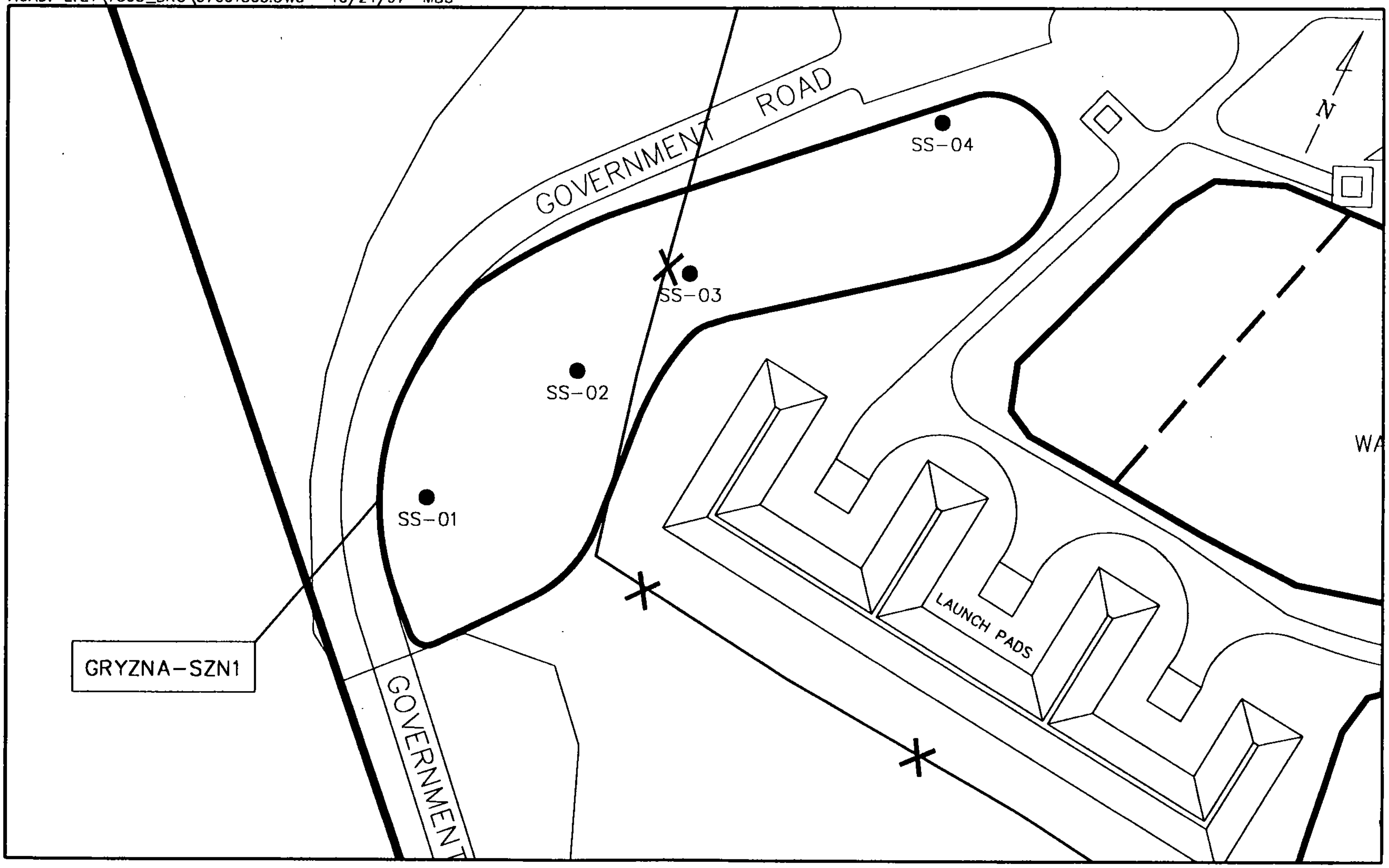
Two subzones within Zone G require sampling and analysis under the BRAC SI. The random placement of soil samples in GRYZNG-SZN1 (Poinciana Housing) is shown in Figure 4-30, while the placement of groundwater screening samples in GRYZNG-SZN2 is shown in Figure 4-31 .

4.4 SAMPLE DESIGNATION

A unique sample number will be utilized to tie a particular sample to a specific physical location. B&R Environmental will place a unique sample number on each sample sent to the laboratory. This sample number will be referenced on field logbooks, sample collection logs, and chain-of-custody forms. The sample designation will be constructed as described below.

- Location identifier, one letter and two digits (A01 = Zone A, Subzone 01)
- Media type
  - SS = surface soil
  - SD = sediment

ACAD: E:Z1\7593_BRC\97061305.DWG 10/24/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 40 80 120
SCALE IN FEET (APPROX.)

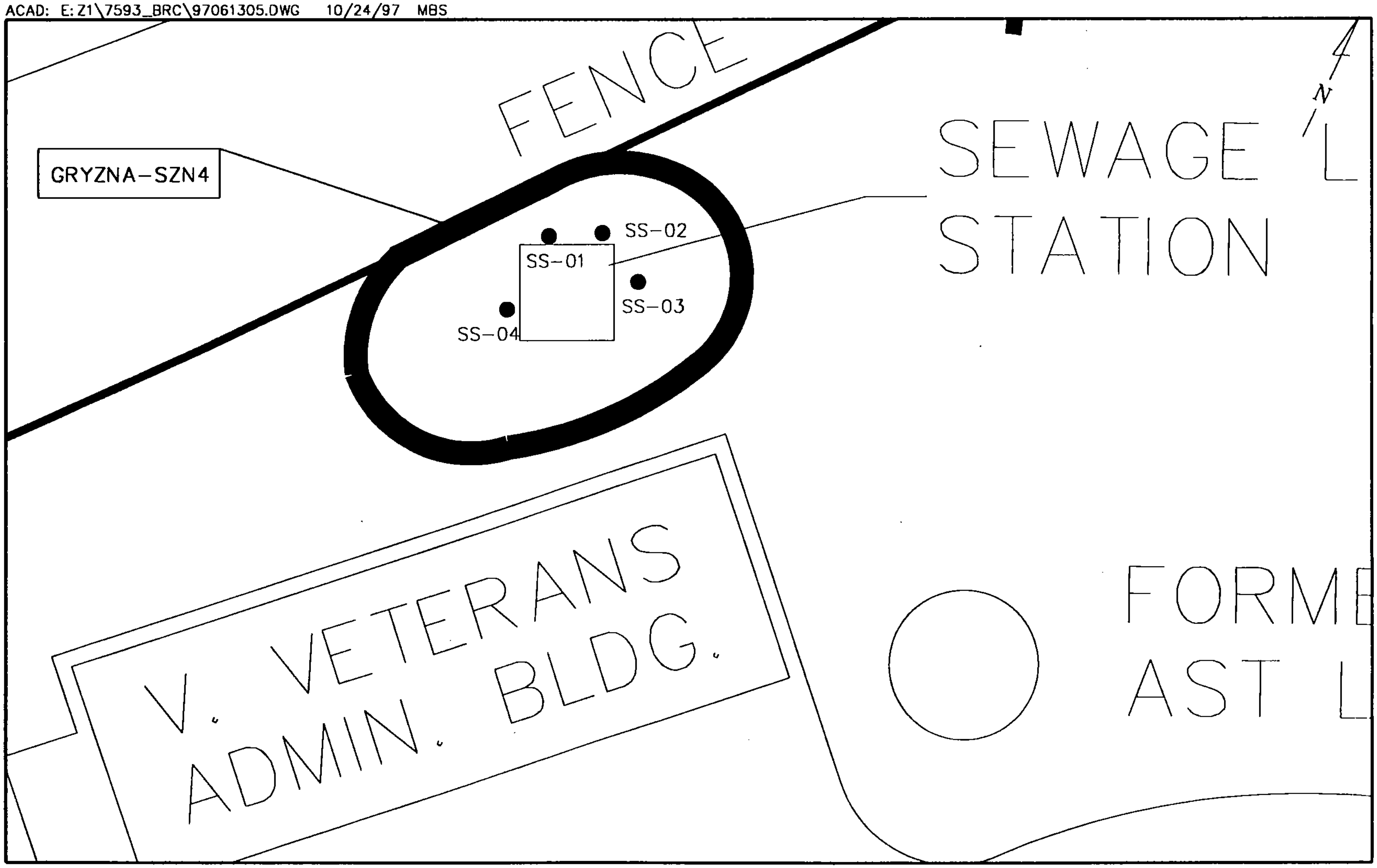
LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 08/12/97 REV.: 0
FILE NAME: 97061305.DWG

FIGURE 4-22. HAWK MISSILE SITE ZONE A - SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97061305.DWG 10/24/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 10 20 30

SCALE IN FEET (APPROX.)

LEGEND

● SOIL-BORING SAMPLE LOCATION

▬ SUBZONE BOUNDARY

DRAWN BY: MDB

CHECKED BY: DK

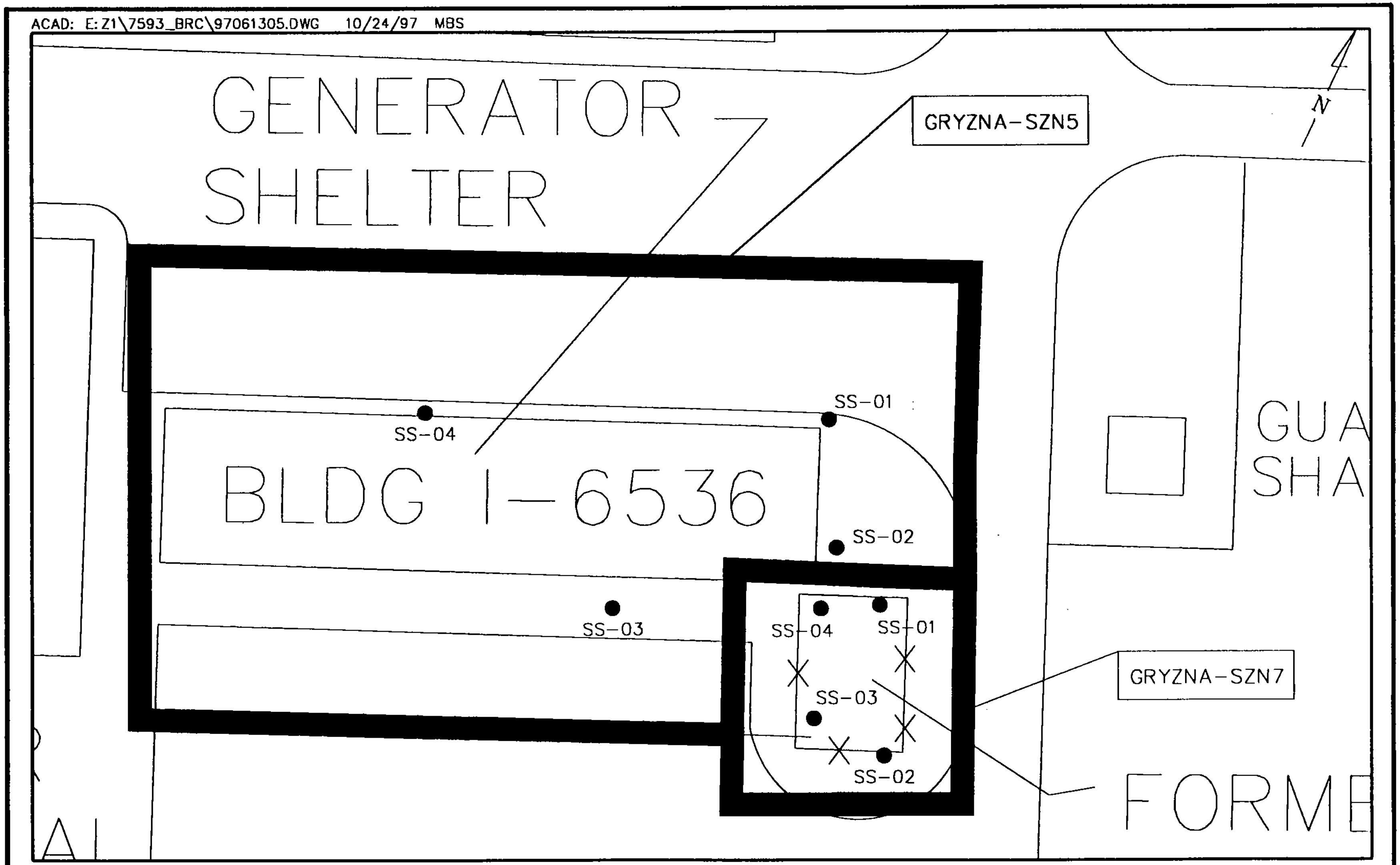
SCALE: AS SHOWN

DATE: 08/12/97 REV.: 0

FILE NAME: 97061305.DWG

FIGURE 4-23. HAWK MISSILE SITE
ZONE A - SOIL SUBZONE 4

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL



BROWN & ROOT ENVIRONMENTAL

0 10 20 30
SCALE IN FEET (APPROX.)

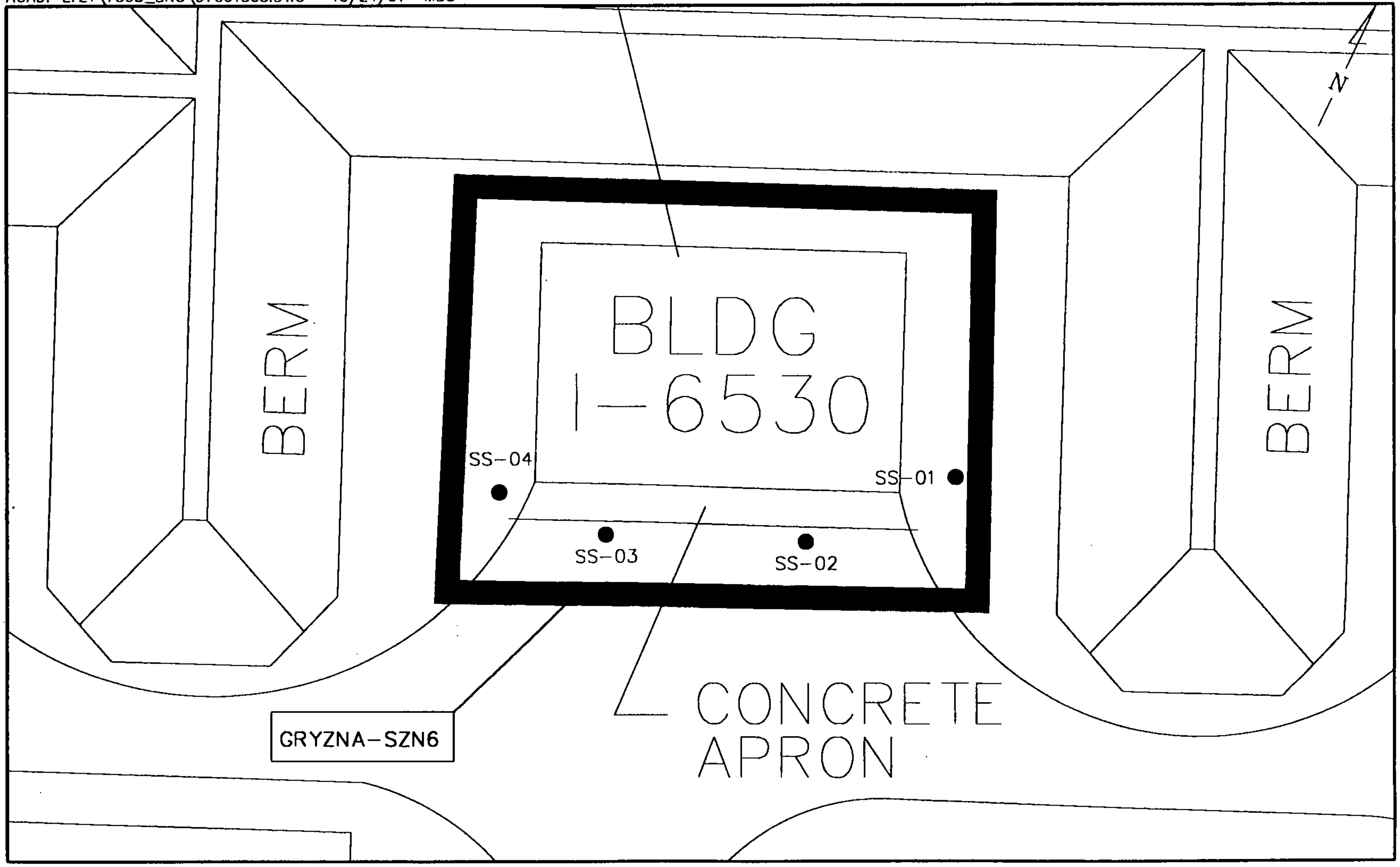
LEGEND
- ● SOIL-BORING SAMPLE LOCATION
- ▬ SUBZONE BOUNDARY

DRAWN BY: MDB
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 08/12/97 REV.: 0
FILE NAME: 9708110a.DWG

FIGURE 4-24. HAWK MISSILE SITE ZONE A - SOIL SUBZONE 5 & 7

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97061305.DWG 10/24/97 MBS



BROWN & ROOT ENVIRONMENTAL

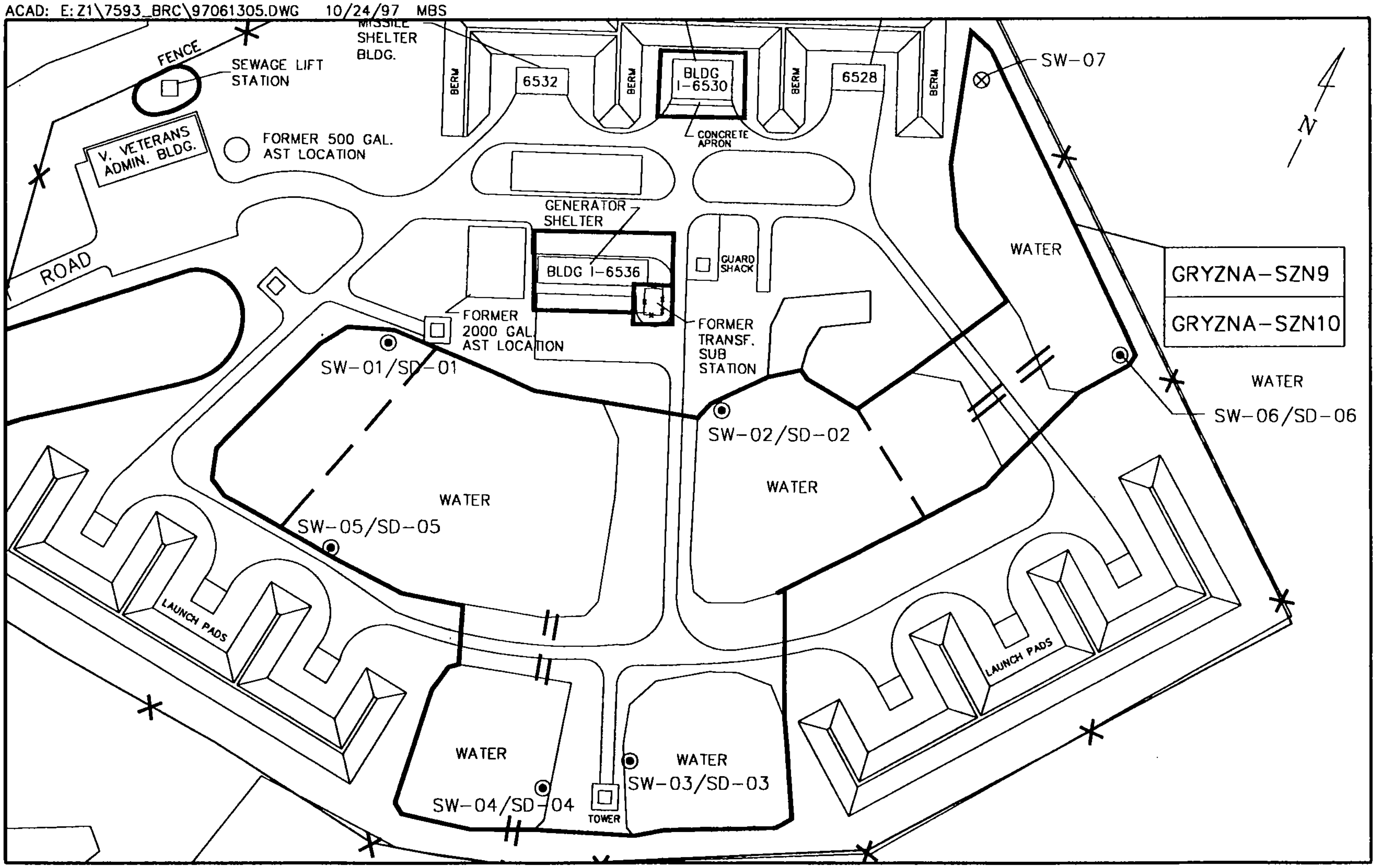
0 10 20 30
SCALE IN FEET (APPROX.)

LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB
CHECKED BY: DK
SCALE: AS SHOWN
DATE: 08/12/97 REV.: 0
FILE NAME: 97061305.DWG

FIGURE 4-25. HAWK MISSILE SITE ZONE A - SOIL SUBZONE 6

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL



BROWN & ROOT ENVIRONMENTAL

0 60 120 180

SCALE IN FEET (APPROX.)

LEGEND

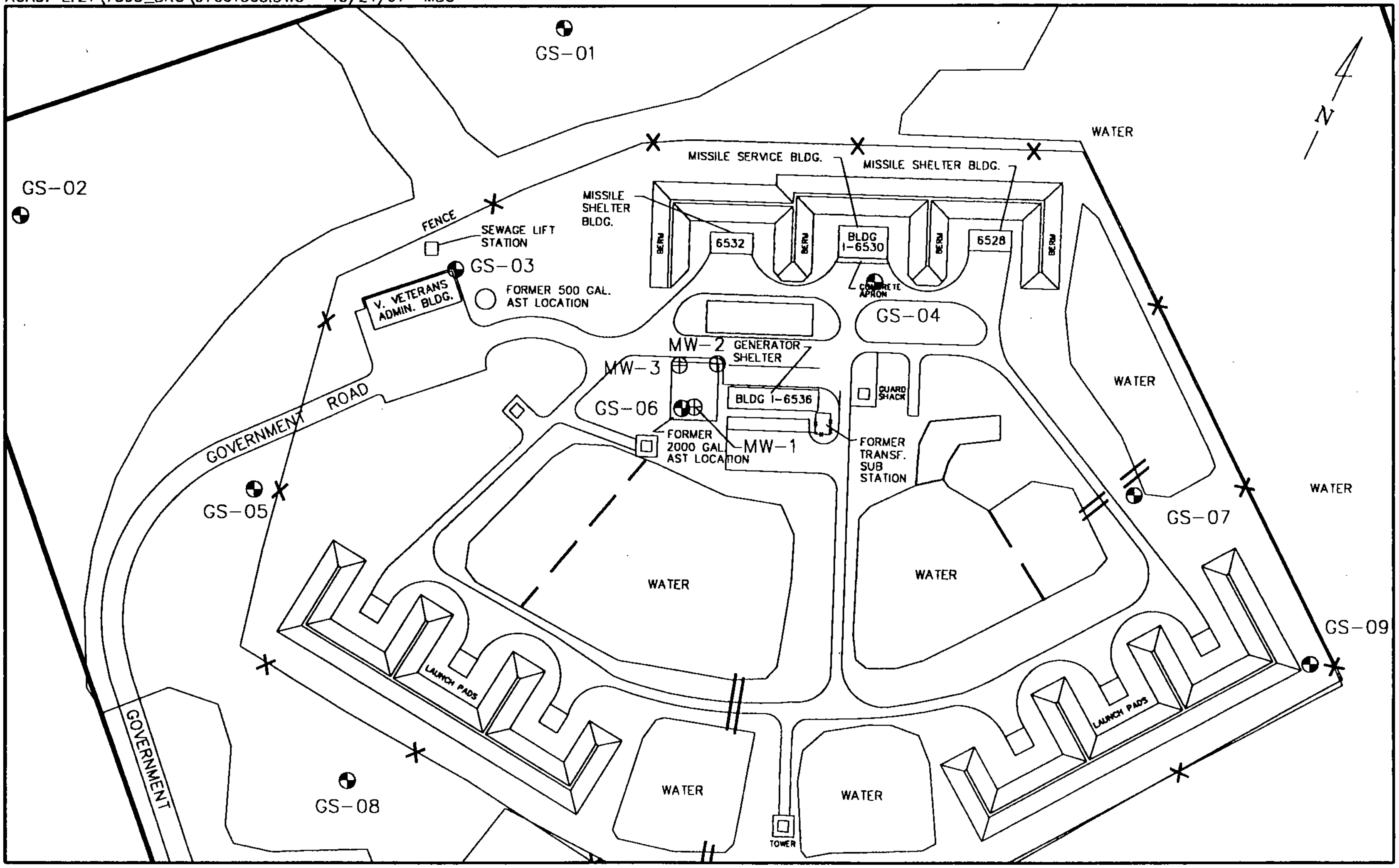
- ⦿ SURFACE-WATER & SEDIMENT LOCATION
- ⊗ SURFACE-WATER SAMPLE LOCATION
- ▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 08/12/97	REV.: 0
FILE NAME: 97061305.DWG	

FIGURE 4-26. HAWK MISSILE SITE
ZONE A – SURFACE WATER & SEDIMENT
SUBZONE 9 & 10

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97061305.DWG 10/24/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 10 20 30
SCALE IN FEET (APPROX.)

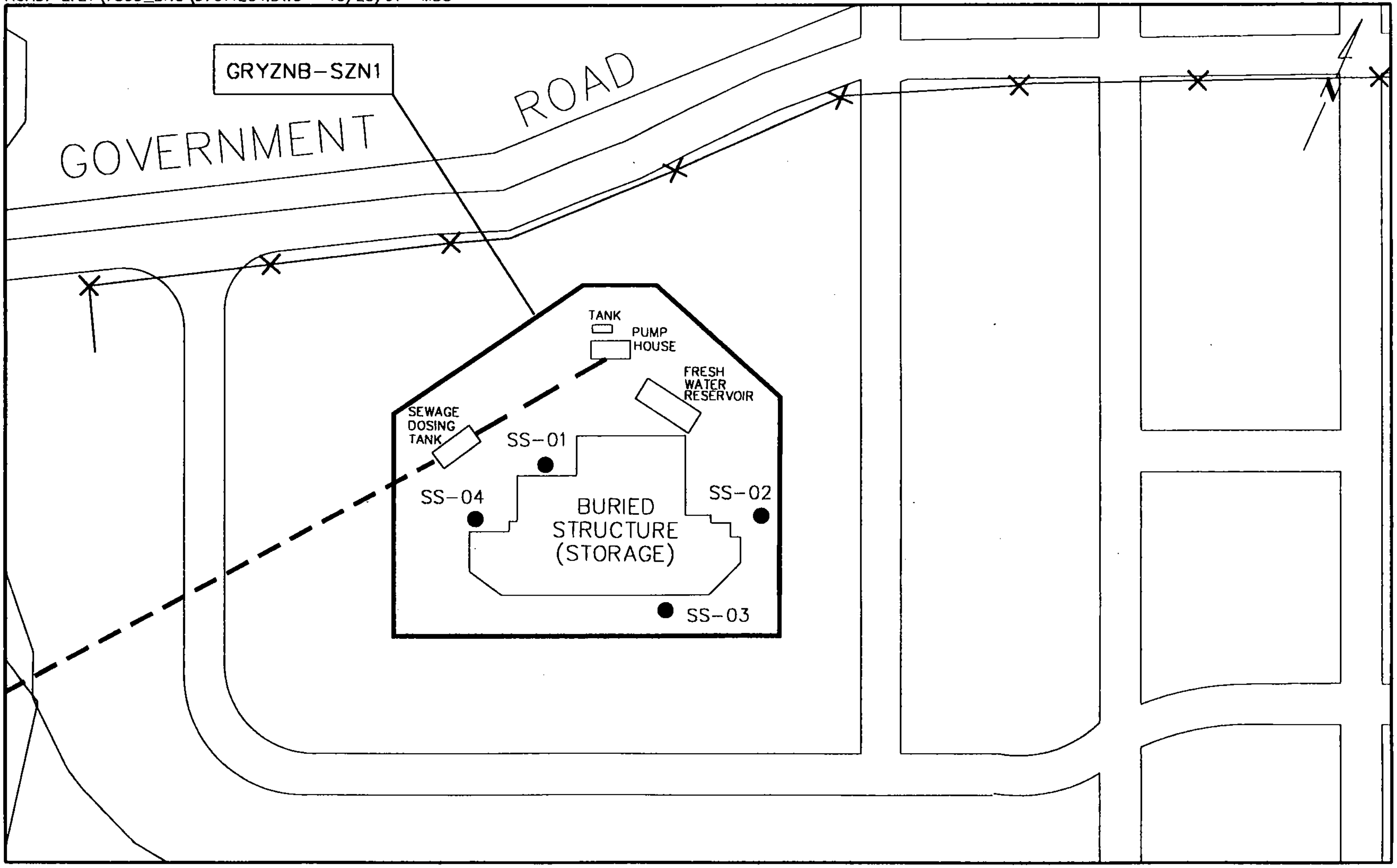
LEGEND
- GROUNDWATER SCREENING SAMPLE LOCATIONS
- EXISTING MONITORING WELLS
- SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 08/12/97	REV.: 0
FILE NAME: 97061305.DWG	

FIGURE 4-27. HAWK MISSILE SITE
ZONE A - GROUNDWATER SUBZONE 11

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011204.DWG 10/25/97 MBS



BROWN & ROOT ENVIRONMENTAL

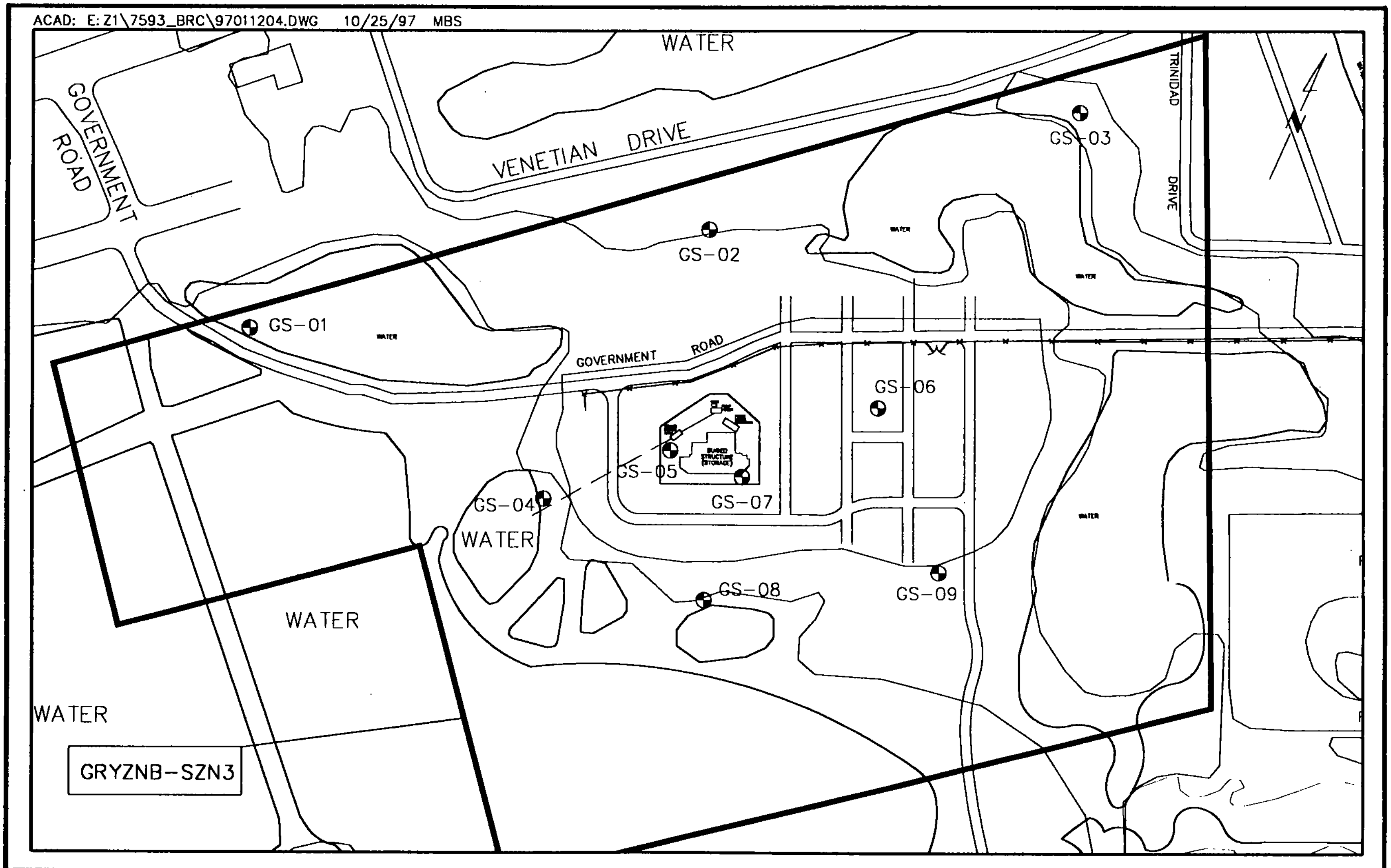
0 40 80 120
SCALE IN FEET (APPROX.)

LEGEND
- ● SOIL-BORING SAMPLE LOCATION
- ▬ SUBZONE BOUNDARY
- – – DRAINAGE TILE
- —×— FENCE

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011204.DWG	

FIGURE 4–28. EAST MARTELLO BATTERY ZONE B – SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL



BROWN & ROOT ENVIRONMENTAL

0 150 300 450
SCALE IN FEET (APPROX.)

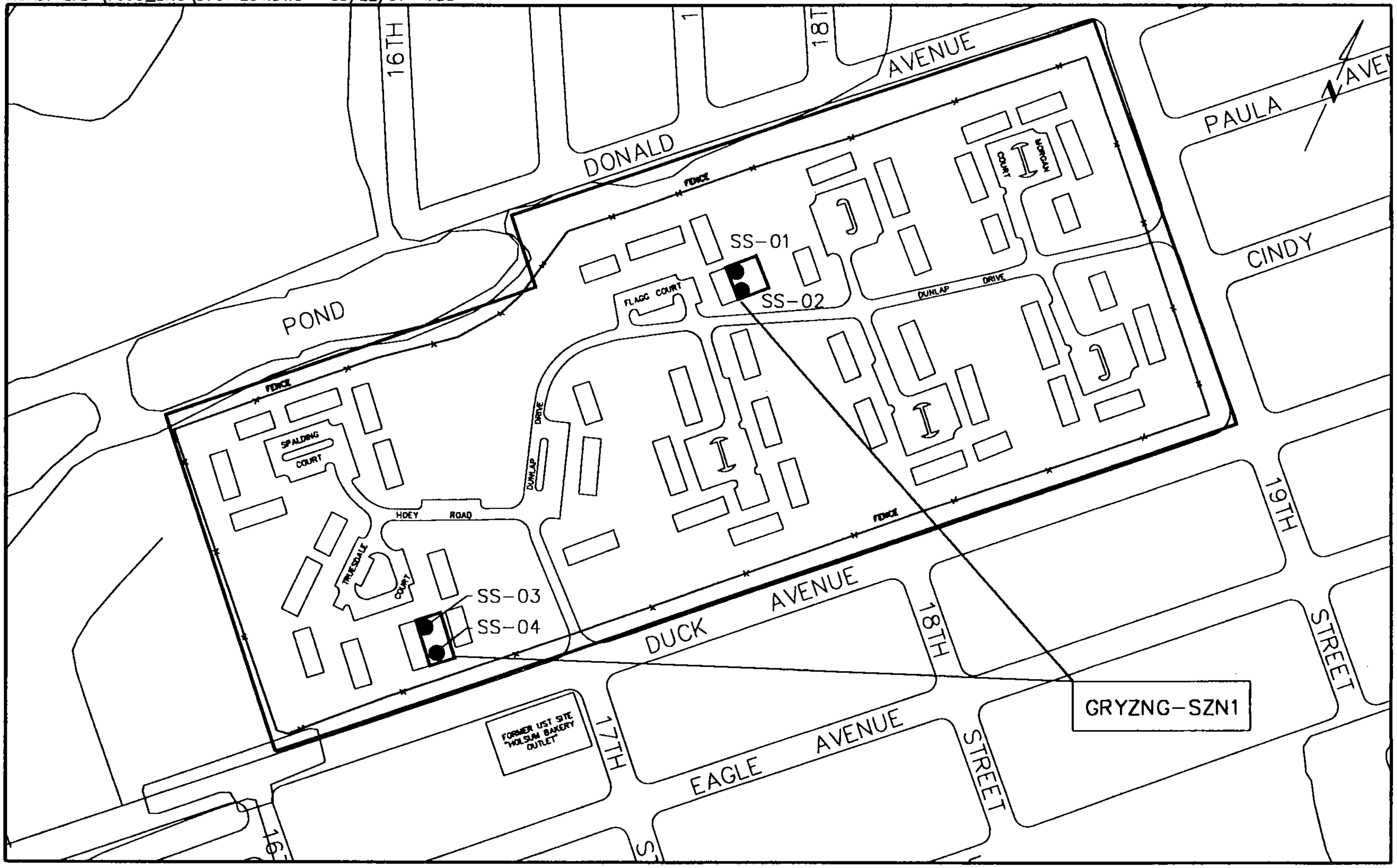
LEGEND
- GROUNDWATER SCREENING SAMPLE LOCATIONS
- SUBZONE BOUNDARY
- DRAINAGE TILE
- FENCE

DRAWN BY: MDB
CHECKED BY: OK
SCALE: AS SHOWN
DATE: 08/12/97 REV.: 0
FILE NAME: 97011204.DWG

FIGURE 4-29. EAST MARTELLO BATTERY ZONE B - GROUNDWATER SUBZONE 3

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

ACAD: E:Z1\7593_BRC\97011204.DWG 09/22/97 MBS



BROWN & ROOT ENVIRONMENTAL

0 150 300 450
SCALE IN FEET (APPROX.)

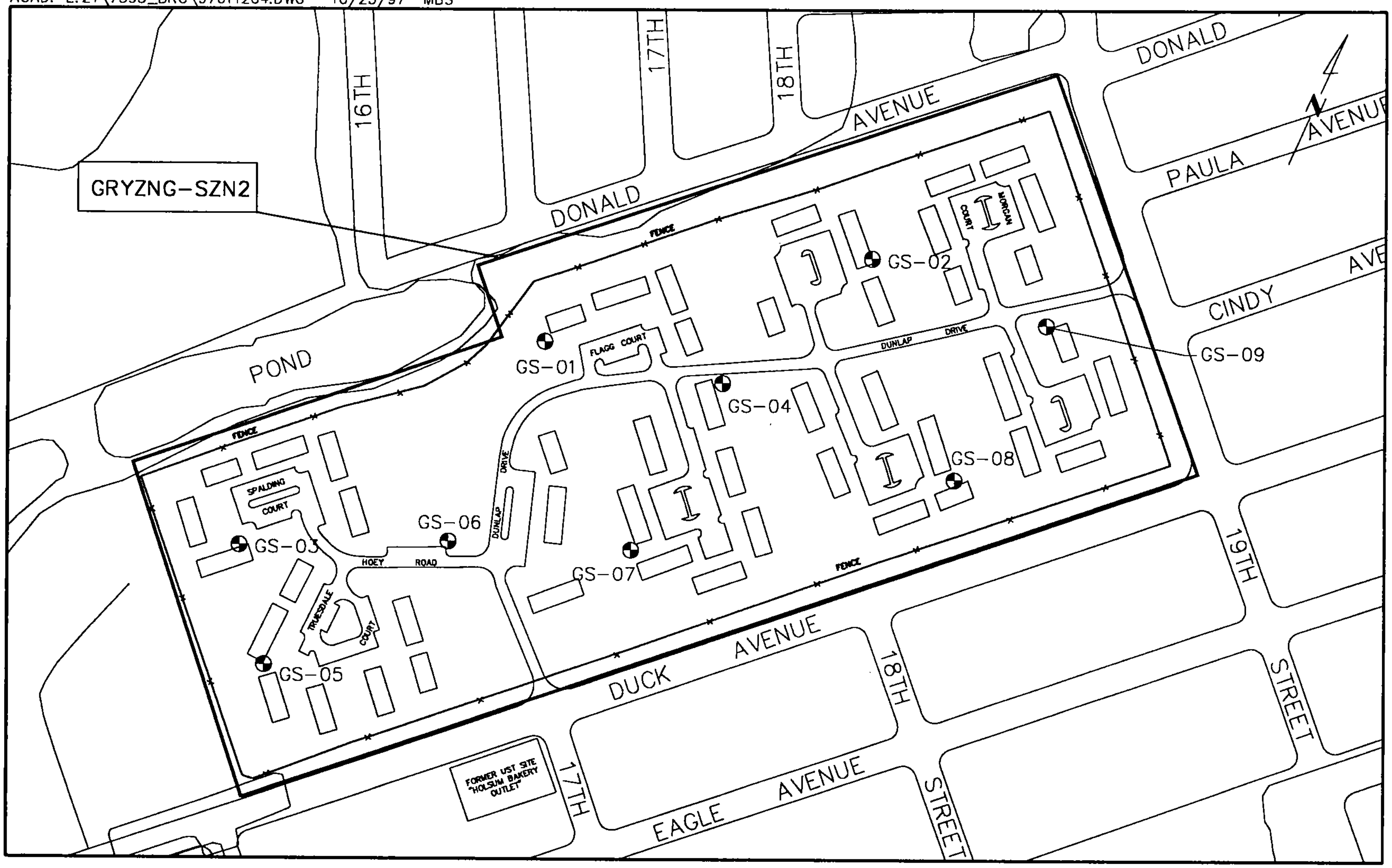
LEGEND
● SOIL-BORING SAMPLE LOCATION
▬ SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 09/12/97	REV.: 0
FILE NAME: 97011204.DWG	

FIGURE 4-30. POINCIANA PLAZA HOUSING ZONE G - SOIL SUBZONE 1

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

AIK-97-0124



BROWN & ROOT ENVIRONMENTAL

0 150 300 450
SCALE IN FEET (APPROX.)

LEGEND

GROUNDWATER SCREENING SAMPLE LOCATIONS

SUBZONE BOUNDARY

DRAWN BY: MDB	
CHECKED BY: DK	
SCALE: AS SHOWN	
DATE: 08/12/97	REV.: 0
FILE NAME: 97011204.DWG	

FIGURE 4-31. POINCIANA PLAZA HOUSING ZONE G - GROUNDWATER SUBZONE 2

NAVAL AIR STATION, NAS KEY WEST KEY WEST, FL

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- SW = surface water
- GS = groundwater (used to identify groundwater screening samples from direct push technology borings)
- MW = groundwater (used to identify groundwater samples from permanent monitoring wells)

• Individual sample identifier (i.e., 01, 02, 03, etc.)

Example: A01-SS-01 for Zone A, Subzone 01, surface soil number 01

4.5 SAMPLING PROCEDURES AND EQUIPMENT

Any sample obtained during a field sampling event should be representative of the sample location and free of contaminants from sources other than the sampling point. The equipment and the techniques that will be employed to obtain representative samples will be in accordance with approved sampling procedures.

4.5.1 Quality Assurance Objectives

This Sampling and Analysis Plan describes measures that will be undertaken by B&R Environmental and its subcontractors to perform quality work to accomplish project objectives and be responsive to the quality assurance requirements of the EPA. The EPA quality assurance (QA) requirements focus on the acquisition of environmental data of acceptable quality. A detailed discussion of QA requirements including objectives for parameter measurement, laboratory analysis and data review are presented in Appendix D (Quality Assurance Elements).

4.5.2 Prevention of Cross-Contamination

Before entering a site, all sampling equipment will be cleaned to remove foreign material and prevent the introduction of contamination to the site. All drilling equipment that will be in contact with the soil will be decontaminated before use in a borehole. All monitoring well screen and blank casing in contact with groundwater will be decontaminated unless packaged from the factory. Sampling equipment will be decontaminated before use at each sample location. Procedures for decontamination of drilling and sampling equipment and provided in Section 4.5.12. Disposal of decontamination byproducts is discussed in Section 6.0.

4.5.3 Sample Turnaround Time

Sample analyses will be scheduled based on SI needs and will be consistent with the sample holding times. The laboratory will provide a turnaround time of approximately 14 days. This timeframe will meet the project schedule and objectives.

4.5.4 Field Documentation

An integral part of the SAP field activities will be maintaining the site logbook and associated sample logsheets. The site logbook is a controlled document that records all major on-site activities during the SI. At a minimum, the following activities/events shall be recorded in the site logbook:

- Date
- Start time
- Weather
- Health and safety issues (tail gate meetings, conditions, concerns, etc.)
- Field personnel
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Levels of personnel protection
- Ambient air monitoring
- Start and completion of borehole/monitoring well installation or sampling activities
- Sampling activities and logsheet references
- Sample pickup (carrier, chain-of custody forms, time etc.)
- Photographs (numbered to correspond to logbook entries)

The site logbook is initiated at the start of the first on-site activity (e.g., initial reconnaissance survey). Entries are made for every day that on-site activities involving SI contractor personnel take place. One current logbook will be maintained per Zone. The Field Operations Leader (FOL) will maintain a daily operations logbook.

Field-generated data forms will be used to document sample collection and soil boring and monitoring well construction. Examples of these forms are found in Appendix C (Brown & Root Environmental Forms). All sample description, identification, and location information will be recorded in field logbooks. Data to be recorded include identification of the monitored location (e.g., boring number, well number), the type of sample, and other data obtained during the sampling activity.

4.5.5 Field Data Management

Field data will be generated and used to assess the BRAC SI Zones. Field data allow for the identification, evaluation, and support of recommended appropriate actions.

Field data including instrument readings, recordings, measurements, and tests will be documented and reviewed by B&R Environmental personnel. Field records will be kept in legible condition and should be sufficient to reconstruct the daily activities by a qualified individual other than the FOL. Field-generated data forms will be collected and reviewed every week for accuracy and completeness by the FOL. The data forms will be assembled into packages that represent each borehole, monitoring well, etc. for use in preparing the Site Investigation Report.

4.5.6 Sample Bottle Preparation and Preservation

All sample bottles used by B&R Environmental will be shipped to NAS Key West by the laboratory in sealed containers and will be EPA-certified clean. For recordkeeping purposes, the documentation certifying the level of cleanliness will be maintained on file. Additionally, as containers are used for sampling, the lot numbers will be noted on the applicable sample collection forms and in the logbook. Table 4-1 presents the types and volumes of sample bottles that may be used for the collection of environmental samples during the field activities, as well as the sample preservation required for each analytical method. Table 4-2 presents the same information for solid investigation derived waste (IDW) samples that will be analyzed for the full regulatory list of TCLP parameters.

4.5.7 Quality Control of Field Data

Field data generated in accordance with the SI Workplan will consist primarily of field temperature, pH, turbidity, and specific conductance data, and data associated with soil boring advancement, monitoring well installation and development, and soil classification. These data will be validated by review of the project documentation to check that all forms specified in the field sampling plan have been completely and correctly filled out and that documentation exists for the required instrument calibration. This documentation will be considered sufficient to ensure that proper procedures have been followed during the field investigation.

TABLE 4-1

TYPES AND VOLUMES OF SAMPLE BOTTLES FOR ENVIRONMENTAL SAMPLE ANALYSES NAS KEY WEST

Matrix	Container	Volume Referenced for Analysis	Preservative	Holding Times
TCL Pesticides by SW-846 Method 8081/8081a[1]				
Aqueous	1 amber glass bottles with teflon-lined cap	1,000 mL	Cool to 4 °C	7 days from VTSR[2] to extraction, 40 days after extraction
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	14 days from VTSR[2] to extraction, 40 days after extraction
TCL PCBs by SW-846 Method 8081/8082[1]				
Aqueous	1 amber glass bottle with teflon-lined cap	1,000 mL	Cool to 4 °C	7 days from VTSR[2] to extraction, 40 days after extraction
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	14 days from VTSR[2] to extraction, 40 days after extraction
TAL Metals plus Tin by SW-846 Methods 6010a/6010b[1] and the 7000a Series				
Aqueous	1 polyethylene bottle	1,000 mL	Cool to 4 °C, HNO_3 to pH < 2	28 days from VTSR[2,3]
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	28 days from VTSR[2,3]
TCL Semivolatiles by SW-846 Method 8270b/8270c[1]				
Aqueous	1 amber glass bottles with teflon-lined cap	1,000 mL	Cool to 4 °C	7 days from VTSR[2] to extraction, 40 days after extraction
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	14 days from VTSR[2] to extraction, 40 days after extraction
TCL Volatiles by SW-846 Method 8260a/8260b[1]				
Aqueous	2 glass vials with teflon septa	40 mL	Cool to 4 °C, HNO_3 to pH < 2	14 days from VTSR[2]
Solid	1 widemouth glass jar	4 oz	Cool to 4 °C	14 days from VTSR[2]

1 Due to the June 1997 adoption of revisions to SW-846, two versions of most methods are designated here. Laboratories were given 6 months to adopt the revisions, and since the end of this grace period falls within the time frame of the BRAC SI, either version of a recently updated method may be employed.
2 VTSR - Validated time of sample receipt.
3 The short holding time is due to the inclusion of mercury analysis. Without mercury analysis, the holding time for inorganics is 180 days from VTSR.

TABLE 4-2

TYPES AND VOLUMES OF SAMPLE BOTTLES FOR FULL TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) ANALYSIS (REGULATORY LIST PARAMETERS) NAS KEY WEST

Matrix	Container	Volume Referenced for Analysis	Preservative	Holding Times
TCLP VOCs SW-846 Method 1311 Followed by Method 8260a/8260b[1]				
Solid	1 widemouth glass jar	4 oz	Cool to 4 °C	14 days from VTSR[2] to TCLP extraction, 14 days from extraction to analysis
TCLP SVOCs SW-846 Method 1311 Followed by Method 8270b/8270c[1]				
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	14 days from VTSR[2] to TCLP extraction, 40 days from extraction to analysis
TCLP Pesticide SW-846 Method 1311 Followed by Method 8081/8081a[1]				
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	14 days from VTSR[2] to TCLP extraction, 40 days from extraction to analysis
TCLP Herbicides SW-846 Method 1311 Followed by Method 8151/8151a[1]				
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	14 days from VTSR[2] to TCLP extraction, 40 days from extraction to analysis
TCLP Metals SW-846 Method 1311 Followed by Method 6010a/6010b[1]				
Solid	1 widemouth glass jar with teflon-lined cap	8 oz	Cool to 4 °C	28 days from VTSR[2] to TCLP extraction, 28 days from extraction to analysis

1 Due to the June 1997 adoption of revisions to SW-846, two versions of most methods are designated here. Laboratories were given 6 months to adopt the revisions, and since the end of this grace period falls within the time frame of the BRAC SI, either version of a recently updated method may be employed.
2 VTSR - Validated time of sample receipt.

4.5.8 Field Equipment Calibration

The calibration or standardization of monitoring, measuring, or test equipment is necessary to assure the proper operation and response of the equipment. In addition, it is necessary to document the accuracy, precision, or sensitivity of the measurement, and determine if correction should be applied.

4.5.8.1 Calibration Procedures

All measuring and/or test equipment used in the field shall be controlled and subject to a formal calibration program. For field equipment, documentation of calibration of the equipment shall be at the time of calibration. Equipment will also be stored in secure areas. The calibration program shall provide equipment for the proper type, range, accuracy, and precision to supply data compatible with project requirements and desired results.

The FOL is responsible for ensuring proper calibration of project-specific B&R Environmental field equipment.

Documented and approved procedures shall be used for calibrating measuring and/or test equipment. Whenever possible, widely accepted procedures or procedures provided by manufacturers shall be adopted. Where pre-established information is not available, procedures shall be developed considering the type of equipment, stability characteristic of the equipment, required accuracy, precision, and the effect of error on the quantities measured. At a minimum, procedures shall include but not be limited to:

- Type of equipment to be calibrated
- Reference equipment and/or standard to be used
- Calibration method and sequential actions
- Acceptable tolerances
- Frequency of calibration
- Data recording format

4.5.8.2 Equipment Identification

Calibrated equipment shall be uniquely identified by using either the manufacturer's serial number, B&R Environmental identification number, or other means. This identification, along with a label indicating when the next calibration is due (only for equipment requiring periodic calibration), shall be attached to the equipment. If this is not possible, records traceable to the equipment shall be readily available for reference. It is the responsibility of all personnel to verify the calibration status from the due date labels or records prior to using the equipment.

4.5.8.3 Calibration Frequency

Field equipment calibration shall be performed and documented on a daily basis. Field calibration procedures and frequencies are summarized in Table 4-3. For field equipment that is not continuously in use, the scheduled periodic calibration will not be performed. The equipment shall be calibrated on an "as needed" basis prior to use. At a minimum, equipment in use will be calibrated once daily, prior to the first sample, and will be verified every 4 hours throughout the day.

It should be noted that a turbidity reading of less than zero is indicative of error and requires instrument cleaning and calibration. Regardless of error indications, the turbidity unit shall be cleaned on a daily basis when being used in a saline environment.

4.5.8.4 Calibration Standards

Whenever possible, equipment shall be calibrated using standards that have known relationships to nationally recognized standards (e.g., National Bureau of Standards) or accepted values of natural constants.

4.5.8.5 Calibration Failure

Equipment that fails to calibrate shall be removed from service and tagged to prevent inadvertent use. The equipment shall be repaired and satisfactorily re-calibrated to the satisfaction of the FOL.

It is the responsibility of all personnel to verify that their field equipment is properly functioning. If an equipment malfunction is suspected, the device should be tagged, removed from service, recalibrated, or replaced.

TABLE 4-3

**FIELD CALIBRATION PROCEDURES AND FREQUENCIES
NAS KEY WEST**

Instrument	Calibration Standards Used	Acceptance Limits	Corrective Action	Documentation
Horiba U-10 water quality checker	Daily: Calibration Solution	Auto 1-point calibration; repeatability requirements: pH ± .05 pH units Conductivity ± 1% Turbidity ± 3% DO ± 0.1 mg/L Temperature ± 0.1 °C	Recalibrate to standards, clean or replace electrode, service unit	Logbook and calibration forms
Sensodyne Flame Ionization Detector	Daily: Known gas standards, Isobutylene at 100 ppm	± 10 %	Recalibrate to standards or replace if faulty	Logbook and calibration forms

4.5.8.6 Calibration Records

A calibration record shall be kept for each piece of field equipment to indicate that established procedures have been followed. Records for calibrated equipment shall include, as appropriate:

- Type and identification number of equipment
- Calibration frequency and acceptance tolerances
- Standards and numbers
- Calibration dates
- Names of individuals performing the calibration
- Standards used for each calibration
- Statements concerning calibration acceptance or failure and repair of failed equipment.

A copy of the B&R Environmental Calibration Form is included in Appendix D.

4.5.9 Preventive Maintenance

Periodic preventive maintenance is required for equipment whose performance can impact results. The objective of a maintenance program is to avoid generating erroneous measurements that could endanger site personnel or lead to inappropriate environmental response. Instrument manuals will be kept on file for reference if equipment needs minor repair. Instructions on minor repairs are often addressed in the troubleshooting section of an equipment manual, or assistance can be obtained from the equipment manufacturer technical support line, or possibly the B&R Environmental Pittsburgh Warehouse Manager (1-800-245-2730).

Appropriate and sufficient replacement parts or backup equipment will be available to avoid a substantial delay of field tasks.

4.5.9.1 Sampling and Analytical Equipment

Field sampling and analytical equipment will be maintained to manufacturer's specifications. Routine preventative maintenance in the form of inspections and checkout procedures will be conducted to verify proper operation of each piece of equipment.

4.5.9.2 Support Equipment

Support equipment includes vehicles, containers, safety devices, radios, and phones that may be required for completing a field monitoring or measurement task. The support equipment will be periodically inspected to maintain the performance necessary for proper and efficient execution of field activities.

4.5.10 Ambient Air Monitoring

Air monitoring will be performed with a Flame Ionization Detector (FID). The FID will be used to monitor the presence of volatile chemical compounds in media during drilling and sampling activities. The actions to be taken by personnel for results that fall above background levels are addressed in the Health and Safety Plan.

Ambient air samples will be collected at the source of the activity (e.g., the borehole or well annulus) and in the "breathing zone" of the personnel present (e.g., the area where personnel are taking in air to breath). All air monitoring results will be recorded in the field logbooks to document the presence or absence of volatile chemical compounds.

4.5.11 Sampling Techniques

Samples within a given media will be collected from the least contaminated to the most contaminated locations at a site. At a given sampling location, sample bottles should be filled in the following order, where applicable: VOCs, extractable organics, total metals, and other inorganics. Media-specific sampling requirements are discussed below. Several general sampling precautions will be used to enhance sample integrity:

- Samples will be collected in order from least contaminated to most contaminated, when known. Anticipated or known direction of groundwater flow will be used to determine sampling order when no chemical data are available. Areas upgradient from contaminant source areas will be sampled first and sampling will then proceed from areas furthest downgradient, working toward the source areas.

- When sampling monitoring wells, wells will be purged to ensure representative sampling of groundwater in the saturated zone.

- Medical-grade or Nitrile gloves will always be worn during and changed between each sample collection, and sample handling will be kept to a minimum.

- Samples, preservatives, and sample containers will be handled carefully to minimize exposure time and potential for evaporative loss and/or airborne contamination.

- Upon completion of a round of sampling for a site, all sampling equipment will be scrubbed with tap water and laboratory grade soap and rinsed thoroughly with tap water, rinsed with deionized water and rinsed twice with a pesticide-grade isopropanol and then with organic-free water. The equipment will then be allowed to air dry for a period of time.

- Samples will be delivered to the analyzing laboratory as soon as possible following sample collection, typically overnight express.

4.5.11.1 Soil Sampling Technique

Surface soil sampling is the only type of soil sampling to be performed. The sample collection technique will be done with the use of a direct-push technology (DPT) system.

The DPT system consists of a truck or van equipped with a hydraulic ram. The hydraulic ram drives a threaded, 1-inch outside diameter (OD), hollow-steel rod assembly attached to an interchangeable stainless-steel sleeve that is driven to the desired sample collection depth of 1 foot. An acetate sleeve will be placed inside the stainless steel sleeve. At the soil sample collection depth, the tip of the direct-push sampler is retracted from a rigid leading position while hydraulic pressure is applied to advance the sample collection sleeve. As hydraulic pressure is applied, the tip of the sampler retracts upward with in the sleeve, and material enters the acetate sample collection sleeve. Upon retrieval, the acetate sleeve will be cut longitudinally and the entire sample screened with an FID, then the sample will be placed in appropriate sample jars. The FID screening results and a description of the soil sample will be made on a soil sample log sheet and in the field logbook. In order to obtain an appropriate amount of sample for the full suite of chemical analyses, it may be necessary to collect several sample sleeves of soil from the same location. Where this is necessary, any VOC samples will be collected from a discrete interval, then the sample will be composited prior to collection. This involves mixing the soil in a stainless steel bowl in order to obtain a homogeneous medium. Following collection, the soil sample will then be placed in a cooler and refrigerated with ice for transport to the offsite laboratory. Boreholes will be grouted and abandoned as per FDEP requirements.

4.5.11.2 Sediment Sampling Technique

If sediment and surface-water samples are to be collected in the same area, the surface-water samples should be collected first, following the procedures in Section 4.5.11.3.

Sediment samples will be collected using a stainless steel spoon/trowel. The sediment sample will be placed in a glass pyrex pan for compositing then transferred into the appropriate sample containers for shipment to the laboratory.

The sediment sample will typically first be composited prior to placement in the sample collection bottle. The only exception to this procedure involves the collection of sediment samples for analyses of purgeable organic compounds (VOC analysis) or discrete (depth) samples. If this type of analysis is to be performed, the sediment will be collected on a grab basis only. These discrete samples will not be mixed in any way and will be transferred from the sample collection device to the sample container with as little disturbance as possible to prevent volatilization.

For other analyses, sediment samples will be composited as described below:

- Remove sediment from the sampling device and place in a glass pyrex pan
- Mix thoroughly using a stainless steel spoon/trowel
- Scrape from the sides, corners, and bottom of the pan; roll to the middle of the pan
- Quarter and move to the four corners of the container
- Mix quarters individually and then roll to the center of the glass plan and mix the entire sample again

Care must be taken when sediment samples are removed from beneath more than 6 inches of water. Such samples will be moved slowly through the water to minimize sample loss due to washing from the trowel. A trowel will not be used to collect sediment samples from water having a depth greater than 18 inches.

4.5.11.3 Surface-Water Sampling Technique

Surface water will be collected from the ponds on site as designated in Section 4.3. Surface-water samples can only be collected if water is present during the sampling event at those chosen locations. Surface-water samples will be collected immediately prior to sediment samples if both media are to be sampled at a specified location. Surface-water samples will be collected by placing the bottles directly into the water, except in the case where pre-preserved bottles are being used. When pre-preserved bottles are used, a clean, intermediate sample container will be employed to transfer the sample from the surface-water body to the actual sample bottle. If there is a flow of water, the sampler will collect the downstream samples first and work upstream to prevent downstream samples from becoming contaminated before being collected. The sampling procedures listed in Sections 4.5.11.3.1 through 4.5.11.3.3 will be followed.

4.5.11.3.1 Volatile Organic Compounds

- VOC sample vials will be preserved with concentrated HCl prior to collecting samples to minimize the chance of air bubbles being introduced into the samples.

- Three screw cap vials with teflon-lined silicone rubber septa (EPA-approved vials) will be filled to overflowing and sealed without any entrapped air bubbles. These vials will be 40 milliliters (ml) or larger.

- Each vial is placed in a cooler.

- The samples will not be composited.

- A sample collection log, a chain-of-custody form, a laboratory request for analysis form, and a sample label will be filled out in the field. These forms, except for the sample collection log, will accompany the samples to the laboratory.

- The sample vials will be placed in a cooler with sufficient packing to prevent breakage during shipment.

- The cooler will be packed with wet ice to maintain the samples at 4°C during shipment, sealed, and transported to the laboratory.

4.5.11.3.2 Semivolatile Compounds, Pesticides, and PCBs

- One liter amber glass sample bottles complete with teflon-lined caps will be filled to 90 percent capacity and sealed to allow 10 percent headspace to compensate for any pressure and/or temperature changes.

- The sample bottles will be placed in a cooler with sufficient packing to prevent breakage during shipment.

- A sample collection log, a chain-of-custody form, a request for analysis form, and a sample label will be filled out in the field. These forms, except for the sample collection log, will accompany the samples to the laboratory.

- Collected samples will be stored prior to shipping in an ice chest filled with wet ice and maintained at approximately 4°C or stored in an on site dedicated refrigerator at approximately 4°C.

- The cooler will be packed with wet ice to maintain the samples at approximately 4°C during shipment, sealed, and transported to the laboratory. To protect sample container integrity during shipment, the cooler will be packed with vermiculite and absorbent material.

4.5.11.3.3 Metals

- Samples will be placed in a 1-liter polyethylene or glass bottle.
- Bottles will be filled to within about 10 mls of capacity.
- Samples will be preserved to pH <2 using HNO_3.
- Samples will be stored on wet ice or in a refrigerator until packing for shipment to the laboratory.
- Samples will be placed in a cooler with sufficient packing to prevent breakage.

4.5.11.4 Groundwater Sampling Technique

Standard activities involved with groundwater sampling include DPT sampling, temporary piezometer construction, monitoring well drilling, construction and development, monitoring well elevation survey, water level measurements, removal of standing water in wells (i.e., well evacuation or purging), and retrieval of groundwater samples.

4.5.11.4.1 Groundwater Screening Sample Collection

Where subsurface features permit, groundwater screening samples will be collected using DPT. To locate the water bearing zone, continuous soil borings will be taken at selected groundwater screening sample locations. It is anticipated water will be encountered 4 to 8 feet below land surface (bls). Then a detachable drive tip attached to a 24 to 48-inch screen encased in a lead probe tube will be advanced into the water bearing zone. The probe then will be withdrawn 24 to 48 inches, allowing the retractable screen to open to the formation. Screening sample collection will adhere to development, water level measurement, purging, and sampling techniques outlined in Sections 4.5.11.4.4 through 4.5.11.4.7. In areas where subsurface features are not conducive to DPT, groundwater screening samples will be collected from a temporary monitoring well installed by hollow-stem auger (HSA) drilling, as described in Section 4.5.11.4.3.1.

For groundwater recovery, a length of tygon tube will be inserted into the probe and connected to a peristaltic pump. Three to five volumes will then be purged from the probe. Three volumes are sufficient if field parameters (measured with a Horiba U-10 Water Quality Checker) have stabilized. Three successive instrument readings meet the stabilization requirements outlined in Section 4.5.11.4.6.5. If parameters do not stabilize within three well volumes then up to five volumes will be purged prior to sampling. All purge water will be either placed directly into 55-gallon drums for later characterization and disposal or will be collected in 5-gallon containers and ferried to 55-gallon drums placed at a central location.

After sufficient purging, all samples except VOC samples will be collected by pumping directly into the sample container. Once water has been drawn into the tubing by pump suction, the pump will be shut off, the tubing will be crimped and disconnected from the pump, the tubing will be extracted from the boring, and VOC samples will be collected by uncrimping the tubing and filling sample vials by gravity-flow. The specific parameter groups will be handled and preserved as discussed in Section 4.5.11.4.7.

4.5.11.4.2 Temporary Piezometer Installation

If existing wells are not present in a groundwater subzone, a minimum of three groundwater screening sample locations will have a temporary piezometer installed. The temporary piezometers will be installed to provide real time water level measurements for the groundwater subzone(s) being investigated. The temporary piezometers will be small diameter [1 inch inner diameter (ID)] in size to a depth of 8 to 10 feet bls. They will remain in place for a period not to exceed one month. The installation of the temporary piezometer is discussed below.

Temporary piezometer installation will be recorded on the Monitor Well Installation Sheet as illustrated in Appendix D. All lines on the form will be filled in. The letter designation "NA" for not applicable or "NK" for not known will be used in all blank spaces. If some steps or procedures were not performed as described, the reason will be stated as completely as is practicable on the appropriate form or submitted as an attachment thereto. Actual materials utilized in the piezometer construction will be documented on the well-specific forms.

Each piezometer well will be constructed in the following manner:

- A borehole will be constructed using HSA technique to an approximate depth of 4 to 8 feet bls.
- The well will be constructed with National Sanitation Foundation (NSF) approved 4-foot long, 1-inch inner diameter (ID) schedule 40 polyvinyl chloride (PVC) 0.010-inch slot well screen with flush threaded joints.

- The bottom of the screen will be fitted with a flush-threaded PVC endcap.

- Piezometer will be cased using blank 1-inch ID schedule 40 PVC riser pipe to the surface. Joints will be flush threaded. Length of PVC riser will be 4 feet and it will also be NSF approved.

- Filter sand pack material will be a U.S. Standard sieve size 20/30 silica sand.

- The annulus between the well and the boring will be backfilled with the sand pack to a height of at least 2 feet above the top of the well screen if the depth to water is in excess of 4 feet bls. With a shallow water table less than 4 feet bls, the sand pack will extend at least 1 foot above the top of the well screen. As the sand pack is installed, the DPT rods will be pulled. Sand will always be maintained several inches up inside the augers to ensure adequate sand pack around the well.

- Where possible, approximately 1 to 2 feet of 1/4 to 3/8 inch bentonite pellets consisting of 90 percent montmorillonite clay will be placed above the sand pack and hydrated.

- All piezometers will be finished with a 3 foot stickup and locking cap.

4.5.11.4.3 Monitoring Well Installation and Sampling

All permanent monitoring wells will be installed in a consistent manner. Boreholes will be drilled using hollow-stem auger drilling techniques, and appropriate field forms will be prepared documenting the construction and completion of each well. The following sections describe the process for monitoring well installation and sampling.

4.5.11.4.3.1 Hollow-Stem Auger Drilling

Borings will be installed by HSA. The need for split-spoon sample collection and collection intervals will be determined in the field by the geologist. The interval at which a split-spoon sample is collected will be based on the specific purpose or needs of the sampling effort. The split-spoon sampler will be driven to the required depth by means of a drill-rig mounted hammer weighing 140 pounds falling 30 inches for each blow.

All split spoon samples obtained from the boreholes will be monitored immediately upon opening with an FID. These readings will be recorded on the boring logs.

The boreholes will be logged by a qualified geologist/hydrogeologist as the drilling proceeds. Boring and test logs will be generated to document subsurface conditions on the Visual Classification of Soils form, based on the American Society of Testing and Material's (ASTM's) D2488 Standard Practice for description identification of soils and the Unified Soil Classification System. The lithologic borehole descriptions submitted to EPA as part of the SI Report will include the following:

- Detailed lithologic description of each unit
- Split spoon blow counts and percent recovery
- Soil classification used
- Depth to first water encountered
- Termination depth of borehole

The methods and procedures for subsurface investigations under ASTM D1586 Method Penetration Test and Split Barrel Sampling of Soils will be followed during this investigation.

The drilling contractor will be responsible for securing boring or well drilling permits as required by the state and/or local authorities and for complying with state or local regulations with regard to the submission of driller's well logs, etc. B&R Environmental will also be responsible for complying with regulations regarding boring/well drilling safety as described in the HASP document. Field activity logs will be filled out on a daily basis to indicate drilling activities such as footage drilled and materials used. Well installation will follow all of the commonly accepted professional drilling procedures.

4.5.11.4.3.2 Well Installation

Monitoring well installation will be recorded on the Monitor Well Installation Sheet as illustrated in Appendix D. All lines on the form will be filled in. The letter designation "NA" for not applicable or "NK" for not known will be used in all blank spaces. If some steps or procedures were not performed as described, the reason will be stated as completely as is practicable on the appropriate form or submitted as an attachment thereto. Actual materials utilized in the well construction will be documented on the well-specific forms.

Each monitoring well will be constructed in the following manner:

- A borehole will be constructed using hollow stem augers technique to an approximate depth of 12 to 15 feet bls.

- The well will be constructed with NSF approved, 10-foot long, 2-inch ID schedule 40 PVC 0.010-inch slot well screen with flush threaded joints.

- The bottom of the screen will be fitted with a flush-threatened PVC endcap.

- Monitoring wells will be cased using blank 2-inch ID schedule 40 PVC riser pipe to the surface. Joints will be flush threaded. Length of PVC riser will be 10 feet and it will also be NSF approved.

- Filter sand pack material will be a U.S. Standard sieve size 20/30 silica sand.

- The annulus between the well and the boring will be backfilled with the sand pack to a height of at least 2 feet above the top of the well screen if the depth to water is in excess of 4 feet bls. With a shallow water table less than 4 feet bls, the sand pack will extend at least 1 foot above the top of the well screen. As the sand pack is installed, the HSA will be pulled. Sand will always be maintained several inches up inside the augers to ensure adequate sand pack around the well.

- Where possible, approximately 1 to 2 feet of 1/4 to 3/8 inch bentonite pellets consisting of 90 percent montmorillonite clay will be placed above the sand pack and hydrated. The bentonite pellets will be allowed to hydrate for minimum of 8 hours before the well is to be grouted. With a shallow water table, the top of the sand pack may be less than 2 feet below the land surface. In this event, most Florida Water Management Districts, the FDEP, and the SOUTHDIV Draft Monitoring Well Installation Guidelines recommend the use of a fine sand (30/65) secondary filter pack topped by grout in place of bentonite and grout.

- Wells will be grouted to the surface with a cement/bentonite mixture. Type 1 Portland cement will be used.

- Due to the shallow nature of the wells, grout materials will be placed by pouring the grout into the annulus of the boring.

- All wells will be fitted with bolted flush mount well covers.

- The well apron will be approximately 2 feet by 2 feet by 0.5 foot thick concrete. The concrete for the apron will extend into the borehole to top of the grout.

- A notch representing the top of casing measuring point will be filed or made permanently on the inner casing of each well and will be identified on the notes and well sketches.

A well completion report will be prepared for the installed well. This report will be included with the final report submitted to the EPA. The well completion report will contain the following:

- Survey of well location map with scale and orientation
- Type of casing material
- Length and diameter of casing material
- Elevation of the notched top of the casing, height of notched casing above ground level, and name of licensed surveyor
- Borehole depth and diameter
- Detailed lithologic borehole descriptions
- Size of screen slot and statement that the slot size was manufactured rather than field slotted
- Screened interval
- Materials and methods used to fill annulus of the boring
- Size and type of filter pack
- Method of installation and date
- Well development procedures and disposal method of development water, drilling fluids, and soils
- Security devices
- Decontamination procedures used on equipment between borings
- Any problems encountered during boring or well installation

- Method of coupling casing sections and screens

- Driller's and/or geologist's complete name(s)

4.5.11.4.4 Monitoring Well Development

The following procedure is presented for the proper development of monitoring wells for groundwater sampling purposes. Monitoring well development will be performed after the grout has cured.

Equipment and materials used in development will be properly cleaned and decontaminated prior to use as described in the following section. Development shall be accomplished with a small pump such as a centrifugal pump.

Well development will be performed to remove fine-grained material from around the well screen and sand pack and to obtain maximum achievable water clarity. Three to five times the amount of the standing water in the well will be removed. Within the three to five volumes, monitoring well development will continue until three consecutive field parameter readings are within the following criteria: pH+/-0.2 standard units, temperature +/-0.2°C., dissolved oxygen +/-0.2 milligrams per liter, specific conductance +/-10 microSiemens per centimeter, and turbidity less than or equal to 5 NTUs. Well development records will be maintained on well development forms, provided in Appendix D.

All water generated during well development will be collected in 5-gallon buckets and ferried to 55-gallon drums or a larger storage container. It is assumed that this material is non-hazardous in nature and will be disposed of on-site at a later date. However, contaminant levels in aqueous investigation-derived waste are above set limits, proper disposal of the water will be documented.

The following data will be recorded on the Well Completion Log contained in Appendix D, or an attachment thereof, as part of development:

- Well designation

- Date(s) of well installation

- Date(s) and time of well development

- Static water level before and after development

- Physical character of the removed water to include changes during development of clarity, color, and particulates

- Type and size/capacity of pump and/or bailer used

4.5.11.4.5 Water Level Measurements

All water level measurements in each monitoring well will be made from a surveyed measuring point located at the top of well casing. The measuring point will usually be positioned on the north side of the well casing and will be conspicuously marked for each measurement. Water level measurements will be made using an electronic probe.

Using an electronic water level indicator, the technician will lower the probe down the center of the well casing. When the probe enters the water, an alarm will sound. The depth to water from the measuring point will be recorded in a field log. The measurement will be repeated two more times to ensure the reading is accurate. The average depth to water will then be subtracted from the measuring point elevation to find the elevation of the water level in the well to the nearest 0.01 foot.

Water level measurements must be obtained at each sampling point every time water samples are collected. After each water level measurement, the probe will be decontaminated according to the following procedure:

- Wash with laboratory detergent and tap water.
- Rinse with tap water.
- Rinse with deionized water.

Total depth of each well will be determined by physical measurement (i.e., tape) and recorded on the appropriate forms when the well is completed.

4.5.11.4.6 Well Purging

All wells will be purged using a peristaltic pump with disposable tubing or teflon well bailers prior to sampling. All purged groundwater will be collected and containerized pending results of the laboratory analyses and determination of disposal options. To help minimize cross contamination, plastic sheeting will be placed around each well during purge events to prevent release of well water to the ground surface. Precleaned teflon tubing interfacing with silicon tubing at the pump head will be used for purging.

4.5.11.4.6.1 Volume Determination

Prior to purging a well, it will be necessary to determine the volume of water being held in the well casing. The calculation of the well volume will be conducted as follows:

- Measure inside diameter of well casing.
- Measure the static water level (as described above).
- Determine the total depth of the well from the measuring point.
- Calculate the number of linear feet of static water (total depth of well minus the static water level).
- Calculate the volume of water in a 2-inch ID well casing using the equation:

$$V = 0.1632h$$

Where,

V = Volume of water (gallons)
0.1632 = Conversion factor constant for well diameter of 2 inches
h = height of water in well (feet)

4.5.11.4.6.2 Placement of Intake Hosing

Monitoring wells will be purged from the top of the water column, even if a monitoring well is likely to go dry. This will force water to move up the well casing to the pump. Otherwise, water standing in the well above the screen may not be evacuated.

4.5.11.4.6.3 Pumping Rate

The pumping rate used for monitoring well purging will be kept to a minimum. Monitoring wells capable of yielding up to 1 gpm will be purged at the rate they are capable of producing. Wells that yield 1 to 5 gpm will be purged at approximately 1 to 2 gpm and wells capable of yielding more than 5 gpm will be purged at approximately 2 to 5 gpm. The flow rate of the pump may be measured using a graduated plastic bucket, graduated cylinder, or a totalizing flow meter.

4.5.11.4.6.4 Volume Purged

Three to five casing volumes will be removed prior to sample collection from the monitoring well. If field parameters including pH, temperature, specific conductivity, and turbidity have stabilized (see Section 4.5.11.4.6.5) after three casing volumes, the well will be sampled, otherwise up to five volumes will be purged prior to sampling. If the monitoring well goes dry during purging, it will be allowed to recover and then it will be sampled once it recovers.

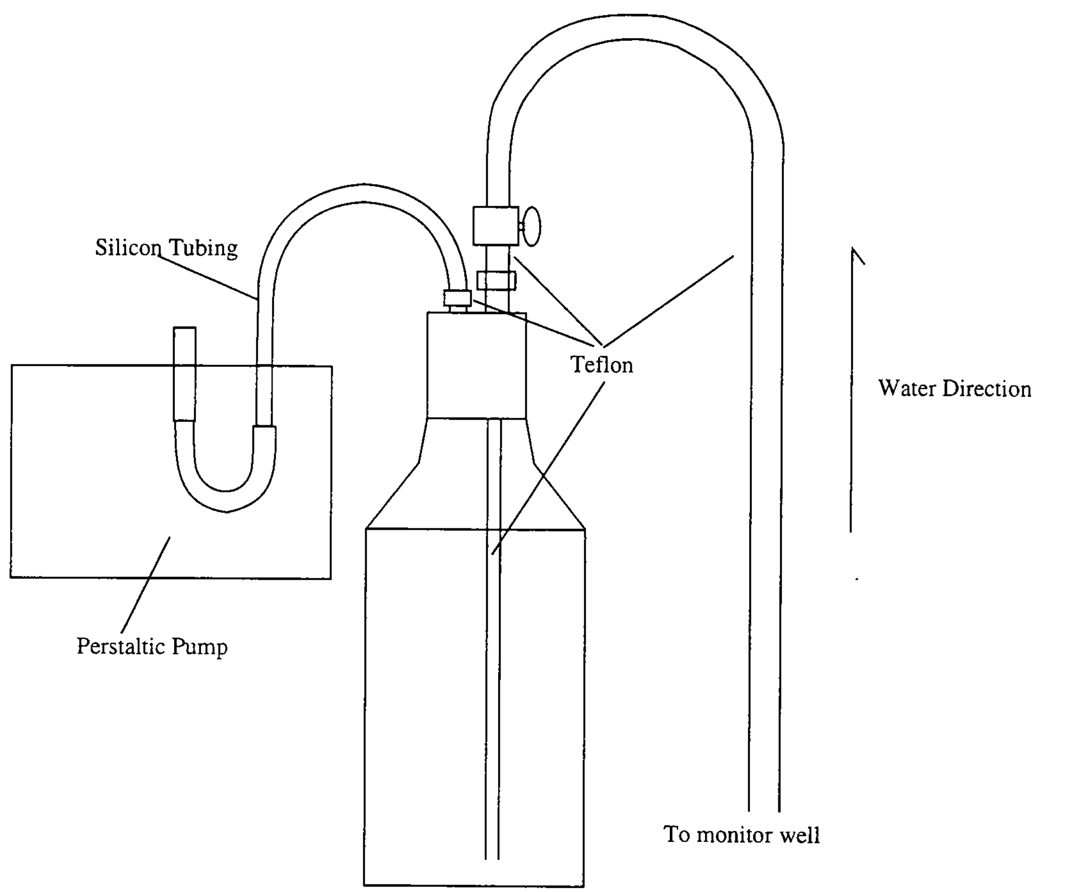
4.5.11.4.6.5 Well Stabilization

In addition to keeping track of the volume of water pumped from a monitoring well, the pH, specific conductivity, and temperature of discharge water will be monitored. A monitoring well will be considered to be sufficiently purged when these three parameters meet the stabilization criterion stated below, provided that a minimum of three casing volumes have been purged (Refer to Section 4.5.11.4.6.4). Temperature will be considered to be stabilized when three consecutive temperature readings are within +/-0.2°C of one another. When three consecutive pH readings are within +/-0.2 standard pH units, pH will be considered stabilized. Conductivity will be considered stabilized when each of three conductivity values are within 10 microSiemens per centimeter (umho/cm) of each other. Turbidity will be considered stabilized when the reading is less than 5 NTUs for three consecutive readings. Temperature, pH, turbidity, and conductivity values obtained during well purging will be recorded in field logbooks. It should be noted that after five well volumes have been purged, the well will be considered stabilized regardless of fluctuations in the above parameters.

4.5.11.4.7 Sample Collection

Immediately after a monitoring well has been properly purged, it will be sampled, unless the well has a very slow recharge rate, in which case, the monitoring well will be sampled within 3 hours. For all parameters except VOCs, wells will be sampled using a peristaltic pump and precleaned teflon tubing, interfaced with silicon tubing at the pump head. Metal samples will be collected first with the standard penistaltic pump set up, where the sample runs through both the teflon tubing and the silicon tubing in the pump head. The set-up will then be re-configured to match that in Figure 4-32, as required by FDEP, and any SVOC, pesticide, or PCB samples will be collected. Following this, for VOC samples, water will be drawn into the teflon tubing by pump suction, the tubing will be crimped and disconnected from the pump, and VOC samples will be collected by gravity-flow induced by uncrimping the tubing. All information will be recorded on a sample collection log form. An example of a sample collection log form used by B&R Environmental for recording well purging and sample collection data during groundwater sample collection is contained in Appendix D.

Water sample collection for VOCs, SVOCs, pesticides, and TAL metals plus tin will be performed in accordance with the procedures outlined in Sections 4.5.11.4.7.1 through 4.5.11.4.7.3.



To sample container is a glass bottle threaded to use either a permanent teflon-lined cap or a sampling cap with teflon insert similar to the design above.

FIGURE 4-32. PERISTALTIC PUMP SET-UP FOR SVOC, PESTICIDE, AND PCB SAMPLING

4.5.11.4.7.1 Volatile Organic Compounds

- VOC sample vials will be preserved by the laboratory with concentrated HCl to minimize the chance of air bubbles being introduced into the samples.

- Three screw cap vials with teflon-lined silicone rubber septa (EPA-approved vials) will be filled to overflowing and sealed without any entrapped air bubbles. These vials will be 40 ml or larger.

- Each vial will be placed in a secure cooler.

- The samples will not be composited.

- A sample collection log, a chain-of-custody form, a laboratory request for analysis form, and a sample label will be filled out in the field. These forms, except for the sample collection log, will accompany the samples to the laboratory.

- The sample vials will be placed in a cooler with sufficient packing to prevent breakage during shipment.

- Collected samples will be stored prior to shipping in an ice chest filled with wet ice and maintained at approximately 4°C or stored in an on-site dedicated refrigerator at approximately 4°C.

- The cooler will be packed with wet ice to maintain the samples at approximately 4°C during shipment, sealed, and transported to the laboratory. To protect sample container integrity during shipment, the cooler will be packed with vermiculite and absorbent material.

4.5.11.4.7.2 Semivolatile Compounds, Pesticides, and PCBs

- One liter amber glass sample bottles complete with teflon-lined caps will be filled to 90 percent capacity and sealed to allow 10 percent headspace to compensate for any pressure and/or temperature changes.

- The sample bottles will be placed in a cooler with sufficient packing to prevent breakage during shipment.

- A sample collection log, a chain-of-custody form, a request for analysis form, and a sample label will be filled out in the field. These forms, except for the sample collection log, will accompany the samples to the laboratory.

- Collected samples will be stored prior to shipping in an ice chest filled with wet ice and maintained at approximately 4°C or stored in an on site dedicated refrigerator at approximately 4°C.

- The cooler will be packed with wet ice to maintain the samples at approximately 4°C during shipment, sealed, and transported to the laboratory. To protect sample container integrity during shipment, the cooler will be packed with vermiculite and absorbent material.

4.5.11.4.7.3 Metals

- Samples will be placed in 1-liter polyethylene or glass bottles that have been pre-preserved with HNO_3.

- Bottles will be filled to within 10 mls of capacity.

- Samples will be stored on wet ice until packing for shipment to the laboratory or stored in an on site dedicated refrigerator at approximately 4°C. To protect sample container integrity during shipment, the cooler will be packed with vermiculite and absorbent material.

- Samples will be placed in a cooler with sufficient packing to prevent breakage.

4.5.12 Decontamination

All drilling equipment is expected to arrive at NAS Key West clean of all rust, soil, and other material from any previous activities. Any equipment with an extreme amount of rust will not be accepted to perform drilling activities. An inspection of the drilling apparatus (i.e., drill rig, direct push rig, etc.) will be performed to ensure that all oil, grease, and hydraulic fluid has been removed from the rig and all gaskets and seals are intact with no major leaks.

4.5.12.1 Drilling Equipment

Drilling equipment should be considered in two parts: the drilling apparatus (i.e., drill rig, direct push rig, etc.) and the downhole sampling equipment.

The drilling apparatus will be decontaminated by the following steps:

- Step 1: Steam clean and brush apparatus using tap water or wash apparatus with a brush using tap water and a laboratory grade detergent.
- Step 2: Rinse thoroughly with tap water.
- Step 3: Allow to air dry.

The downhole sampling equipment will be decontaminated by the following steps:

- Step 1: Steam clean and brush apparatus using tap water or wash apparatus with a brush using tap water and a laboratory grade detergent.
- Step 2: Rinse thoroughly with tap water.
- Step 3: Rinse thoroughly with organic-free water.
- Step 4: Rinse with pesticide-grade isopropanol.
- Step 5: Allow to air dry.
- Step 6: Repeat Step 3.

All drilling equipment will be decontaminated when it arrives at NAS Key West. Decontamination locations will be designed at specified locations on NAS Key West. A temporary decontamination catchment with sump will be erected to collect all decontamination liquids and solids. The Investigation-Derived Waste (IDW) Plan (Section 6.0) addresses the containerization, storage, and disposal of these wastes.

The drilling apparatus will be decontaminated between each Zone and decontaminated downhole sampling equipment will be used for each borehole.

4.5.12.2 Sampling Equipment

A variety of sampling equipment will be utilized during the execution of the SAP. This equipment includes reusable items such as stainless steel bowls, spoons, dredges, augers, and trowels. To limit the amount of IDW, disposable sampling items such as bailers and tubing may be used.

A designated area will be set aside for the decontamination of reusable sampling equipment. Following use, all reusable equipment will be placed in this area and decontaminated as needed. It will be assumed that any reusable equipment not wrapped in aluminum foil requires decontamination. As decontamination is carried out, the quantities of equipment decontaminated will be noted in the logbook. In order to ensure that all used equipment has undergone decontamination, the FOL will then compare the quantity of equipment decontaminated to the quantity of equipment used for sample collection.

The reusable sampling equipment will be decontaminated by the following steps:

- Step 1: Wash apparatus with a brush using tap water and a laboratory grade detergent.
- Step 2: Rinse thoroughly with tap water.
- Step 3: Rinse thoroughly with organic-free water.
- Step 4: Rinse with pesticide-grade isopropanol.
- Step 5: Rinse with organic-free water.
- Step 6: Allow to air dry.
- Step 7: Wrap in aluminum foil.

All waste soap, tap water, and organic-free water solutions will be disposed on-site. All waste solvents will be collected, containerized, and turned over to the base for disposal.

4.6 SAMPLE HANDLING AND ANALYSIS

All samples will be labeled, tracked, shipped, and analyzed based on the requirements outlined below.

4.6.1 Sample Custody

To support the integrity of the field data, it is necessary to document the location of sample collection and demonstrate that samples reach the laboratory without being altered prior to analysis. To accomplish this, evidence of the collection, shipment, laboratory receipt, and custody until disposal must be documented. The documentation will be performed with a chain-of-custody record. The chain-of-custody record tracks each sample and the individuals responsible for sample collection, shipment, and receipt. A sample will be considered in custody if it is in the possession of an authorized individual, in view after being in physical possession, or sealed and in a secured area restricted to authorized personnel.

B&R Environmental personnel will use the following chain-of-custody process for sample tracking:

- Sample identification and labeling
- Sample chain-of-custody form (includes laboratory request analysis)
- Container and custody seals
- Carrier airbill for shipping samples

4.6.1.1 Sample Identification and Labeling

All sample labels will be marked with a unique identifier (includes location and sample type), analyses, date and time of collection, preservative, and initials of sampler. The format for the unique identifier is explained in Section 4.3 (Sample Designation).

4.6.1.2 Laboratory Analysis Request and Chain-of-Custody Form

The laboratory analysis request will be accomplished with the use of the chain-of-custody form. The chain-of-custody form will be provided by the laboratory. The chain-of-custody form includes the sampling location, sample type and amount, date and time of collection, name(s) of persons responsible for sample collection, the number and type of laboratory analyses, date and time of all custody transfers, signature of the person relinquishing or accepting sample custody, and an explanation field. An example of this form is found in Appendix D. A copy of the completed chain-of-custody form will be maintained in the field file.

4.6.1.3 Sample Logsheet

A sample logsheet will be prepared for each media sampled to record information pertaining to the location, condition, and collection of a sample. The sample logsheets will be prepared either in the field or from field logbook notes in the office following field activities. The information to be recorded includes the following:

- Project name and number
- Date and time of collection
- Field personnel responsible for sample collection
- Sample identification and type (e.g., soil, water, sediment, etc.)

- Any field testing results (e.g., FID readings, pH, temperature, specific conductance, etc.)
- Sketch of sample location
- Weather conditions
- General field observation
- Depth of sample

4.6.1.4 Sample Packing and Shipment

Sample Storage

All samples will be collected and properly labeled according to Section 4.3. Samples will be put in individual zip-lock type plastic bags and placed in field coolers packed with ice. The field coolers will be sturdy and have the drain plug duct-taped if present. Samples will be transferred from the field coolers to a refrigerator or be repacked for shipment. Clean field coolers will be received from the laboratory, and the coolers will be cleaned as necessary during the sample collection, storage, and shipment process in order to ensure that no samples are packed in contaminated shipping containers.

Sample Packing

Packaging of samples will be accomplished by the following steps:

- Step 1: Double bag ice in one-gallon sealing plastic bags (e.g., typically 5 bags to a cooler).
- Step 2: Record sample container and analysis on chain-of-custody record.
- Step 3: Ensure that all sample containers have been sealed in plastic bags.
- Step 4: Wrap all glass sample containers with plastic packing material (e.g., place around plastic bag).
- Step 5: If present, duct-tape the drain plug of a sturdy cooler.
- Step 6: Line the cooler with a large heavy duty plastic bag (e.g., garbage bag).
- Step 7: Place 2 inches of vermiculite or comparable material in the bottom of the bag.

- Step 8: Place samples upright in the bottom of the prepared cooler.

- Step 9: Place ice bags into the cooler around upright samples.

- Step 10: Pour vermiculite or a comparable material into the cooler to fill any voids between samples.

- Step 11: To prevent breakage, check to see that none of the sample containers come into direct contact with one another.

- Step 12: Place ice bags on top of the samples.

- Step 13: Tape or tie shut heavy plastic bag to seal in samples.

- Step 14: Tape shut cooler lid(s) across top and down sides with packing tape (EXCEPT ONE COOLER TO PLACE COMPLETED CHAIN-OF-CUSTODY FORM).

- Step 15: Place two chain-of-custody seals on either side of each cooler.

<u>Shipment</u>

Samples will be shipped on average within 24 hours of collection. There may be incidences where sampling will be conducted on the weekend and shipping will not be available until the following Monday. Samples will be secured in refrigerators or iced coolers while awaiting shipment. Shipment will be accomplished by the following steps:

- Step 1: Place complete chain-of-custody record in a sealable plastic bag and tape to the inside of one cooler lid for entire shipment (e.g., HAVE SHIPPING AIRBILL NUMBER RECORDED ON CHAIN-OF-CUSTODY FORM. BE SURE TO SIGN AND RELINQUISH TO SHIPPER WITH DATE AND TIME).

- Step 2: Tape shut cooler lid across top and down sides with packing tape.

- Step 3: Place two (2) chain-of custody seals on either side of the cooler.

Transportation

Samples will be shipped in a manner to protect the integrity of the sample. B&R Environmental expects to sample only media (e.g., soil, sediment, surface water, groundwater) during the SI field effort. Therefore, the samples will be shipped as nonhazardous environmental samples. If there is any doubt as to the nonhazardous nature of the environmental samples Department of Transportation (DOT) procedures (49 CFR) for packing, marking, labeling, and shipping will be utilized.

4.6.1.5 Laboratory Receipt

An offsite laboratory contractor will be conducting the analytical work associated with this Workplan. The offsite laboratory will be responsible for the following:

- Delivery of appropriate sample containers with preservatives
- Sample receipt and check in
- Storage of samples
- Initiation of testing program
- Sample disposal
- Issuance of certificate of analysis

4.6.2 Sample Analysis

Analytical procedures were selected for the BRAC SI based on site history and existing data. Quality control (QC) samples will be collected and analyzed by the same procedures in order to ensure that the data are adequate and representative. Analytical procedures and QC samples are addressed in more detail below.

4.6.2.1 Analytical Procedures

Standard analytical methods have been selected to characterize the parameter groups of interest at the BRAC sites. Based on existing data and site history, sets of analytical parameters were defined for each subzone. These are shown in Table 3-4. Since the individual parameters vary depending on the analytical method, specific methods were selected based on the correlation between the parameters included in the method and known or suspected contaminants on the properties. Table 3-3 identifies the selected methods and the parameters selected for inclusion under each method. The methods were generally defined as described below:

- TAL metals and tin by SW-846 methods 6010/6010A and the 7000a series
- Target Compound List (TCL) PCBs by SW-846 method 8081/8082
- TCL pesticides by SW-846 method 8081/8081a
- TCL SVOCs by SW-846 method 8270b/8270c
- TCL VOCs by SW-846 method 8260a/8260b

Due to the June 1997 adoption of revisions to SW-846, two versions of most methods are designated here. Laboratories were given 6 months to adopt the revisions, and since the end of this grace period falls within the time frame of the BRAC SI, either version of a recently updated method may be employed.

4.6.2.2 Sample Quality Control

QC procedures are designed to assure the consistency and continuity of data. The frequency of QC checks is based on the type of analysis. Standard sample QC analyses include, but are not limited to, duplicate samples, equipment rinsate blanks, trip blanks, matrix spike and matrix spike duplicate samples, and field water blanks. All QC samples will be analyzed by the offsite laboratory performing analyses at DQO Level III. QC samples will be analyzed for the same parameters as the environmental samples collected during the site-specific sampling event, except for trip blanks, which will be analyzed for TCL VOCs only. Quantities and types of QC samples are provided in Table 4-4.

Other internal QC activities are undertaken during the performance of work to ensure that the service, designs, and documents produced meet currently accepted professional standards. QC on this assignment will entail periodic discussions among the technical staff, Project Manager, and Program Manager. An internal audit will be performed as described in Section 4.8.

4.7 SURVEYING

Sample location coordinates will be surveyed using a hand-held global positioning system (GPS) unit. In addition, several GPS readings will be taken at permanent physical features (e.g., building corners) on each site in order to confirm the placement of site features on existing figures. All coordinates will be saved in the GPS unit for down-loading to a database, and will also be noted in the logbook and on the appropriate sample collection forms.

TABLE 4-4

SAMPLE ANALYSIS, MATRIX, AND EXPECTED NUMBER OF QC SAMPLES NAS KEY WEST

Matrix	Number of Samples	Laboratory QC Samples[1]	Field QC Samples[2]
TCL Volatiles by SW-846 Method 8260b			
Solid	75 (69 SO/6 SD)	7 MS/7 MSD	10 TB, 5 RB, 8 Dups
Aqueous	100 (GW)	7 MS/7 MSD	10 TB, 10 Dups, 3 RB, 4 FB
TCL Semivolatiles by SW-846 Method 8270c			
Solid	87 (81 SO/6 SD)	6 MS/6 MSD	5 RB, 9 Dups
Aqueous	103 (96 GW/7 SW)	7 MS/7 MSD	11 Dups, 3 RB, 4 FB
TCL Pesticides by SW-846 Method 8081			
Solid	10 (4 SO/6 SD)	1 MS/1 MSD	1 RB, 1 Dup
Aqueous	0	--	4FB
TCL PCBs by SW-846 Method 8082			
Solid	12 (12 SO)	2 MS/2 MSD	1 RB, 2 Dups
Aqueous	0	--	4 FB
TAL Metals plus tin by SW-846 Methods 6010b/7000a			
Solid	99 (93 SO/6 SD)	7 MS/7 DUP	5 RB, 10 Dups
Aqueous	107 (100 GW/7 SW)	7 MS/7 DUP	11 Dups, 3 RB, 4 FB
Full TCLP by SW-846 Method 1311 and various Analytical Methods			
Solid	6[3]	1 MS/1 MSD	1 RB, 1 Dup

1 Laboratory QC samples [matrix spikes (MS) and matrix spike duplicates (MSD)] will be collected at a rate of one per every 20 samples (or 5 percent). When calculating the quantity of laboratory QC samples, all samples, blanks, and duplicates were considered.

2 Field water blanks (FB) will be collected from every water source used during the investigation. One trip blank will be analyzed per cooler of samples submitted for volatile organic analysis (VOA). It is estimated that 12 VOA samples will fit in a single cooler. Rinsate blanks (RB) will be collected from one of every 20 pieces of sampling equipment cleaned. The number may vary depending on the quantity of equipment used. One duplicate (Dup) sample will be collected for every 10 environmental samples.

3 The number of samples analyzed by Toxicity Characteristic Leaching Procedure (TCLP) and the resulting number of QC samples will depend on the quantity of solid investigation-derived waste (IDW) that is containerized. One sample will be analyzed for TCLP per 55-gallon drum of solid IDW. Solid IDW will be containerized only at those sites where the field operations leader (FOL) has reason to be believe the IDW may qualify as hazardous waste. At this time it is estimated that 6 drums or less of solid IDW will be containerized.

All monitoring wells will be surveyed by a certified land surveyor. An X-Y-Z coordinate system will be used to identify locations. Each monitoring well location will be measured from a reference point tied to the state plane system, where the X coordinate describes the east-west axis location (Easting) and the Y coordinate describes the north-south axis location (Northing). The vertical coordinates (Z coordinates) of each well will be surveyed in reference to the National Geodetic Vertical Datum.

All surveyed locations will be reported using the Florida State Plane Coordinate System-Eastern Zone. Existing installation benchmarks will serve as the horizontal and vertical data for the survey. Elevations and horizontal locations will be measured to the nearest hundredth of a foot. The elevations of all monitoring wells will be surveyed at the water-level measuring notch on the riser pipe and on the undisturbed ground surface adjacent to the pad, as well as on the pad itself.

4.8 GEOPHYSICAL SURVEY

A geophysical survey of East Martello Battery will be performed prior to sampling in order to determine the location of the tiled septic drain field located at the terminus of the septic line running through the southwest portion of the site. Electromagnetic survey methods will be employed, and the resultant data will be used to ensure that samples are appropriately located in order to adequately characterize the drain field area.

4.9 PERFORMANCE SYSTEM AUDITS AND FREQUENCY

Audits are performed to confirm that work being completed within the SI program complies with QA program goals. Internal audits of laboratory subcontractors are routinely conducted, and subcontracted laboratories must be both Contract Laboratory Program (CLP) and SW-846 qualified and Naval Facilities Engineering Service Center (NFESC) approved.

All primary documents will receive internal technical reviews, and a minimum of one internal audit will be scheduled for the SI program. Technical reviews and internal audits will be performed in accordance with the Quality Assurance elements in the Workplan and Appendix E. A minimum of one internal audit will be scheduled by the Quality Assurance Manager (QAM) in coordination with the FOL during the SI sampling activities. All audit records, including audit plans, reports, written responses, and corrective action forms, will be maintained with the project files.

4.10 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Management personnel at all levels will receive QA reports appropriate to their level of responsibility. The QAM will receive copies of all QA documents. QC documentation will be maintained in the project files. Other types of QA reports may include periodic assessment of measurements data accuracy, precision, and completeness; results of performance audits and/or systems audits; significant QA problems and recommended solutions for future projects; and status of solutions to any problems previously identified. Additionally, incidents requiring corrective action will be fully documented. These reports will be provided to the QAM and, in turn, will be submitted to management. The summary of findings will be factual, concise, and complete. Supporting information will be appended to the report.

5.0 DATA MANAGEMENT PLAN

The data management plan describes how the results of the sampling and field measurements will be assessed, validated, documented, tracked, and reported. Project documentation procedures, filing requirements, and formats used to report data and conclusions are described in this section.

5.1 DATA QUALITY ASSESSMENT (DQA)

Data collected from the investigation activities include survey data and laboratory analytical data. All survey calculations will be reviewed and verified. All analytical data will undergo a data review. Results from QC samples including duplicates, matrix spikes and matrix spike duplicates, and blanks will be reviewed and used as a potential basis for rejecting analytical data points. Data review will also entail calculations of accuracy, precision, representativeness, comparability, and completeness that are designed to assess the general quality of the dataset. All electronic data will be verified against supporting documentation. Any inconsistencies between the electronic data supplied by the laboratory and the corresponding Certificates of Analyses or Chains of Custody will be clarified and corrected.

5.2 MAPS

Maps will be prepared showing features including potential receptors, study areas, and sampling and field measurement locations. As discussed under Section 5.3, maps also will be employed to provide a spatial representation of site data.

5.3 DATA PRESENTATION FORMAT

The reduction of field and analytical data will consist of summarizing water level measurements, soil boring logs, well logs, field parameters, and analytical results. These summaries will be presented as tables, illustrations, and/or graphics. The complete array of this data will be available in appendices to the report, while summaries of pertinent information will be included in the main body of the report. Chemical data and some physical data will be stored and managed with a data management system. The system will be capable of sorting data by a number of different parameters and presenting the data in tabular form. All detections of each analytical parameter at a given site will be presented in a table and will be sorted by fraction, parameter, and result.

Several types of data will be represented pictorally. Soil boring logs and well logs will be included in an appendix to the report, and will be represented graphically. Groundwater level measurements will be documented numerically in the appendix that includes field data forms, and will also be shown in the main body of the report on maps characterizing the observed groundwater flow direction. Additionally, in order to clearly document the nature and extent of contamination at the sites under investigation, any data points in excess of action levels will be depicted on site maps.

All raw data will be appended to the report. This will include a copy of the electronic analytical database, all Certificates of Analyses, soil borings, well logs, surveying data, and all field data collection forms. Additionally, an appendix will be included documenting the modifications to the Comprehensive Background Dataset (B&R Environmental, 1997b) that were necessary in support of the SI.

6.0 INVESTIGATION DERIVED WASTE PLAN

Based on previous sampling efforts and the history of the properties under investigation, it is unlikely that RCRA hazardous IDW will be generated by site investigations at the 10 BRAC zones under consideration. Although it is assumed that the solid [e.g., soil, sediment, and personal protective equipment (PPE)] and aqueous wastes (e.g., groundwater, surface water, and decontamination fluids) generated during the SI will be RCRA nonhazardous wastes, professional judgment will be used along with field screening to evaluate each IDW waste stream to ensure its RCRA nonhazardous nature.

All aqueous waste streams will be containerized in 55-gallon drums and ferried to a central storage area. Each drum will be labeled to identify the source of the contents. The results of groundwater analyses from the monitoring well that corresponds to a given drum will be used to characterize its contents.

Assuming that the use of DPT is effective at NAS Key West, only small amounts of soil waste are expected from soil sampling and groundwater screening. Larger quantities of solid IDW will generated from the installation of monitoring wells with the HSA technique. In accordance with EPA's guidance on the handling of IDW, solid material will be left at the location of origin, unless the FOL has reason to believe it may constitute a RCRA hazardous waste (EPA, 1992). In this event, the solid IDW will also be containerized in 55-gallon drums and ferried to a central storage location. A sample will be collected from each drum of solid IDW and submitted for a full TCLP analysis under SW-846 method 1311. Assuming the successful use of DPT in obtaining soil and groundwater screening samples, a relatively small amount of solid IDW will be generated during the initial portion of the investigation, and the initial environmental samples will provide an indication of the nature of waste that will be generated during monitoring well installation. Based on this assumption, it is estimated that only five to six drums of solid IDW will require containerization.

Waste containers and characterization information will be remanded into base custody for disposal. If the characterization information confirms the nonhazardous nature of the IDW, it will be disposed of onsite. In the event any of the waste is determined to be RCRA hazardous, it will be containerized, handled, and disposed of accordingly.

6.1 METHODS OF WASTE QUANTITY MINIMIZATION

The SI soil boring, monitoring well installation, and sampling will be conducted to minimize the quantities of solid and aqueous IDW. Since the water table is very shallow on Key West, surface soil borings will be shallow in nature (0 to 1.5 ft bls) and the subsurface borings for the monitoring wells will be no more than 12 ft bls on average. Surface soil borings will be performed with direct-push technology to minimize cuttings and decontamination fluids. Where possible, subsurface borings also will be performed using DPT; however, in instances where this is not possible, conventional auger drilling methods will be employed. Soil samples will be taken directly from the direct-push and drilling split spoons.

Cardboard, glass, paper, metal, and plastic will be transported for recycling at NAS Key West Trumbo Point Recycling Center or stored for reuse on future NAS Key West field activities if possible. Onsite recycling was performed during the supplemental RFI/RI activities (September 1996) with great success, significantly reducing the amount of solid waste generated. Excess expendable materials were left at NAS Key West for use during the CMS field activities (November 1996).

6.2 TYPES AND QUANTITY OF WASTES

IDW generated during the field effort will include soil from surface and subsurface borings, groundwater from well development and purging, decontamination water, PPE, and sanitary wastes. In a worst case scenario, assuming all wells are installed by conventional auger drilling method, approximately 1,430 gallons (equivalent to 26 55-gallon drums, if all soil IDW were being containerized) of soil waste will be generated from subsurface borings (approximately 27 gallons per boring). In reality, actual quantities of soil IDW should be much lower than this estimate, as DPT will be used whenever practicable for the groundwater screening samples. It is estimated that 4,400 gallons of groundwater IDW will be produced during the course of the field investigation (approximately 83 gallons of development and purge water per monitoring well and screening sample). Decontamination fluids will include those fluids resulting from the decontamination of spoons and bowls used for sediment sampling (and soil sampling in any instance where conventional auger drilling methods are used), direct-push sampling equipment, and drilling equipment. It is estimated that the total amount of decontamination fluid will be less than 2 55-gallon drums (110 gallons). Sanitary solid waste will be generated from nonrecyclable containers, plastic, waste foods, and PPE (e.g., gloves). It is estimated that 300 pounds of sanitary wastes could be generated.

6.3 APPLICABLE OR APPROPRIATE AND RELEVANT REQUIREMENTS OF CONCERN

Each container of solid IDW will be characterized through TCLP testing. The TCLP limits established by EPA will be used to evaluate the results of the analyses.

The contents of each container of aqueous IDW will be characterized based on the analytical results that correspond to the monitoring well where the waste fluids originated. The analytical results will be evaluated through a comparison with the groundwater action levels, as well as a comparison to EPA's TCLP limits.

6.4 ONSITE HANDLING METHODS

IDW will be handled as follows:

- All aqueous IDW will be containerized and labeled with the medium, date generated, and the source.
- All solid IDW that is suspected of constituting a hazardous waste will be containerized.
- All solid IDW for sites where existing information supports a nonhazardous classification will be left at the location of origin.
- All containers of solid IDW will be characterized through laboratory analyses (TCLP testing).
- All containers of aqueous IDW will be characterized based on groundwater analytical data.
- Nonhazardous groundwater and decontamination fluids will either be poured onto the ground to allow infiltration or will be treated at the base Federally Owned Treatment Works (FOTW).
- Any hazardous aqueous IDW will be disposed of in accord with the provisions of RCRA.
- All waste solvents from the decontamination process will be containerized, labeled, and turned over to base personnel for proper disposal.
- Decontaminated PPE will be double bagged and deposited in a site dumpster.

6.5 CONTAINERIZATION, STORAGE, AND TESTING OF WASTE

Any solid IDW suspected of being hazardous and all aqueous IDW will be containerized in 55-gallon drums and ferried to a central accumulation area. The containers will be labeled with a BRAC Zone identifier, the date of generation, and the media type. A sample from each container of solid IDW will undergo TCLP testing to determine the nature of the waste.

7.0 PROJECT MANAGEMENT PLAN

This section identifies key roles in the project and program organization and specifies on the proposed project schedule.

7.1 KEY PROJECT PERSONNEL

The following highlights key individuals in the Brown & Root Environmental Comprehensive Long-Term Environmental Action, Navy (CLEAN) program and this SI. Project organization is depicted on Figure 5-1.

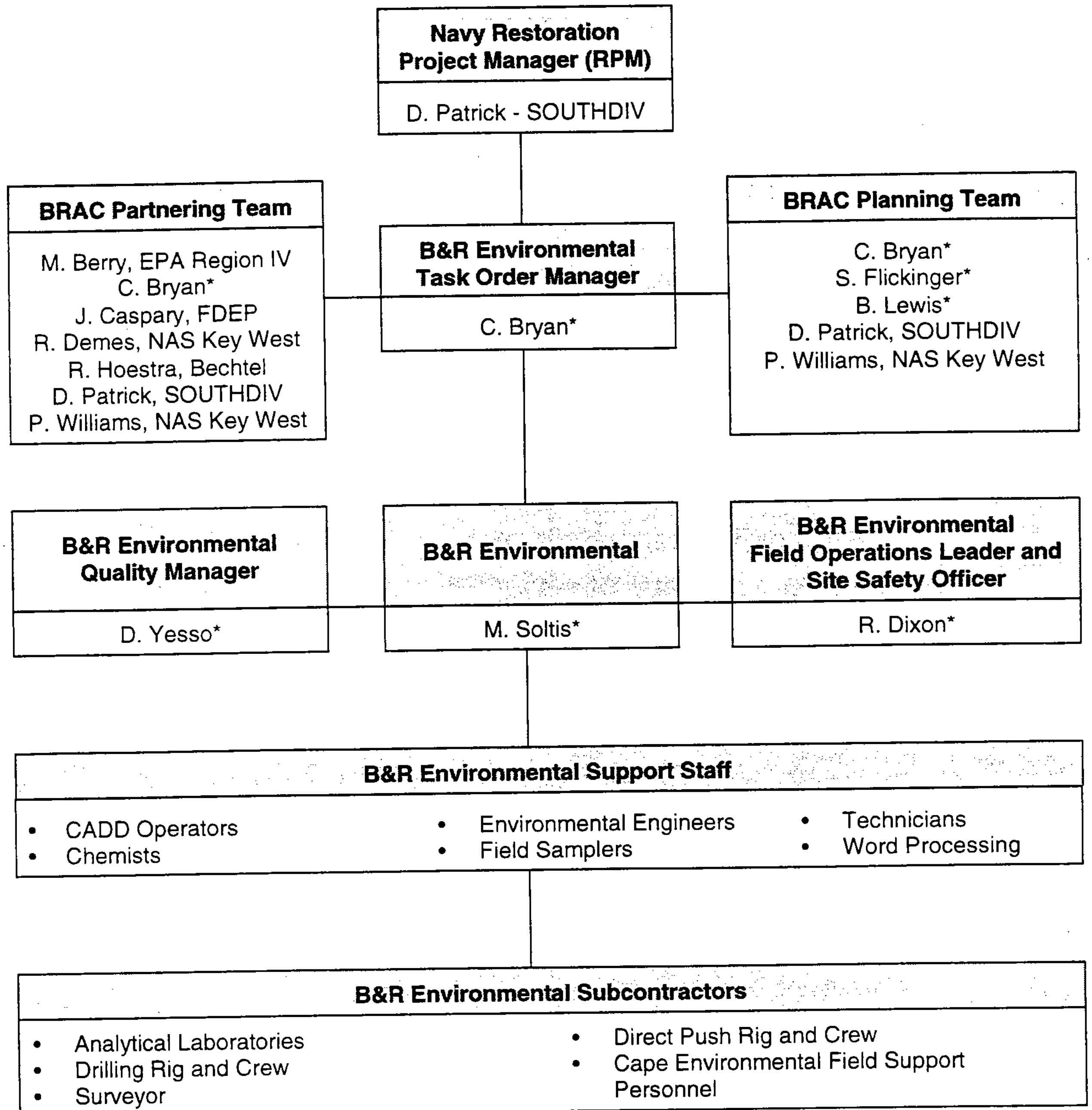
Southern Division, Naval Facilities Engineering Command (SOUTHDIV) is responsible for establishing policy guidance for the CLEAN program. SOUTHDIV awards contracts, approves funding, and has primary control of report release and interagency communication.

7.1.1 SOUTHDIV Remedial Project Manager

The SOUTHDIV Remedial Project Engineer, Mr. Dudley Patrick, is responsible for the technical and financial management of the SI activities at NAS Key West. Mr. Patrick is the primary project contact. He prepares the project statement of work; manages the project scope, schedule, and budget; and provides technical review and approval of all deliverables. Mr. Patrick will be responsible for approving changes in the scope of work identified during Project Manager's Meetings.

7.1.2 Base Realignment and Closure Partnering Team

The Partnering Team is a structured approach for the Navy SOUTHDIV, and NAS Key West Public Works, the SOUTHDIV contractor, FDEP, and EPA Region IV to work together in the interest of a project. For the BRAC SI, the Partnering Team met to determine the DQOs for the project. The role of the Partnering Team is to come to consensus on the pertinent decisions for the project prior to the execution of the investigation. The Partnering Team will continue to review decisions for the project until the final report is completed.



* Personnel employed by B&R Environmental.

FIGURE 7-1. PROJECT ORGANIZATION CHART - NAS KEY WEST BASE REALIGNMENT AND CLOSURE SITE INVESTIGATION

7.1.3 B&R Environmental Task Order Manager

The Task Order Manager (TOM) for the SI is responsible for evaluating the appropriateness and adequacy of the technical and engineering services provided. He/she is responsible for financial and schedule management and for ensuring that the project fulfills and remains within the contracted scope of work. He/she will be responsible for identifying necessary changes in the scope of work during Project Manager's Meetings. The TOM is also responsible for the daily conduct of work, including integration of input from supporting disciplines and subcontractors and will serve as the primary project contact.

7.1.4 BRAC Planning Team

The BRAC Planning Team is a subgroup of the BRAC Partnering Team made up primarily of the Navy and its contractors. The Planning Team is often tasked with the action items of the Partnering Team or the DQO issues of the investigation.

7.1.5 B&R Environmental QA Manager

The TOM and Field Operations Leader (FOL) are supported by a QA Manager who will report to the Program Manager (PM). The QA Manager will oversee the implementation of appropriate NFESC and EPA protocols. The QA Manager will also work with the TOM to establish QC procedures.

7.1.6 B&R Environmental Health and Safety Manager

The TOM and FOL are supported by the Health and Safety Manager (HSM) who will report to the PM. The HSM will oversee the implementation of the appropriate corporate health and safety requirements and the CLEAN Program HASP.

7.1.7 B&R Environmental Field Operations Leader

The FOL is responsible for the field support staff and subcontractors executing the Site Investigation Sampling and Analysis Plan in the field. The FOL will be the field liaison between SOUTHDIV and the NAS Key West point of contact. On small field efforts, the FOL will also act as the Site Safety Officer.

7.1.8 Site Safety Officer

The Site Safety Officer is responsible for field support staff and subcontractor compliance with corporate health and safety requirements and the CLEAN program Health and Safety Plan (HASP). Conformance with safety protocols will be assessed though periodic site visits and daily supervision by the FOL. For this project, the FOL will act in this role.

7.2 PROJECT SCHEDULE

A tentative project schedule for the BRAC SI at NAS Key West is summarized on Figure 7-2.

Act ID	Description	Orig Dur	Early Start	Early Finish
500	**NAS KEY WEST, BRAC SI**	**349d**	**01OCT97**	**12FEB99**
1000	**PROJECT MANAGEMENT**	**349d**	**01OCT97**	**12FEB99**
1010	Notice to Proceed	0	01OCT97	
1020	Project Support	288d	01OCT97	16NOV98
1030	Project Closeout	62d	16NOV98	12FEB99
1040	End Project	0	12FEB99	
2000	**COMMUNITY RELATIONS**	**288d**	**01OCT97**	**16NOV98**
2010	TRA/RAB Meeting Support	288d	01OCT97	16NOV98
3000	**FIELD INVESTIGATIONS**	**64d ***	**13NOV97**	**13FEB98**
3010	Field Authorization	0	13NOV97	
3020	Field Operations Management	90d	13NOV97	13FEB98
3030	Geoprobe Sampling	61d	14NOV97	16JAN98
3040	Drilling	58d	02DEC97	30JAN98
3050	Surveying	8d	06FEB98	13FEB98
3060	IDW Management/Demobilization	89d	14NOV97	13FEB98
3070	End Field Operations	0	13FEB98	
4000	**LABORATORY ANALYSIS**	**77d ***	**17NOV97**	**06MAR98**
4010	Media Sample Analysis	107d	17NOV97	06MAR98
5000	**DATA VALIDATION**	**88d ***	**01DEC97**	**03APR98**
5010	Data Review	122d	01DEC97	03APR98
6000	**DATA EVALUATION & REPORT**	**696d**	**04APR98**	**27NOV98**
6010	Prepare Draft SI Report	55d	04APR98	29MAY98
6020	On-Board Navy Review	11d	01JUN98	15JUN98
6030	Submit Draft SI Report to Regulators	0	13JUL98	
6040	Regulator Review of Draft SI	60d	14JUL98	06OCT98
6050	Comment/Response Meeting with Regulators	1d	06OCT98	06OCT98
6060	Prepare Final SI Report	22d	06OCT98	04NOV98
6070	Submit Final SI Report	1d	04NOV98	04NOV98
6080	Government Approval of Final SI Report	0	27NOV98	

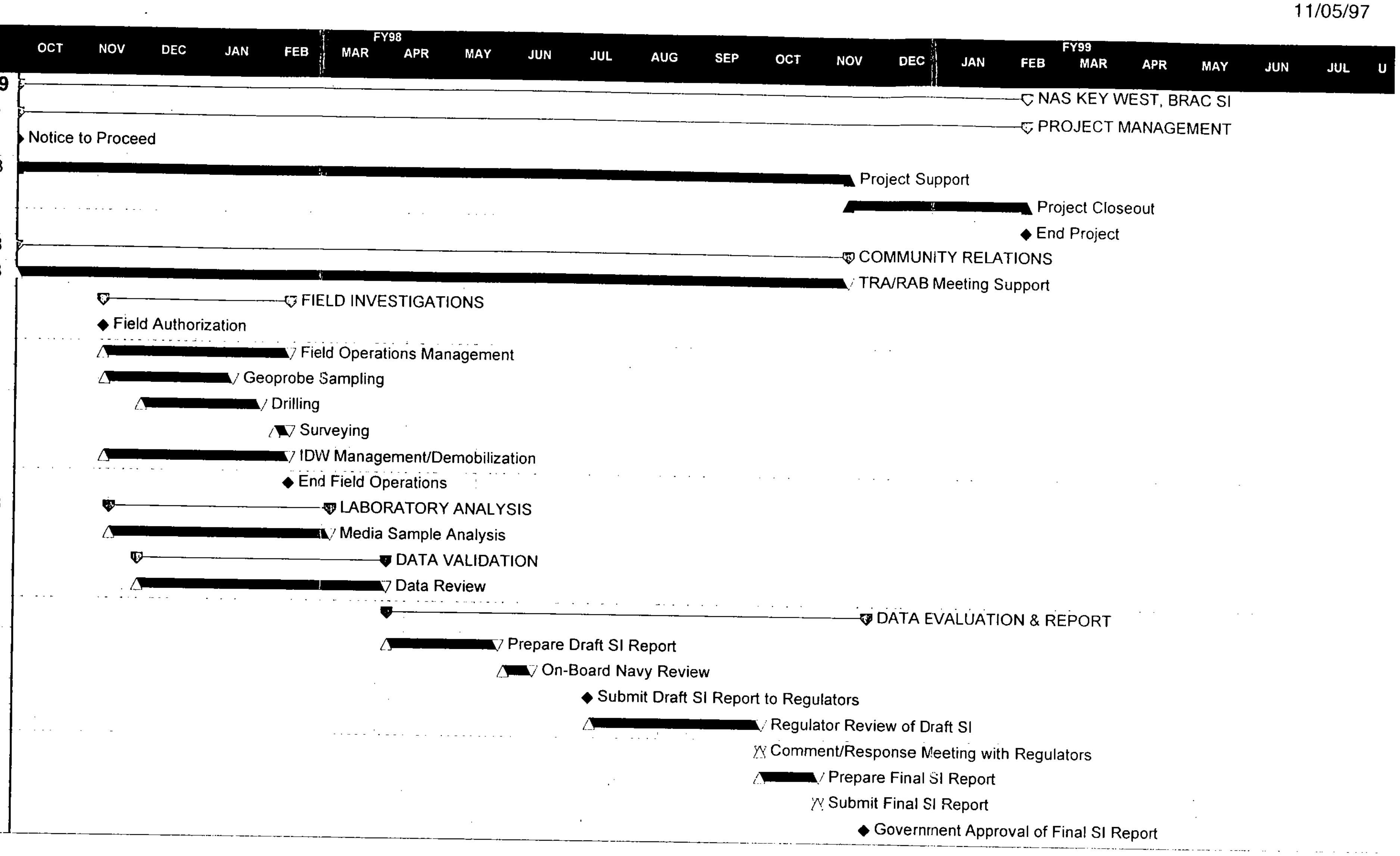
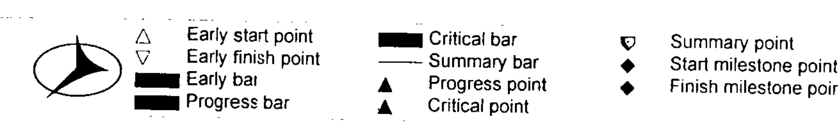


FIGURE 7-2. PROJECT SCHEDULE FOR THE BRAC SI AT KEY WEST.



REFERENCES

ABB (ABB Environmental Services, Inc.), 1995, Facility and Remedial Investigation NAS Key West, Workplan, Volume 1 and Sampling and Analysis Plan, Volume 2, prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command, Tampa, Florida, June.

B&R Environmental (Brown and Root Environmental), 1996, B&R Environmental/Navy Site Visit, November.

B&R Environmental (Brown and Root Environmental), 1997a, B&R Environmental/Navy Site Visit, March.

B&R Environmental (Brown & Root Environmental), 1997b, Comprehensive Background Report for Naval Air Station, Key West, Florida, prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command, Aiken, South Carolina.

CAPE Environmental Management, Inc., 1997, Lead-Based Paint Survey of the Naval Family Housing Located at Poinciana Plaza, March.

Deyrup, M. and R. Franz, 1994, Rare and Endangered Biota of Florida, Invertebrates, Florida Committee on Rare and Endangered Plants and Animals, University Press of Florida, Gainesville, Florida.

EPA (U.S. Environmental Protection Agency), 1992, Guide to Management of Investigation-Derived Wastes, Office of Solid Waste and Emergency Response, Washington, D.C., April.

EPA (U.S. Environmental Protection Agency), 1994, Guidance for the Data Quality Objectives Process, EPA QA/G-4, Quality Assurance Management Staff, Washington D.C., September.

FNAI (Florida Natural Areas Inventory/The Nature Conservancy), 1994, Ecological Survey of U.S. Navy Property in the Lower Florida Keys, Monroe County, Florida, Florida Natural Areas Inventory, Tallahassee, Florida.

Frank, P., 1996, Florida Game and Fresh Water Fish Commission, personal communication to M. L. Whitten, Brown & Root Environmental, Aiken, South Carolina, July.

Gilbert, C. R. 1992, Rare and Endangered Biota of Florida, Fishes, Florida Committee on Rare and Endangered Plants and Animals, University Press of Florida, Gainesville, Florida.

IT Corporation, 1994, RCRA Facility Investigation/Remedial Investigation, Final Workplan and Sampling and Analysis Plan, NAS Key West, Boca Raton, Florida, prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command, Tampa, Florida, March.

Myers, R. L. and J. J. Ewel (eds.), 1990, Ecosystems of Florida, University of Central Florida Press, Orlando, Florida.

Schuetz, A., 1996, Naval Air Station Key West, Boca Raton, Florida, personal communication with M. L. Whitten, Brown & Root Environmental, Aiken, South Carolina, August.

USCBS (U.S. Census Bureau Service), 1990, U.S. Census, 1990.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1992a, Contamination Assessment Report (CAR) for Electric Power Plant Building 103, September.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1992b, Contamination Assessment Report (CAR) for Berthing Wharf Bldg, 189, February.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1993a, Contamination Assessment Report (CAR) Addendum for Electric Power Plant Building 103, September.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1993b, Contamination Assessment Report (CAR) Addendum for Berthing Wharf Bldg, 189, November.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1996a, Predraft EBS Poinciana Housing, October.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1996b, Contamination Assessment Report (CAR) for Trumbo Point Fuel Farm, October.

USN - NPWC (U.S. Navy - Navy Public Works Center), 1995, Lead and Asbestos Survey of Poinciana Housing, May 22.

USN - SUPSHIP (U.S. Navy - Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment), 1996, Predraft EBS Realignment Parcels; Environmental Baseline Survey, October.

Appendix A

Health and Safety Plan

Health and Safety Plan
for
Base Re-Alignment and Closure Site Investigation

Naval Air Station Key West
Key West, Florida

Southern Division
Naval Facilities Engineering Command
Contract No. N62467-94-D-0888
Contract Task Order 0032

October 1997

HEALTH AND SAFETY PLAN
FOR
BASE RE-ALIGNMENT AND CLOSURE SITE INVESTIGATION
AT
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY 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 NO. N62467-94-D-0888
CONTRACT TASK ORDER 0032

OCTOBER 1997

SUBMITTED BY:

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APPROVED BY:

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CLEAN HEALTH & SAFETY MANAGER
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1.0 INTRODUCTION

The objective of this Health and Safety Plan (HASP) is to provide the minimum safety practices and procedures for Brown & Root Environmental (B&R Environmental) personnel conducting various Site Investigation (SI) activities to support Base Re-Alignment and Closure (BRAC) activities at the Naval Air Station (NAS) Key West, located in Key West, Florida.

This HASP has been prepared using the latest available information regarding known or suspected chemical contaminants and potential and foreseeable physical hazards associated with the planned work at NAS Key West. This HASP has been designed to be used in accordance with the Brown & Root Environmental Health and Safety Guidance Manual. The Guidance Manual provides detailed information pertaining to procedures to be performed on site as directed by the HASP, as well as B&R Environmental standard operating procedures.

The Health and Safety Guidance Manual and this HASP have been developed to be used together. It is recommended that both documents be present at the site to comply with the requirements stipulated in the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.120.

This HASP has been written to support proposed tasks and techniques associated with the scope of work as presented in Section 4.0. Should the proposed work site conditions and/or suspected hazards change, or if new information becomes available, this document will be modified. All changes to the HASP will be made with the approval of the B&R Environmental CLEAN Health and Safety Manager (HSM) and the Task Order Manager (TOM). The TOM will notify all affected personnel of all changes.

The elements of this HASP are in compliance with the requirements established by OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER). The information contained in this plan, as well as policies on conducting on site operations, have been obtained from the B&R Environmental Health and Safety Program and NAS Key West policies and procedures.

1.1 AUTHORITY

This work is authorized under the Comprehensive Long - Term Environmental Action Navy (CLEAN) contract, administered through the U.S. Navy Southern Division Naval Facilities Engineering Command, as defined under Contract No. N62467-94-D-0888; Contract Task Order Number 0032.

1.2 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibilities for site safety and health for B&R Environmental and subcontractor employees conducting environmental sampling and other field activities. Personnel assigned to these positions shall exercise the primary responsibility for all on site health and safety. These persons will be the primary point of contact for any questions regarding the safety and health procedures and the selected control measures.

- The B&R Environmental TOM is responsible for the overall direction and implementation of health and safety for this work.

- The B&R Environmental Field Operations Leader (FOL) is responsible for implementation of this HASP. The FOL manages field activities, executes the work plan, and enforces safety procedures, as applicable to the work plan. Specifically, the FOL will:

  - Verify training and medical status of on-site personnel in relation to site activities.
  - Assist and represent B&R Environmental with emergency services (if needed)
  - Provide elements site-specific training for all on site personnel.

- The B&R Environmental Site Safety Officer or their representative supports the FOL concerning all aspects of health and safety including, but not limited to:

  - Coordinating all health and safety activities
  - Selecting, applying, inspecting, and maintaining personal protective equipment
  - Establishing work zones and control points
  - Implementing air monitoring procedures
  - Implementing hazard communication, respiratory protection, and other associated safety and health programs
  - Coordinating emergency services
  - Providing elements of site-specific training

- Compliance with these requirements is monitored by the Project Health and Safety Officer (PHSO) and is coordinated through the HSM.

1.3 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Naval Air Station (NAS) Key West **Address:** Key West, Florida

Site Point of Contact: Mr. Phillip Williams **Phone Number:** (305)293-2061

Purpose of Site Visit: B&R Environmental will conduct various environmental sampling and field activities to supporting Base Re-Alignment and Closure activities at NAS Key West. See Sections 3.0 and 4.0 for details concerning the site background and scope of work.

Proposed Dates of Work: November 1997 - February 1998

Project Team:

B&R Environmental Personnel:	Discipline/Tasks Assigned:
Mr. Chuck Bryan	Task Order Manager (TOM)
Ms. Regina Dixon/Scott Flickinger (alternate)	Field Operations Leader (FOL)
Matthew M. Soltis, CIH, CSP	Health and Safety Manager (HSM)
Delwyn E. Kubeldis, CIH, CSP	Project Health and Safety Officer (PHSO)
Devin Kennemore/Marty Ray	Sampler
Regina Dixon	Site Safety Officer (SSO)
Paul Calligan	Geologist
To be determined	Surveyor

Subcontractor Personnel:	Discipline/Tasks Assigned:
To be determined	Drilling Subcontractor
To be determined	Direct Push Technology Subcontractor
To be determined	Cape Environmental Field Technician

Prepared by: Delwyn E. Kubeldis, CIH, CSP

Reviewed and Approved by:

Chuck Bryan
Task Order Manager

Matthew M. Soltis, CIH, CSP
CLEAN Health & Safety Manager

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a preplanning effort to direct and guide field personnel in the event of an emergency. However, given the nature of the work planned significant emergencies are not anticipated. Also, since a majority of potential emergency situations will require assistance from outside emergency responders, B&R Environmental personnel will not provide emergency response support for emergency events beyond the capabilities of on site personnel. In the event of emergencies that cannot be handled by personnel, an evacuation will be initiated. In an evacuation, site personnel will move to a safe place of refuge and the appropriate emergency response agencies will be notified. The emergency response agencies listed in this plan are capable of providing the most effective response, and as such, will be designated as the primary responders. These agencies are located within a reasonable distance from the area of operations, which ensures adequate emergency response time. This emergency action plan conforms to the requirements of OSHA Standard 29 CFR 1910.38(a), as allowed in OSHA 29 CFR 1910.120(l)(1)(ii).

B&R Environmental personnel will, through the necessary actions, provide incidental response measures for incidents such as:

- Incipient Fire and spill prevention and response
- Removal of personnel from emergency situations
- Provision of initial medical support for injury/illnesses requiring only first-aid level support
- Provision of site control and security measures, as necessary

2.2 PRE-EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, there is very minor potential for injury or illnesses resulting from exposure to chemical, physical, or other hazards, and subsequently little likelihood of emergency situations. To further minimize or eliminate potential emergency situations, pre-emergency planning activities associated with this project shall be implemented. The FOL is responsible for:

- Coordinating response actions with NAS Key West Emergency Services personnel to ensure that B&R Environmental emergency action activities are compatible with existing facility emergency response procedures.
- Identifying a chain of command for emergency action.
- Educating site workers to the hazards and control measures associated with planned activities at the site, and providing early recognition and prevention, where possible.

2.3 EMERGENCY RECOGNITION AND PREVENTION

2.3.1 Recognition

Foreseeable emergency situations that may be encountered during site activities will generally be recognizable by visual observation. Visual observation will be the principal method of identifying any hazards that may be associated with the proposed scope of work. These potential hazards, the activities with which they have been associated, and the recommended control methods are discussed in detail in Sections 5.0 and 6.0 of this document.

2.3.2 Prevention

B&R Environmental personnel will minimize the potential for emergencies by ensuring compliance with the HASP, the Health and Safety Guidance Manual, applicable OSHA regulations, and by following directions given by those persons responsible for the health, safety, and welfare of personnel.

2.4 SAFE DISTANCES AND PLACES OF REFUGE

In the event that the site must be evacuated, all personnel will immediately stop activities and report to a pre-determined safe place of refuge. The safe place of refuge may also serve as the telephone communication point, as communication with emergency response agencies may be necessary. Telephone communication points and safe places of refuge will be determined prior to the commencement of site activities and will be conveyed to personnel as part pre-site training. Upon reporting to the refuge location, personnel will remain there until directed otherwise by the B&R Environmental FOL or the On-Scene Incident Commander. The FOL will take a head count at this location to confirm the presence of all site personnel. Emergency response agencies will be notified of any unaccounted for personnel.

2.5 EVACUATION ROUTES AND PROCEDURES

Once an evacuation is initiated, personnel will terminate site activities and proceed immediately to the designated place of refuge, unless doing so would further jeopardize the welfare of workers. In such an event, personnel will proceed to a designated alternate location and remain there until further notification from the FOL. The use of these locations as assembly points provides communication and a direction point for emergency services, should they be needed.

2.6 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

Since B&R Environmental personnel will be working in close proximity to each other, voice commands will comprise the mechanisms to alert site personnel of an emergency. If an incident occurs, site personnel will initiate the following procedures:

- Initiate incident alerting procedures (if needed) verbally.
- Describe to the FOL (who will serve as the Incident Coordinator) what has occurred and provide as many details as possible.
- If the FOL determines that the situation is beyond the capabilities of the site personnel emergency services will be contact using the emergency reference information listed in Table 2-1. Explain the situation and the appropriate emergency services will be dispatched. **Stay on the phone and follow the instructions of the emergency contact.**

2.7 EMERGENCY CONTACTS

Prior to performing work at the site, all personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. As indicated earlier, Table 2-1 provides a list of emergency contacts and their corresponding telephone numbers. This table will be made readily available to all site personnel.

TABLE 2-1
EMERGENCY REFERENCE
NAS KEY WEST
KEY WEST, FLORIDA

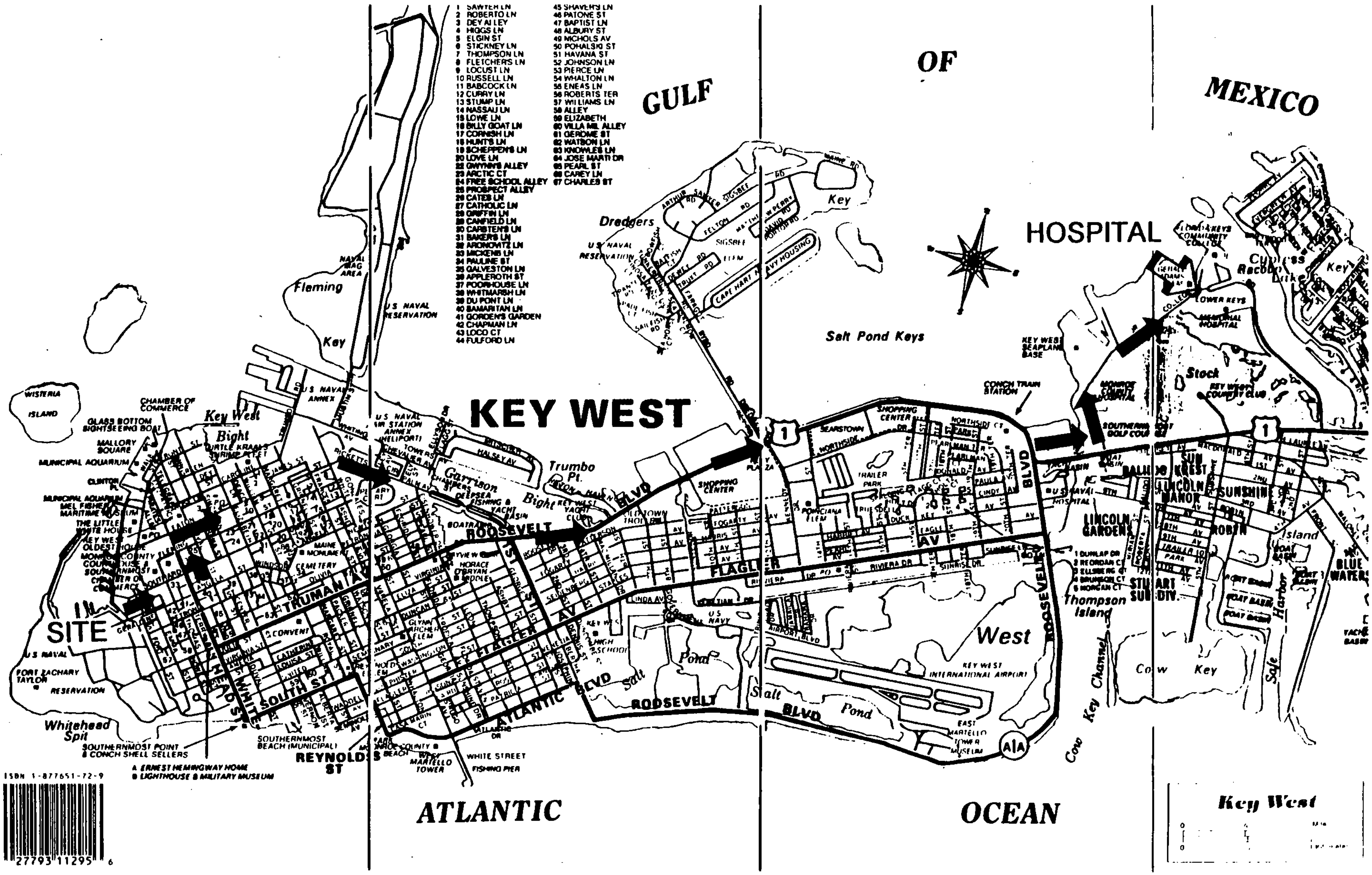
AGENCY	TELEPHONE
Key West Police/Rescue Services	911 or (305) 293-2971
NAS Key West Point of Contact Phillip Williams	(305)293-2016
Base Police	(305)293-2114
Base Fire Department Boca Chica	(305)293-3333
Hospital: Lower Florida Keys Health System	(305)294-5531
Base Officer of the Day (OOD)	(305)293-2971
Chemtrec National Response Center	(800)424-9300 (800)424-8802
Project Specific Contacts:	
B&R Environmental, Aiken Office	(800)368-5497
Task Order Manager Chuck Bryan	(803)649-7963 x345
Field Operations Leader/Site Safety Officer Regina Dixon	(803)649-7963 x346
B&R Environmental, Pittsburgh Office	(800)245-2730
Health and Safety Manager Matthew M. Soltis, CIH, CSP	(412)921-8912
Project Health and Safety Officer Delwyn E. Kubeldis, CIH, CSP	(412)921-8529

2.8 EMERGENCY ROUTE TO HOSPITAL

The closest hospital to NAS Key West is Lower Florida Keys Health System. An area map showing the proximity of NAS Key West to the hospital is incorporated into this HASP as Figure 2-1. Directions are as follows:

> From TRUMAN ANNEX, use the SOUTHARD STREET GATE EXIT and proceed 2 blocks to WHITEHEAD STREET. Turn LEFT and proceed 2 blocks to EATON STREET. Turn RIGHT and proceed to ROOSEVELT BOULEVARD (U.S. 1). Turn LEFT and proceed off island of Key West to first traffic light at JUNIOR COLLEGE ROAD. Turn LEFT and proceed on JUNIOR COLLEGE ROAD and you will see HOSPITAL SIGN. Follow road to HOSPITAL which will be on the RIGHT. Hospital is located at 5900 COLLEGE ROAD ON STOCK ISLAND.

FIGURE 2-1. LOWER FLORIDA KEYS HEALTH SYSTEM HOSPITAL



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3.0 SITE BACKGROUND

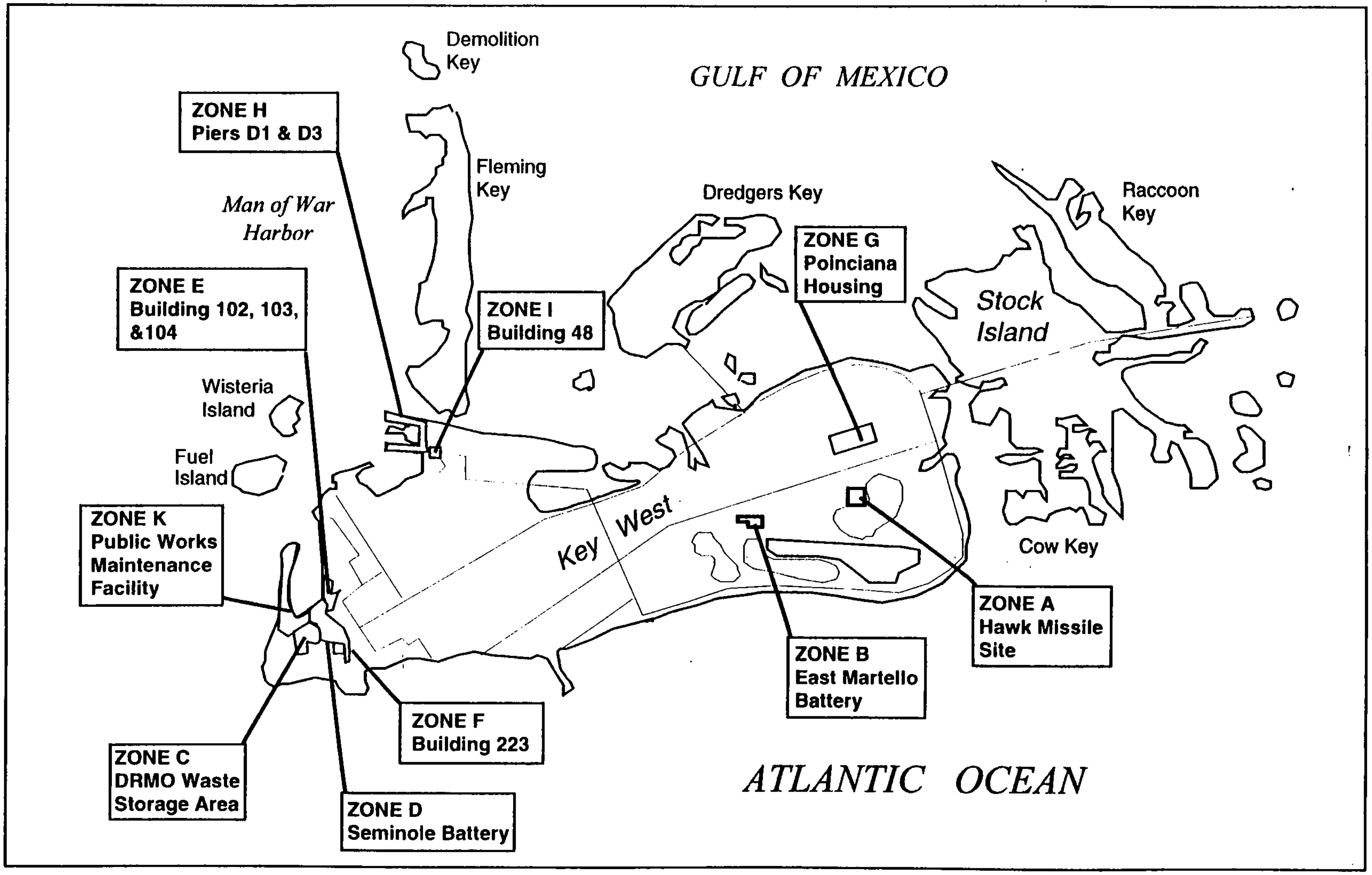
NAS Key West is in southern Monroe County, Florida. The U.S. Navy manages 6,323 acres of land divided into twenty separate tracts in the lower Florida Keys, concentrated around Key West and Boca Chica Key (see Figure 2-1 of the Work Plan). The Naval Station at Key West was disestablished in 1974, resulting in the relocation of several units. At present, NAS Key West is proceeding with realignment of aviation operations, a research laboratory, communications intelligence, counternarcotics air surveillance operations, a weather service, and several other activities on Key West. In addition to the Naval activities and units, other DOD and Federal agencies at NAS Key West include the U.S. Air Force, U.S. Army, and U.S. Coast Guard.

Several installations in various parts of the lower Florida Keys comprise the Naval Complex at Key West. Most of these are on Key West and Boca Chica Key. Key West, one of the two westernmost major islands of the Florida Keys, is approximately 150 miles southwest of Miami and 90 miles north of Havana, Cuba. Key West connects to the mainland by the Overseas Highway (U.S. Highway No. 1). The topography at the NAS Key West is generally flat.

On NAS Key West proper, there have been various properties identified for inclusion in the BRAC program and which are the subject of this SI (see Figure 3-1). The portions of the BRAC properties (which may encompass the entire property or small portions of a contiguous property) are known as BRAC Zones. Descriptions of each of the ten BRAC Zones included within the scope of this HASP are found below. For discussion purposes the ten Zones are grouped into three areas based on their location (Truman Annex, Trumbo Point and Key West Interior).

3.1 TRUMAN ANNEX

Buildings 102, 103, and 104; the Defense Reutilization and Marketing Office (DRMO) Waste Storage Area; Seminole Battery; Building 223; and the Waterfront Maintenance Facilities are all Truman Annex BRAC properties. These five Truman Annex BRAC Zones make up a contiguous land parcel on the southwest end of Key West (see Figure 2-3 of the Work Plan). The area is flat terrain that slopes gently to the southwest. Information pertaining to the current and past operations on these properties is limited since the Environmental Baseline Surveys (EBSs) for the Truman Annex Properties are in draft form.



Brown & Root Environmental

0 1.5 3.0

Scale in Miles (Approximate)

FIGURE 3-1. BRAC ZONE LOCATION MAP

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY LHO	SCALE	DATE 09/03/97	REV 2
CHECKED BY	CONTRACT NO	FILE NAME 7593-1PC/BRAC-SI-HASP\F3-1BRAC	

3.1.1 Zone C (DRMO Waste Storage Area)

The Zone includes Buildings 795, 284 and 261 and two large storage areas that house DRMO. DRMO receives excess government materials. In the recent past, Building 261 stored hazardous materials. Buildings 284 and 795 stored inert material. A cleared area in front of Building 795, known as IR 2, has been investigated for PCB contamination under the Navy's Installation Restoration Program. The PCBs were the result of PCB contaminated oil used for dust suppression in the area. The investigation recommended that no further action be taken based on sampling and risk assessment results. The two large storage areas have primarily stored metal debris. In addition motors, vehicles, boats, refugee debris and fuel trucks have been stored in those areas (B&RE 1997a,b). Currently, there is metal debris including some machinery with motors present (B&RE 1997c). A review of historic maps indicates that oil racks were present within the storage areas during the 1940s and 1950s (USN-NAS 1942, 1957).

3.1.2 Zone D (Seminole Battery)

Zone D includes the Seminole Battery and an adjacent area known to include a fueling area and grease rack that operated in the 1940s and 1950s. The battery was constructed during the Civil War and a modern battery addition was added to the existing structure in the 1950s. The addition was similar in construction to the East Martello Battery. Both structures are currently unused and entry is restricted. The materials used while the batteries were in operation are unknown. The old portion of the battery has the remnants of a generator exhaust system (USN-NAS 1996a).

The former fueling area is known as 248 Tanks A&B, and is located to the west of Seminole Battery. The fueling island and the tanks were removed in August 1995. The area is now covered in asphalt. The UST Closure Report recommends a study of groundwater in the area. To the northeast of the 248 Tanks A&B site concrete slabs are present from former grease racks used to lubricate and service vehicles. No visible stains are present on the slabs (USN-NAS 1957a).

3.1.3 Zone E (Buildings 102, 103, and 104)

Zone E includes the waterfront property around Buildings 102, 103, and 104. The area has served as a naval docking and support facility for over a century. Building 102 (former Torpedo Overhaul and Storehouse), Building 103 (former Central Power Plant), and Building 104 (former Battery Overhaul and Storage) are out of service. Knowledge of the operations in the buildings are limited to activities supporting naval submarines. Hazardous materials are believed to have been used in each of the buildings specifically volatiles, semivolatiles, and inorganics. PCBs are known to have been present in transformers at Building 103 (B&RE 1997d). In the mid 1980s, these transformers were removed from the building. A petroleum Contamination Assessment Report (CAR) was prepared for the area around the three buildings. The CAR recommended the preparation of a Remedial Action Plan (RAP) that was approved in April 1995 by the Florida Department of Environmental Protection (FDEP) (USN-NFEC 1994a).

Building 189 (former Liquor Store) is adjacent to an area discovered to have been impacted by a petroleum leak from an underground pipeline that serviced the docks. The pipeline enters the Zone from Eaton Street and runs along the waterfront across Zone E and Zone K ending on Outer Mole Pier. A petroleum CAR was prepared for the area north of Building 189. The CAR recommended the preparation of a RAP that was approved in November 1995 by FDEP (USN-NFEC 1994b).

Former Building 136 (Shipfitter's Shop and prior to 1951 the Plate and Mold Shop) was demolished and the debris was buried in and around the building's footprint. According to base personnel the debris in the area was later removed for disposal and is believed to have failed TCLP testing for lead. The area around the former Building 136 is currently level-graded crushed limestone. Other former buildings in the Zone that have been razed according to the draft EBS (USN-NAS 1996a) include the following:

- 26 - Cistern (distilled water)
- 59 - Storehouse
- 60 - Boiler Shop
- 79 - Electrical Shop
- 100 - Cold Storage
- 101 - Submarine General Shops and Offices
- 115 - Diesel Oil Storage Tank
- 116 - Steam Plant
- 117 - Fuel Oil Storage
- 118 - Battery Water Storage Tank
- 122 - Fire Station
- 123 - Public Works Maintenance Office, Garage and Shops
- 136 - Shipfitter's Shop and former Plate and Mold Shop (pre 1951)
- 147 - Sound School Shop and Laboratory
- 148 - Fresh Water Tank
- 156 - Submarine Storage Shed
- 157 - Equipment Shed
- 160 - Ordnance Warehouse former Anti-Aircraft Trainer (pre 1951)

- 168 - Storage Building
- 169 - General Storage
- 171 - Storehouse
- 172 - WAVE Officers' Quarters
- 173 - WAVE Officers' Quarters
- 174 - Cistern

3.1.4 Zone F (Building 223)

Building 223 (Equipment Repair Shop) is currently used as storage for Port Services. Little is known about the activities in the building; however, from the name of the building it can be inferred that naval support equipment was repaired at the building. A closed hazardous waste storage area is present to the south of Building 223. Building 1287 is a closed galley facility that operated during the 1960s. Building 1287 was supported by an aboveground storage tank (AST) that has been removed. In June 1997, sampling of soil and groundwater was conducted to prepare a petroleum CAR on the site. Adjacent to Building 1287 was a motor pool area that operated during the 1950s (B&RE 1996).

3.1.5 Zone K (Waterfront Maintenance Facilities)

This Zone includes Buildings 84, 112, 113 and 149. Building 113 is currently a Special Forces Operations Center (former Paint and Oil Storage). Building 149 is currently the NAS Key West Port Operations (Port Ops) Building (former Gear and Spare Parts Storage). Port Ops provides and maintains boats (less than 60 feet) to support naval activities for NAS Key West. Building 84 is vacant and was previously used as a Naval Convenience Store and a Transportation Pool. Building 112 is currently a Public Works Warehouse and formerly a Submarine Spare Parts Building. Former buildings in the Zone that have been razed according to the Draft EBS (USN-NAS 1997) include the following:

- 111 - Paint Shop former Marine Railway Utilities (pre 1951)
- 137 - Outside Machine Shop former Fitting Out Shop (pre 1951)
- 138 - Central Tool Room former Galvanizing Shop (pre 1951)
- 139 - Pipe and Copper Shop
- 140 - Boiler Shop
- 141 - Foundry
- 143 - Lumber Shed
- 144 - Public Work Warehouse
- 145 - P.C. Boat Shop

- 146 - Experimental Lab
- 150 - Echo Repeater Shop former Paint Shop (pre 1951)
- 153 - Rigger's Shop former Cafeteria Annex (pre 1951)

3.2 TRUMBO POINT

The two Trumbo Point BRAC Zones make up a contiguous land parcel on the northwest end of Key West (see Figure 2-4 of the Work Plan). The terrain is generally flat, sloping gently to the southeast. Three of the buildings currently present on BRAC properties at Trumbo Point (B-27, B-28, and B-48) were originally constructed as ordnance facilities. B-27 and B-28 were used as shop and maintenance facilities for ordnance, while B-48 was used as a classroom and training facility.

The City of Key West, the Monroe County School District, and the U.S. Coast Guard (USCG) own parcels of land adjacent to the Navy BRAC properties located on Trumbo Point. The City of Key West was granted an easement for sewer lines that travel through naval property on Trumbo Point and discharge to the Key West Bight. The lines are no longer used, have been capped, and the visible portions of discharge piping are severely rusted and pitted. The Monroe County School District uses its parcel of land as a garage, maintenance facility, and administrative complex. Three ASTs used for gasoline, diesel fuel, and oil storage are located on the school district's property. In 1976 ownership of Pier D-2, located on Trumbo Point, was transferred from the Navy to the USCG. The USCG currently holds approximately 13 acres on Trumbo Point. Ship refueling and hazardous waste storage are among the activities performed at these USCG facilities (USN-NAS 1996b).

3.2.1 Zone H (Piers D1 and D3)

Piers D1 and D3 are two of the three original harbor terminal piers constructed in 1914 by the Florida East Coast Railroad Company. The piers were used by the railroad and P.O. Steamship Company as part of an overseas railroad freight car ferry system. The piers were abandoned in 1935 due to severe hurricane damage. Sometime later Pier D3 was used as an oil dock by Orange State Oil Company. In August 1942, Pier D1 was purchased by the Navy from Trumbo Point Properties Inc. Pier D3 was purchased from Orange State Oil Company in December 1942. The Navy used the property in support of various ship and craft operations until the late 1980s. A chain link fence has been installed along the length of Pier D1. The U.S. Coast Guard (USCG) uses the north side of the pier and Naval Air Warfare Center uses the south side (including all buildings and structures). The Navy is not currently using Pier D3, but the USCG is using a fenced portion of the pier, including Building 45.

The EBS documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site (USN-NAS 1996b).

- Although the storage of hazardous and petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed.

- No stains were observed on site soils, although numerous small stains that appear to be paint or petroleum-related were noted throughout the site facilities.

- Two oily water flow-through process tanks are located at the northern corner of Pier D1. The tanks are not used by the present tenant.

- Pier D3 contains two underground storage tanks (USTs) - a 550-gallon waste oil tank and a 250-gallon oily waste tank. Both tanks have been abandoned. The fueling operations and associated piping have also been abandoned.

- The presence of PCBs is not suspected at Piers D1 or D3. Transformers at Pier D3 have been identified as non-PCB.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- Based on the 1995 inspection performed by the Navy Public Works Center, both lead-based paint (LBP) and asbestos containing building materials (ACBM) are present in Pier D1 buildings. Pier D3 appears to contain numerous areas of LBP, but there is no ACM associated with current facilities, although it is likely that ACM has been used and handled there in the past.

3.2.2 Zone I (Building 48)

Building 48 is a two-story structure constructed in 1955. The building has been identified as an ordnance and training facility. The south end of the second floor has been used as a photographic laboratory since 1962. Known uses of the building include photographic film and prints development, office space, machining operations, handling fuels, hydraulic equipment repair, electronic gear repair, ordnance handling/maintenance, emergency shelter, and training. Currently, a large portion of Building 48 is being used by the USCG for storage of manuals associated with Alien Migration Intradiction Operations. The EBS documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site (USN-NAS 1996b).

- Although the storage of hazardous and petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed. The hazardous waste collection site on Trumbo Point, located behind Building B-48 is officially closed for the collection of hazardous waste.

- No stains were observed on site soils, although numerous small stains, apparently petroleum-related, were noted in air conditioning rooms and in the compressor room.

- Based on investigations and observations, it does not appear that any storage tanks were associated with Building B-48.

- The presence of PCBs is not suspected at Building B-48. Transformers at the site have been identified as non-PCB.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- Based on the 1995 inspection performed by the Navy Public Works Center, both lead-based paint (LBP) and asbestos containing materials (ACM) are present in Building B-48.

3.3 KEY WEST INTERIOR

The three Key West Interior BRAC Zones are made up of three divided land parcels on the eastern end of Key West. Each Zone has a flat terrain with a surface water body. A portion of each Zone drains to its respective surface water body.

3.3.1 Zone A [Hawk Missile Site (KW 65)]

Based on historical maps and aerial photographs, the land for Hawk Missile Site was previously salt ponds that were filled by the U.S. Army in order to adapt the area for use as a missile site (see Figure 2-5 of the Work Plan). This facility was built in 1964 as a defense to repel potential Cuban and Russian assault as a result of the Cuban Missile Crisis. It was used for coastal defense until the early 1980s, at which time it was transferred to the Navy. The Navy did not use the property, but allowed its use as a refuge for homeless veterans in 1994 and 1995. During the ten months in which Vietnam veterans occupied the site, wastewater from showers and washing machines was discharged into the surrounding wetlands.

Hawk Missile Site is bordered to the south by Key West International Airport, where petroleum products are stored and used. The northern border is bounded by Flagler Canal, a man-made canal connected to the Atlantic Ocean. The canal is used by private boats and appears to overflow onto the site at times. Woodlands and wetlands border the property to the east and west. The EBS documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site (USN-NAS 1996b).

- Although the storage of hazardous and petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed.

- No stains were observed on site soils, although old stains of an indeterminate nature were found on the floors of several site facilities.

- At one time, two ASTs in bermed foundations were used for fuel oil/diesel storage. Both of these ASTs have since been removed, although there are currently several other empty ASTs located at site. Two of these tanks, located north of Building I-6504, reportedly contained water.

- Vandalism of three on-site transformers, abandoned by the Army, resulted in a small PCB spill. Initial testing by the Navy showed very low PCB concentrations in soil, and subsequent tests did not indicate any PCB contamination.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- A water storage tank and sewage pumping station are located on-site, but have not been operable for many years

- Based on the 1995 inspection performed by the Navy Public Works Center, both lead-based paint (LBP) and asbestos containing materials (ACM) are present in Hawk Missile Site facilities and infrastructure.

3.3.2 Zone B (East Martello Battery)

The U.S. Army built East Martello battery in the early 1940s for use as a Coastal Defense Battery and it was used as such until the property was transferred to the Navy in 1950 (see Figure 2-6 of the Work Plan). The Navy developed the property in the early 1950s to accommodate 100 trailers to be used as housing. The trailer housing project also included two laundry facilities, but no dry cleaning operations were known to have been conducted on site. The trailer project was deactivated in 1956 and all trailers and buildings were removed from the site. Monroe County Civil Defense used the bunker from 1985 until 1992 as an administrative command post. The county has placed yard and tree cuttings on the property to dry prior to mulching and replacing.

East Martello Battery is located on the western border of Key West International Airport, at the end of the runway. The airport stores and uses petroleum products. The northern border is bounded by old residential communities, while the southern and western borders are saltwater ponds and undeveloped woodlands. The EBS documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site (USN-NAS 1996b).

- Although the storage of hazardous and petroleum substances at the site in the past has been documented, no visible sheen or discoloration of surface water has been observed.

- No stains were observed on site soils, although old stains of an indeterminate nature were found on the floors of several site facilities.

- A fresh water tower and tank were previously located at the site, but have been removed.

- Concrete fresh water storage and sewage dosing tanks are located in the northeast and northwest corners of Zone B, but appear to have been out of service for many years.

- A septic drain field was located on the southwest portion of the property, but it has not been used since the 1950s, when the sanitary waste dosing station ceased operation.

- There is no reason to suspect PCB contamination at this facility.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- Based on the 1995 inspection performed by the Navy Public Works Center, both LBP and suspected ACMs are present in East Martello Battery facilities and infrastructure.

3.3.3 Zone G (Poinciana Housing)

Poinciana housing is situated on 36 acres on the east end of Key West near the Naval Regional Medical Clinic (see Figure 2-7 of the Work Plan). The property is bounded on three sides by Duck Avenue, 19th Street, and Donald Avenue. The fourth side is bounded by residential property. The residential property consists of 212 townhouse-type units constructed in 1966. Since 1942, the property has been used as residential housing. No industrial activities have taken place at the site since its acquisition by the Navy in 1947. The parcel is located in a residential neighborhood and commercial area. Recreational areas are nearby, including boating, a sports complex, malls, etc. The EBS and a Lead and Asbestos Survey documented a number of other factors that are potentially helpful in characterizing the current physical condition of the site (USN-NAS 1996c).

- Hazardous substances and petroleum products were stored and used in the housing area, but quantities and strengths were no greater than those normally found in private residences.

- No gas station was maintained on this parcel.

- No storage tanks or oil/water separators were maintained at this site.

- No stains were observed on site grass or soils. Stains attributable to automotive oil and fluid leaks were noted in the parking area.

- There is no reason to suspect PCB contamination, as PCB transformers are not present on the site.

- Although pesticides are commonly used for mosquito and pest control throughout NAS Key West, there is no evidence of pesticide misuse at the site.

- Based on the 1995 inspection performed by the Navy Public Works Center, both LBP and ACMs are present in Poinciana Housing structures. Lead was also detected in soil samples collected in the Zone.

4.0 SCOPE OF WORK

This section of the HASP addresses all proposed site activities that are to be conducted while performing the SI at the NAS Key West. If tasks other than those identified are to be performed at this site this HASP will be modified accordingly.

The investigative methods to be conducted include, but may not be limited to:

- Installation of groundwater screening sample locations using direct push technology
- Installation of groundwater monitoring wells at Zones A, B, C, D, E, F, G, H, and K using a hollow stem auger
- Collection of soil, sediment, surface water, and groundwater samples; and chemical analysis for Target Compound List (TCL) volatile organics, semivolatile organics, pesticides, polychlorinated biphenyls (PCBs), target analyte list metals, and cyanide.

The activities will be performed to identify the nature and extent of actual or potential site contamination. Any tasks to be conducted outside of the elements listed here will be considered a change in scope requiring modification of this document. All requested modifications to this document will be submitted to the HSM by the TOM or a designated representative.

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

Table 5-1 of this section lists the anticipated hazards, recommended control measures, monitoring recommendations, required Personal Protective Equipment (PPE), and decontamination measures for each site task. Through using the table, the FOL and SSO can determine which hazards are associated with each task and what associated control measures are necessary to minimize exposure or injuries related to those hazards. This table also assists the FOL and SSO in determining which PPE and decontamination procedures to use based on proper air monitoring techniques and project-specific conditions. This information can then be transposed to the Safe Work Permit (Section 9.4) for directing field crews within those specific duties. This table and the associated control measures will be changed if the scope of work, contaminants of concern, or other conditions change.

Tasks to be conducted as part of this environmental investigation effort as addressed here in Table 5-1 are as follows:

- Mobilization/Demobilization
- Decontamination of heavy and sampling associated equipment
- Soil boring and groundwater screening samples (Direct Pust Technology)
- Permanent monitoring well installation (Hollow Stem Auger)
- Monitoring well development and purging
- Multi-media sampling:
  - Surface soils
  - Sediment
  - Surface water
  - Groundwater
  - Investigation derived waste (IDW) if necessary
- Sample and well location surveys.

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TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM FOR NAVAL AIR STATION KEY WEST, KEY WEST, FLORIDA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring	Personal Protective Equipment	Decontamination Procedures
Soil borings and installation of monitoring wells. (using Direct Push Technology and Hollow Stem Augers)	*Chemical Hazards* 1) Air/particulate/water borne contaminants including VOCs (primarily vinyl chloride and 1,2-Dichloroethylene), SVOCs (primarily naphthalene), pesticides (primarily DDT and chlordane), PCBs (represented as Aroclor-1260) and metals (primarily arsenic, cadmium, lead, and cyanides). Further information on these contaminants is presented in Table 6-1. 2) Transfer of contamination into clean areas or onto persons *Physical hazards* 3) Contact/entanglement with rotating equipment or machinery 4) Noise 5) Energized systems 6) Lifting 7) Natural Hazards 8) Inclement weather	1) For VOCs, use real-time monitoring instrumentation, action levels, and identified PPE to control exposures to potentially contaminated media (air, water, soils, etc.). Generation of dusts should be minimized to the greatest extent possible to avoid exposure to non-VOCs present as particulates or bound to particulates. If airborne dusts are observed, area wetting methods will be used to reduce the generation of dusts created during drilling activities. If area wetting methods are not feasible, upgraded levels of protection or termination of activities will be used to minimize exposure to observed airbonre dusts. 2) Decontaminate all equipment and supplies between boreholes and prior to leaving the site. 3) All equipment to be used will be - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600,.601,.602), and manufacturers design and documented as such using the Equipment Record Sheet (See Section 10.0 of the B&R Environmental health and Safety Guidance Manual). - Operated by Certified operators, and knowledgeable ground crew. - Used within establish safe zones and routes of approach - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (i.e. pins, etc.). In addition, to equipment considerations the following safe operating procedures will be incorporated: - All personnel not directly supporting this operation will remain at least 25 feet from the point of operation. - Drilling, drill masts, or other projecting devices shall be at least 20 feet from overhead power sources and a minimum of 3 feet from underground utilities unless the exact location of the underground utility is known. - Hand signals will be established prior to the commencement of the operation. - The driller and helper can simultaneiously handle moving augers or flights only when there is a standby person to activate the emergency stop device. - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (i.e., flight connectors etc.). - Work areas will be kept clear of clutter. - Secure all loose articles to avoid possible entanglement. - All equipment shall be equipped with movement warning systems. - All personnel working in high equipment traffic areas are required to wear reflective vests for high visibility, and to establish unimpeded work areas around the operation. This activity may require areas of the building to be coordined off during this operation. - All personnel will be instructed in the location and operations of the emergency shut off device(s). This device will be tested initially (and then periodically) to insure its operational status. - Areas will be inspected prior to the movement of drilling and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - Drill rigs and support vehicles will be moved no closer than 3 feet to floor openings, sidewalls, and excavations. 4) Hearing protection will be used during all subsurface activities until the SSO can quantify associated noise levels. 5) All utility clearances shall be obtained prior to subsurface activities. Prior to any subsurface investigations, the locations of all underground utilities will be identified and marked. Obtain written permit clearance prior to all subsurface investigations. 6) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 7) Avoid nesting areas, employ repellents (DO NOT use repellents during sampling activities). Report potential hazards to the SSO. 8) Suspend or terminate operations until directed otherwise by SSO	**It is anticipated that potential contaminant concentrations at outdoor locations will be dispersed via natural wind currents and dilution prior to reaching worker breathing zones.** Photoionization Detector w/ 10.6 eV UV lamp source, or a Flame Ionization Detector, will be used to detect VOCs as follows: Source (borehole and geoprobe sampler) monitoring will be conducted at regular intervals determined by the SSO. The SSO will also monitor the breathing zone (BZ) of all potentially affected employees, with the following guidance: - Workers must don Level C PPE if sustained BZ concentrations are 10 ppm above background, but less than 50 ppm. - Workers must evacuate to a safe area if sustained BZ concentrations exceed 50 ppm. Many of the contaminants of concern are solids, and are non-detectable using PID/FID direct reading instruments. Also, other site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to the greatest extent possible to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be qualitative by observing work conditions for visible dust clouds or accumulations. Potential exposure to contaminants attached to dust particles will be controlled by using water to suppress dusts, by avoiding dust plumes, or by upgrading the level of protection. Upgrade to Level C protection shall occur anytime sustained visible dust is present in a worker's breathing zone. The SSO will perform noise dosimetry to ensure the drilling activities, and any contributional levels associated with the operation do not surpass the noise attenuation factors associated with the hearing protection selected. Where the utility clearance cannot be obtained in a reasonable period, or not located, intrusive activities shall proceed with extreme caution using a magnetometer for periodic downhole surveys every 2 feet to a depth of at least 6 feet.	All subsurface operations are to be initiated in Level D protection. Level D protection constitutes the following minimum protection - Standard field attire (Long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential exists for soiling work attire. - Nitrile gloves or leather gloves with surgical style inner gloves - Safety shoes (Steel toe/shank) - Safety glasses - Hardhat - Reflective vest for high traffic areas - Hearing protection for high noise areas, as directed by the SSO. **Level C** Upgrade to Level C protection, defined as follows, may be necessary as discussed under Hazard Monitoring. - full-face Air-Purifying Respirator (APR) with a combination High Efficiency Particulate Air (HEPA) filter and organic vapor (OV) cartridge. - Standard field attire (long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers. Note: PVC splash suit and impermeable boot covers required if a potential for splashes or contact with pesticides exists. All joints in the ensemble (wrists, ankles, etc.) must be securely taped. Personnel must closely inspect all PPE prior to beginning any on-site activities. - Nitrile gloves or leather gloves with surgical style inner gloves - Safety shoes (Steel toe/shank) - Hardhat (when overhead hazards exists, or identified as an operation requirement) - Reflective vest for high traffic areas - Hearing protection for high noise areas, as directed by the SSO.	**Personnel Decontamination** will consist of a soap/water wash and rinse for outer protective equipment (boots, gloves, PVC splash suits, etc.). This function will take place at an area adjacent to the site activities. This procedure will consist of: - Equipment drop - Soap/water wash and rinse of outer boots and gloves **Note:** For PPE Level C, cartridge change out would take place at this point, if necessary. - Soap/water wash and rinse of the outer splash suit, as applicable - Outer suit, boot covers, outer glove removal - Respiratory (face mask) protection removal - Wash hands and face, leave contamination reduction zone **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing steam or pressure washers. Heavy equipment such as geoprobe, will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will be restricted access to exclusion zones, or also have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving onsite and that which is to leave the site. No equipment will be authorized access or exit without this authorization. Evaluation will consist of - Visual inspection - Scanning equipment with monitoring instruments

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM FOR NAVAL AIR STATION KEY WEST, KEY WEST, FLORIDA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring	Personal Protective Equipment	Decontamination Procedures
Multi-media sampling including sediment, soils (surface and subsurface) and water (surface and ground)	*Chemical Hazards* 1) Air/particulate/water borne contaminants including VOCs (primarily vinyl chloride and 1,2-Dichloroethylene), SVOCs (primarily naphthalene), pesticides (primarily DDT and chlordane), PCBs (represented as Aroclor-1260) and metals (primarily arsenic, cadmium, lead, and cyanides). Further information on these contaminants is presented in Table 6-1. 2) Transfer of contamination into clean areas *Physical hazards* 3) Noise 4) Lifting (muscle strains and pulls) 5) Pinches and compressions 6) Slip, trips, and falls 7) Natural hazards (Insect/animal bites and stings) 8) Inclement weather	1) For VOCs, use real-time monitoring instrumentation, action levels, and identified PPE to control exposures to potentially contaminated media (air, water, soils, etc.). Generation of dusts should be minimized to the greatest extent possible. If airborne dusts are observed, area wetting methods will be used to reduce the generation of dusts created during drilling activities. If area wetting methods are not feasible, upgraded levels of protection or termination of activities will be used to minimize exposure to observed airbonre dusts. 2) Decontaminate all equipment and supplies between sampling locations and prior to leaving the site. 3) When sampling at the drilling rig use hearing protection. The use of hearing protection to protect against excessive noise outside of 25 feet from the point of operations should be incorporated under the following condition: Hearing protection during sample acquisition outside of the boring sample will be determine on a case by case scenario. As a general rule of thumb, if you have to raise your voice to talk to someone who is within 2 feet of your location, noise levels may becoming excessive. 4) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 5) Use pinch bars or other equipment to remove hands from the point of operation. 6) Preview work locations for unstable/uneven terrain. Barricade all excavations and other associated drop off points at least 3 feet from the edge. 7) Avoid nesting areas, employ repellents (DO NOT use repellents during sampling activities). Report potential hazards to the SSO. 8) Suspend or terminate operations until directed otherwise by SSO	Monitoring instrumentation will be used as specified in the Sampling and Analyses Plan to bias samples. **It is anticipated that potential contaminant concentrations at outdoor locations will be dispersed via natural wind currents and dilution prior to reaching worker breathing zones.** Photoionization Detector w/ 10.6 eV UV lamp source, or a Flame Ionization Detector, will be used to detect VOCs as follows: Source (borehole and geoprobe sampler) monitoring will be conducted at regular intervals determined by the SSO. The SSO will also monitor the breathing zone (BZ) of all potentially affected employees, with the following guidance: - Workers must don Level C PPE if sustained BZ concentrations are 10 ppm above background, but less than 50 ppm. - Workers must evacuate to a safe area if sustained BZ concentrations exceed 50 ppm. Many of the contaminants of concern are solids, and are non-detectable using PID/FID direct reading instruments. Also, other site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to the greatest extent possible to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be qualitative by observing work conditions for visible dust clouds or accumulations. Potential exposure to contaminants attached to dust particles will be controlled by using water to suppress dusts, by avoiding dust plumes, or by upgrading the level of protection. Upgrade to Level C protection shall occur anytime sustained visible dust is present in a worker's breathing zone.	Level D protection will be utilized for the initiation of all sampling activities. Level D - (Minimum Requirements) - Standard field attire (long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential for soiling work attire exists. - Nitrile gloves with surgical style inner gloves for soil and groundwater sampling - Safety shoes (steel toe/shank) - Safety glasses - Hardhat (when overhead hazards exists, or identified as a operation requirement) - Reflective vest for high traffic areas - Hearing protection for high noise areas, or as directed on an operation by operation scenario. **Excessive chemical contaminant concentrations impacting field crews during this task are not anticipated. The following information is based on a contingency action only.** **Level C** Upgrade to Level C protection, defined as follows, may be necessary as discussed under Hazard Monitoring. - full-face Air-Purifying Respirator (APR) with a combination High Efficiency Particulate Air (HEPA) filter and organic vapor (OV) cartridge. - Standard field attire (long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers. Note: PVC splash suit and impermeable boot covers required if a potential for splashes or contact with pesticides exists. All joints in the ensemble (wrists, ankles, etc.) must be securely taped. Personnel must closely inspect all PPE prior to beginning any on-site activities. - Nitrile gloves or leather gloves with surgical style inner gloves - Safety shoes (Steel toe/shank) - Hardhat (when overhead hazards exists, or identified as an operation requirement) - Reflective vest for high traffic areas - Hearing protection for high noise areas, as directed by the SSO.	**Personnel Decontamination** will consist of a soap/water wash and rinse for outer protective equipment (e.g. boots, gloves, PVC splash suits, etc.). This function will take place at a satellite location. Disposable PPE will be bagged between sampling events. This procedure will consist of - Sample acquisition - Clean (Deionized water spray) the outside of the sample containers/label/bag This decontamination procedure for **Level D** protection will consist of - Equipment drop - Soap/water wash and rinse of outer boots and outer gloves, as applicable - Soap/water wash and rinse of the outer splash suit, as applicable - Wash hands and face, leave contamination reduction zone For **Levels C** in addition to that described above: **Note:** APR cartridge change out would take place at this point. - Outer suit, boot covers, outer glove removal - Respiratory (face mask) protection removal - Wash hands and face, leave contamination reduction zone **Equipment Decontamination** - Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. MSDS for any decon solutions (Alconox, methanol, isopropanol, hexane, etc.) will be obtained and used to determine proper handling / disposal methods and protective measures (PPE, first-aid, etc.). All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving onsite and that which is to leave the site. No equipment will be authorized access or exit without this evaluation.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM FOR NAVAL AIR STATION KEY WEST, KEY WEST, FLORIDA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring	Personal Protective Equipment	Decontamination Procedures
Mobilization/ Demobilization	*Physical Hazards* 1) Lifting (muscle strains and pulls) 2) Pinches and compressions 3) Slip, trips, and falls 4) Moving machinery 5) Natural hazards (Insect/animal bites and stings) 6) Vehicular and foot traffic	1) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 2) Use pinch bars or other equipment if caught in the machine point of operation. 3) Preview work locations for unstable/uneven terrain. Barricade all excavations from access closer than two feet from the edge. 4) All equipment will be - Inspected in accordance with OSHA, and manufacturers design. - Operated by Certified operators, and knowledgeable ground crew. 5) Avoid nesting areas, use repellents (Do NOT use repellents during sampling activities). Report potential hazards to the SSO. 6) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Boom + 3 feet). - Secure all loose articles to avoid possible entanglement. - All equipment shall be equipped with movement warning systems. - Employ safety belts and follow the site traffic rules. Traffic patterns will be dictated supporting onsite activities. However, regulated patterns in and about the work zones and support thereof will be established to safely control moving equipment, vehicles, and pedestrians around the area of operation.	Not required	Level D - (Minimum Requirements) - Standard field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - *Safety glasses* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.* *(Items in italics are deemed optional as conditions or the FOL or SSO dictate.)*	Not required
Decontamination of Sampling and Heavy Equipment	*Chemical Hazards* 1) Air/particulate/water borne contaminants including VOCs (primarily vinyl chloride and 1,2-Dichloroethylene), SVOCs (primarily naphthalene), pesticides (primarily DDT and chlordane), PCBs (represented as Aroclor-1260) and metals (primarily arsenic, cadmium, lead, and cyanides). Further information on these contaminants is presented in Table 6-1. 2) Decontamination fluids - Liquinox (detergent), acetone or methanol, and hexane *Physical Hazards* 3) Lifting (muscle strains and pulls) 4) Pinches and compressions 5) Inclement weather	1) and 2) Use protective equipment to minimize contact with site contaminants and hazardous decontamination fluids. Obtain manufacturer's MSDS for any decontamination solvents used onsite. Use appropriate PPE as identified on MSDS. 3) Use multiple persons where necessary for lifting and handling sampling equipment for decontamination purposes. 4) Provide stacking racks for air drying of decontaminated equipment to prevent unstable drying stacks of equipment from collapsing. 5) Suspend or terminate operations until directed otherwise by SSO	Use visual observation, and real-time monitoring instrumentation to ensure all equipment has been properly cleaned of contamination and dried.	*For Heavy Equipment* This applies to high pressure soap/water, steam cleaning wash and rinse procedures. Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Chemical resistant boot covers - Nitrile outer gloves, cotton liners - PVC Rainsuits or PE or PVC coated Tyvek - Safety glasses underneath a splash shield Respiratory protection is not anticipated for this activity. *For sampling equipment (trowels, MacroCore Samplers, bailers, etc.)*, the following PPE is required Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Nitrile outer gloves, cotton liners - Safety glasses underneath a splash shield In the event of overspray of chemical decontamination fluids employ PVC Rainsuits or PE or PVC coated Tyvek as necessary.	This decontamination procedure for **Level D** protection will consist of - Soap/water wash and rinse of outer gloves - Soap/water wash and rinse of the outer splash suit, as applicable - Wash hands and face, leave contamination reduction zone

TABLE 5-1

**TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM FOR
NAVAL AIR STATION KEY WEST, KEY WEST, FLORIDA**

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring	Personal Protective Equipment	Decontamination Procedures
Monitoring well development and purging .	*Chemical Hazards* 1) Air/particulate/water borne contaminants including VOCs (primarily vinyl chloride and 1,2-Dichloroethylene), SVOCs (primarily naphthalene), pesticides (primarily DDT and chlordane), PCBs (represented as Aroclor-1260) and metals (primarily arsenic, cadmium, lead, and cyanides). Further information on these contaminants is presented in Table 6-1. 2) Transfer of contamination into clean areas or onto persons *Physical hazards* 3) Pinch/compression points 4) Noise 5) Energized systems	1) For VOCs, use real-time monitoring instrumentation, action levels, and identified PPE to control exposures to potentially contaminated media (air, water, soils, etc.). Generation of dusts should be minimized to the greatest extent possible. If airborne dusts are observed, area wetting methods will be used to reduce the generation of dusts created during drilling activities. If area wetting methods are not feasible, upgraded levels of protection or termination of activities will be used to minimize exposure to observed airbonre dusts. 2) Decontaminate all equipment and supplies between boreholes and prior to leaving the site. 3) All equipment to be used will be - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600,.601,.602), and manufacturers design. - Operated by Certified operators, and knowledgeable ground crew. - Used within establish safe zones and routes of approach - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (i.e. pins, etc.). In addition, to equipment considerations the following safe operating procedures will be incorporated: - All personnel not directly supporting this operation will remain at least 25 feet from the point of operation. - Hydraulic masts or other projecting devices shall be at least 20 feet from overhead power sources and a minimum of 3 feet from underground utilities unless the exact location of the underground utility is known. - Hand signals will be established prior to the commencement of the operation. - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (i.e., flight connectors etc.). - Work areas will be kept clear of clutter. - Secure all loose articles to avoid possible entanglement. - All equipment shall be equipped with movement warning systems. - All personnel working in high equipment traffic areas are required to wear reflective vests for high visibility, and to establish unimpeded work areas around the operation. This activity may require areas of the building to be coordined off during this operation. - All personnel will be instructed in the location and operations of the emergency shut off device(s). This device will be tested initially (and then periodically) to insure its operational status. - Areas will be inspected prior to the movement of drilling and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - The drilling and support vehicles will be moved no closer than 3 feet to floor openings, sidewalls, and excavations. 4) Hearing protection will be used during all subsurface activities until the SSO can quantify associated noise levels. 5) All utility clearances shall be obtained prior to subsurface activities. Prior to any subsurface investigations, the locations of all underground utilities will be identified and marked. Obtain written permit clearance prior to all subsurface investigations.	**It is anticipated that potential contaminant concentrations at outdoor sample locations will be dispersed via natural wind currents and dilution prior to reaching worker breathing zones.** Photoionization Detector w/ 10.6 eV UV lamp source, or a Flame Ionization Detector, will be used to detect VOCs as follows: Source (borehole and geoprobe sampler) monitoring will be conducted at regular intervals determined by the SSO. The SSO will also monitor the breathing zone (BZ) of all potentially affected employees, with the following guidance: - Workers must don Level C PPE if sustained BZ concentrations are 10 ppm above background, but less than 50 ppm. - Workers must evacuate to a safe area if sustained BZ concentrations exceed 50 ppm. Many of the contaminants of concern are solids, and are non-detectable using PID/FID direct reading instruments. Also, other site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to the greatest extent possible to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be qualitative by observing work conditions for visible dust clouds or accumulations. Potential exposure to contaminants attached to dust particles will be controlled by using water to suppress dusts, by avoiding dust plumes, or by upgrading the level of protection. Upgrade to Level C protection shall occur anytime sustained visible dust is present in a worker's breathing zone.	Level D protection will be utilized for the initiation of all sampling activities. Level D - (Minimum Requirements) - Standard field attire (long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential for soiling work attire exists. - Nitrile gloves with surgical style inner gloves for soil and groundwater sampling - Safety shoes (steel toe/shank) - Safety glasses - Hardhat (when overhead hazards exists, or identified as a operation requirement) - Reflective vest for high traffic areas - Hearing protection for high noise areas, or as directed on an operation by operation scenario. **Excessive chemical contaminant concentrations impacting field crews during this task are not anticipated. The following information is based on a contingency action only.** **Level C** Upgrade to Level C protection, defined as follows, may be necessary as discussed under Hazard Monitoring. - full-face Air-Purifying Respirator (APR) with a combination High Efficiency Particulate Air (HEPA) filter and organic vapor (OV) cartridge. - Standard field attire (long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers. Note: PVC splash suit and impermeable boot covers required if a potential for splashes or contact with pesticides exists. All joints in the ensemble (wrists, ankles, etc.) must be securely taped. Personnel must closely inspect all PPE prior to beginning any on-site activities. - Nitrile gloves or leather gloves with surgical style inner gloves - Safety shoes (Steel toe/shank) - Hardhat (when overhead hazards exists, or identified as an operation requirement) - Reflective vest for high traffic areas - Hearing protection for high noise areas, as directed by the SSO.	**Personnel Decontamination** will consist of a soap/water wash and rinse for outer protective equipment (boots, gloves, PVC splash suits, etc.). This function will take place at an area adjacent to the site activities. This procedure will consist of: - Equipment drop - Soap/water wash and rinse of outer boots and gloves **Note:** For PPE Level C, cartridge change out would take place at this point, if necessary. - Soap/water wash and rinse of the outer splash suit, as applicable - Outer suit, boot covers, outer glove removal - Respiratory (face mask) protection removal - Wash hands and face, leave contamination reduction zone **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing steam or pressure washers. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will be restricted access to exclusion zones, or also have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving onsite and that which is to leave the site. No equipment will be authorized access or exit without this authorization. Evaluation will consist of - Visual inspection - Scanning equipment with monitoring instruments

6.0 HAZARD ASSESSMENT AND CONTROLS

This section provides reference information regarding the chemical and physical hazards which may associated with activities that are to be conducted as part of the scope of work. Table 6-1 provides specific information related to the various chemical hazards that may be present at the planned project areas within NAS Key West. Specifically, toxicological information, exposure limits, symptoms of exposure, physical properties, and air monitoring and sampling data are discussed in the table.

6.1 CHEMICAL HAZARDS

Information provided regarding previous site activities and potential sources of contamination indicates the following primary contaminants of concern:

- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)
- Polychlorinated Biphenyls (PCBs)
- Pesticides
- Metals

Exposure to chemical hazards while performing the elements identified within the scope of work is considered to be minimal even though the activity is intrusive. This assessment is based on the number of locations to be investigated, the method of extraction, and the contaminant concentrations identified during prior sampling programs.

6.2 PHYSICAL HAZARDS

The following is a list of physical hazards that may be encountered at the site or may present during the performance of site activities associated with the scope of work.

- Slip, trip, and fall hazards
- Strain/muscle pulls from manual lifting
- Noise in excess of 85 dBA
- Exposure to pinch or compression points
- Entanglement or contact with moving or rotating equipment/machinery

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
FOR NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA
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Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Vinyl chloride	75-01-4	PID: I.P. 9.99 eV, High response with PID and 10.2 eV lamp. FID: 40% response with FID.	Air sample using charcoal or Anasorb CMS sorbent tube; carbon disulfide desorption; gas chromatography-flame ionization detection; Sampling and analytical protocol shall proceed in accordance with NIOSH Method #1007, or OSHA Method #75.	OSHA: 1.0 ppm PEL 5.0 ppm (Ceiling) ACGIH: 5 ppm NIOSH: Lowest Feasible Concentration	Inadequate - Odor threshold 10-20 ppm. Gas Mask with a vinyl chloride Type N canister may be employed for concentrations up to 25 ppm. Canisters employed must have a minimum service life of 4-hrs. Exceedances over 25 ppm, must use a positive pressure demand, open-circuit, self-contained breathing apparatus, pressure demand type, with full facepiece. Refer to 29 CFR 1910.1017(g) for specific requirements based on atmospheric concentrations of vinyl chloride. **Recommended gloves:** Silver shield >6.00 hrs; Nitrile 5.70 hrs; or Viton 4.4 hrs	**Boiling Pt:** 7°F; -13.9°C **Melting Pt:** -256°F; -160°C **Solubility:** 0.1% @ 77°F; 25°C **Flash Pt:** 18°F; -8°C **LEL/LFL:** 3.6% **UEL/UFL:** 33% **Vapor Density:** 2.21 **Vapor Pressure:** 3.3 atm **Specific Gravity:** N.A. **Incompatibilities:** Oxidizers, copper, aluminum, peroxides, iron, steel, **Appearance and Odor:** Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations.	A severe skin, eye, and mucous membrane irritant(Liquid: frostbite). Narcotic effect causing weakness, abdominal pains, GI bleeding, and pallor skin or cyanosis. Chronic exposure has been linked to the formation of malignant tumors originating from blood lymphatic vessels in the liver (associated enlargement of the liver), and kidneys (angiosarcoma and nephroblastoma). Listed as a carcinogen by NTP, IARC and ACGIH.
1,2-Dichloroethylene	540-59-0	PID: I.P. 9.65 eV, high response with PID and 10.2 eV lamp. FID: 50% response with FID.	Air sample using charcoal tube; and carbon disulfide desorption; Sampling and analytical protocol in accordance with OSHA Method #07; and NIOSH Method #1003.	OSHA; NIOSH; ACGIH: 200 ppm IDLH: 1000 ppm	Adequate- odor threshold 0.085-17 ppm. Use organic vapor/acid gas cartridges for exceedances above the TWA up to 1,000 ppm. >1,000 ppm should use pressure-demand supplied air respirator above exposure limits. **Recommended glove:** nitrile - 0.12 hrs; viton - 0.95 hrs	**Boiling Pt:** 117°F; 47°C **Melting Pt:** 7°F; -13.8°C **Solubility:** 0.4% **Flash Pt:** 36°F; 2.2°C **LEL/LFL:** 5.6% **UEL/UFL:** 12.8% **Vapor Density:** 2.0 **Vapor Pressure:** 180-260 mmHg **Specific Gravity:** 1.27 @ 90°F; 32°C **Incompatibilities:** Strong oxidizers, alkalis, potassium hydroxide, and copper. When heated to decomposition temperatures will emit toxic fumes of phosgene. **Appearance and Odor:** Colorless liquid with an acrid odor.	Overexposure may result in CNS depression with potential to cause sleepiness, hallucinations, distorted perceptions, and stupor (narcosis). Systemically, symptoms may result in nausea, vomiting, weakness, tremors, and cramps. May also irritate the eyes, skin, and mucous membranes. Chronic exposures may result in dermatitis, liver, kidney, and lung damage.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
FOR NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Naphthalene	91-20-3	PID: I.P. 8.12 eV, relative response ratio unknown. No information was found as to the relative response for FID, however it is certain it is detectable at a high response.	Air sample using charcoal tube; carbon disulfide desorption; GC/FID detection. Sampling and analytical protocol in accordance with OSHA Method #35 or NIOSH Method #1501.	OSHA; NIOSH; ACGIH: 10 ppm NIOSH; ACGIH: have established a STEL of 15 ppm. IDLH: 250 ppm	Odor Threshold 0.038 ppm, Adequate - Use an air purifying respirator with organic vapors and dust/mists cartridges for concentrations up to 250 ppm. **Recommended glove:** Nitrile >6.00 hrs; Neoprene >6.00 hrs	**Boiling Pt:** 424°F; 218°C **Melting Pt:** 176°F; 80°C **Solubility:** 0.003% **Flash Pt:** 174°F; 79°C **LEL/LFL:** 0.9% **UEL/UFL:** 5.9% **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg **Specific Gravity:** 1.15 **Incompatibilities:** Strong oxidizers, chromic anhydride **Appearance and odor:** Colorless to brown solid with and odor of mothballs	Overexposure to this substance may result in irritation to the eyes, headache, confusion, excitement, nausea, vomiting, abdominal pain, irritation of the bladder, profuse sweating, jaundice, blood in the urine, renal (kidney shutdown), and dermatitis. Prolonged or chronic exposure may further cause optical neuritis, and corneal damage. Target organs are listed as eyes, blood, liver, kidneys, skin, red blood cells, and central nervous system.
Arsenic	7440-38-2	Particulate form - This substance is unable to be detected by PID/FID.	Air sample using a particulate filter; acid desorption; AAS detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7900.	OSHA: Organic compounds 0.5 mg/m³ Inorganic compounds 0.01 mg/m³ NIOSH: (Ceiling) 0.002 mg/m³ ACGIH: 0.2 mg/m³ IDLH: 5 mg/m³ as arsenic	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. This substance may be presented as a pesticide, therefore a cartridge suitable for pesticides (MSA-GMP). **Recommended Gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** sublimation @ 1134°F; 612°C **Melting Pt:** 1497°F; 814°C @ 36 atm **Solubility:** Insoluble in water;soluble in nitric acid **Flash Pt:** Nonflammable, however, airborne in the form of a dust this substance will support combustion **LEL/LFL:** Nonflammable **UEL/UFL:** Nonflammable **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 372°C (sublimes) **Specific Gravity:** 5.73 **Incompatibilities:** Oxidizers, halogens,zinc, lithium, azides, and acetylides **Appearance and odor:** Gray to black, brittle, crystalline, amorphous, odorless.	Overexposure to this substance through inhalation or ingestion may result in ulceration of the nasal septum, GI disturbances resulting in violent purging and vomiting, hoarse voice, sore throat, excessive salivation, peripheral neuropathy (numbness and burning sensations beginning at the extremities followed by motor weakness), respiratory irritation leading to possible pulmonary edema. Skin or eye contact may result in irritation, conjunctiva, dermatitis, and hyperpigmentation (darkening of the areas exposed) of the skin. This substance has been judged to be a Human carcinogen by NTP, and IARC.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
FOR NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Cadmium	7440-43-9	Particulate Form - Unable to be easily detected by PID or FID.	Air sample using a mixed cellulose-ester filter / acid desorption and analysis by atomic absorption-flame. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7300 or #7048.	OSHA: 2 µg/m³ (0.002 mg/m³) ACGIH: 0.01 mg/m³ (total particulate) 0.002 mg/m³ (respirable particulate) IDLH: 9 mg/m3 (as cd)	The use of an air purifying, full face-piece respirator with a high efficiency particulate air filter for concentrations up to 0.25 mg/m³. **Recommended Gloves:** This is in particulate form. Therefore any glove suitable to prevent skin contact.	**Boiling Pt:** 1412°F; 767°C **Melting Pt:** 610°F; 321°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 741°F; 394°C **Specific Gravity:** 8.65 @ 90°F; 32°C **Incompatibilities:** Strong oxidizers, elemental sulfur, selenium, tellurium, zinc, nitric acid, and hydrazoic acid **Appearance and Odor:** Metal: Silver-white, blue-tinged lustrous, odorless solid. Fume: yellow-brown, finely divided particulate dispersed in air.	Overexposure to this substance may result in irritation to the respiratory tract, dyspnea, tightness in the chest, coughing, possibly pulmonary edema. Overexposure to fumes causes symptoms characteristic of the flu (headaches, chills, muscle aches, nausea, vomiting, diarrhea). Chronic exposure may result in damage to the lungs, kidneys and liver. This substance has been identified as a confirmed animal; potential human carcinogen by IARC and NTP.
Lead	7439-92-1	Particulate form - Unable to be detected by either PID or FID.	Air sample using a mixed cellulose ester filter; or HNO_3 or H_2O_2 desorption; or Atomic absorption detection. NIOSH Method #7082 or #7300.	OSHA: 0.05 mg/m³ ACGIH: 0.15 mg/m³ NIOSH: 0.10 mg/m³ IDLH: 100 mg/m³ as lead	The use of a air purifying, full-face respirator with high efficiency particulate air filter for up to 2.5 mg/m³. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 3164°F; 1740°C **Melting Pt:** 621°F; 327°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** Not available **Vapor Pressure:** 0 mmHg **Specific Gravity:** 11.34 **Incompatibilities:** Strong oxidizers, peroxides, sodium acetylide, zirconium, and acids **Appearance and Odor:** Metal: A heavy ductile, soft gray solid.	Overexposure to this substance via ingestion or inhalation may result in metallic taste in the mouth, dry throat, thirst, Gastrointestinal disorders (burning stomach pain, nausea, vomiting, possible diarrhea sometimes bloody or black, accompanied by severe bouts of colic), CNS effects (muscular weakness, pain, cramps, headaches, insomnia, depression, partial paralysis possibly coma and death. Extended exposure may result in damage to the kidneys, gingival lead line, brain, and anemia.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
FOR NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA
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Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
DDT and the major metabolites; DDD and DDE.	50-29-3 72-54-8 72-55-9	Substance is not volatile, I.P. is unknown, detection by PID is unknown. Substance non-combustible, therefore a FID is anticipated to have reduced response to DDT.	Air sample using a binder free, glass fiber filter; isoctane desorption; gas chromatography-electron capture detector. Sampling and analytical protocol will proceed in accordance with NIOSH Method #3(S274).	OSHA; ACGIH: 1 mg/m³ NIOSH: 0.5 mg/m³	Adequate - Can use air purifying respirator with high efficiency particulate air filter (HEPA). **Recommended glove:** Nitrile acceptable for incidental contact.	**Boiling Pt:** 230°F; 110°C **Melting Pt:** 226°F; 108°C **Solubility:** Insoluble **Flash Pt:** 162-171°F; 72-77°C **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** Low **Specific Gravity:** 0.99 **Incompatibilities:** Strong oxidizers and alkalis **Appearance and Odor:** Colorless crystals or off-white powder with a slight aromatic odor	Large doses are followed by vomiting due to gastric irritation, diarrhea may follow. Numbness and parethesias of the lips tongue and face associated with malaise, headache, sorethroat, fatigue and weakness. Coarse tremors (usually first of the neck, head, and eyelids). This may be accompanied by confusion, apprehension, and depression. Convulsions may result and death may occur from respiratory failure. DDT is absorbed and retained in the fat of humans. Chronic exposure may result in damage to the liver, kidneys and Peripheral Nervous System. DDT is recognized as possessing carcinogenic properties by IARC and NTP.
Chlordane	57-74-9	Substance is not volatile (VP=.00001 mmHg) I.P. is unknown, therefore detection by PID is unknown. Substance is non-combustible, therefore a FID is not expected to have a response to chlordane.	Air sample using Chromosorb-102 sorbent tube with mixed cellulose-ester filter or a xad-2 sorbent tube with filter. Toluene desorption and analysis by gas chromatography-electron capture detector. Sampling and analytical protocol will proceed in accordance with NIOSH Method #5510 or OSHA Method #67.	OSHA; NIOSH; ACGIH: 0.5 mg/m³	Adequate - can use an air purifying respirator with an organic vapor & high efficiency air filter cartridges. **Recommended gloves:** PTFE Teflon for pure product. Nitrile acceptable for incidental contact.	**Boiling Pt:** 347°F; 175°C **Melting Pt:** Not available **Solubility:** Insoluble **Flash Pt:** Not available **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 0.00001 mmHg **Specific Gravity:** 1.56 @ 60°F; 15.5° C **Incompatibilities:** Strong oxidizers and alkaline reagents **Appearance and Odor:** Amber-colored, viscous liquid with a pungent, chlorine like odor.	Earliest signs of overexposure manifest as hypersensitivity of the central nervous system characterized by hyperactive reflexes, muscle twitching, tremors, incoordination, ataxia, and clonic convulsions. Cycles of excitement and depression may be repeated over and over. Chronic health hazard information similar to those for DDT.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
FOR NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Aroclor-1260 (Polychlorinated Biphenyl, PCB) It should be noted that this substance is representative of the more common isomers Aroclor - 1242, 1254, which may be encountered.	11096-82-5 53469-21-9 (42%) 11097-69-1 (54%)	Substance is not volatile (VP=0.00006 mmHg), I.P. is unknown however is anticipated to be elevated, therefore, PID is not anticipated to detect substance. Substance is non combustible and as a result will not be detected by FID.	Air sample using a particulate filter, Florisil sorbent tube with glass fiber filter; hexane desorption; gas chromatography-electron capture detector. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #5503 (PCBs).	OSHA; ACGIH: 0.5 mg/m³ (skin) NIOSH: 0.001 mg/m³ IDLH: 5 mg/m³	Inadequate - However due to the low volatility it is assumed unless agitated this substance does not present a volatile vapor or gas respiratory threat. For dusty conditions where this material may cling to particulates, use a HEPA filter. APRs are approved for escape only when concentrations exceed the exposure limits. Concentrations greater than the exposure limits require PAPR or supplied air respirators. **Recommended glove:** Butyl rubber >24 hrs; Neoprene rubber >24.00 hrs; Silver shield or Viton (for pure product).	**Boiling Pt:** distillation range 689- 734 °F; 365-390°C **Melting Pt:** -2 to 50°F; -19 to 10°C **Solubility:** Insoluble **Flash Pt:** Not applicable **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable Nonflammable liquid, however, exposure to fire results in black soot containing PCBs, dibenzofurans, & chlorinated dibenzo-p-dioxins **Vapor Density:** Not available **Vapor Pressure:** 0.00006 - 0.001 mmHg **Specific Gravity:** 1.566 @ 60°F; 15.5 °C **Incompatibilities:** Strong oxidizers **Appearance and Odor:** Colorless to pale yellow, viscous liquid or solid (Aroclor 54 below 50°F) with a mild, hydrocarbon odor	This substance is irritating to the eyes and skin. Chronic effects of overexposure may include potential to cause liver damage, chloracne, and reproductive effects. Recognized as possessing carcinogenic properties by NIOSH, and NTP.

- Contact with energized sources (aboveground and underground)
- Ambient temperature extremes
- Inclement weather
- Natural Hazards (ticks, snakes, plants, etc.)

Many of these physical hazards are discussed in detail in Section 4.0 of the Health and Safety Guidance Manual. Additional information regarding physical hazards associated with the site is provided in Table 5-1 of this HASP.

7.0 AIR MONITORING

Direct reading instruments (Photoionization Detector or Flame Ionization Detector) will be used when possible to detect and evaluate the potential presence of VOCs and other ionizable agents as indicated in Table 6-1. The specific type of monitoring and the associated instruments, frequency of use, and applicable action levels are dependent upon the specific scope of work and the contaminants of concern. As a result, specific air monitoring measures and requirements have been established in Table 5-1 of this site-specific HASP. Additionally, Section 1.0 of the B&R Environmental Health and Safety Guidance Manual contains detailed information regarding direct reading instrumentation and personal and area air sampling procedures, as well as general calibration procedures of various instruments.

In most cases, however, the contaminants of concern are unable to be detected or are difficult to detect with the use of direct reading instruments. In particular, SVOCs, PCBs, pesticides, and metals exhibit poor detection characteristics due to their solid nature, low vapor pressure, or non-ionizing properties. The greatest potential for exposure to these contaminants generally would be as a result of inhalation or ingestion of contaminant-laden particulates (i.e., dusts). As a result, any observations of airborne particulates will indicate a potential for exposure, and will require control measures such as area wetting, upgrade of PPE, or evacuation. Given the proposed activities, however, it is not anticipated that airborne particulates will be generated in concentrations to present a significant health hazard.

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

8.1.1 Requirements for Brown & Root Environmental

This section is included to specify health and safety training and medical surveillance requirements for B&R Environmental personnel participating in on site activities. All B&R Environmental personnel must complete 40 hours of introductory hazardous waste site training prior to performing work at the NAS Key West. B&R Environmental personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training within the past 12 months before being cleared for site work. In addition, 8-hour supervisory training in accordance with 29 CFR 1910.120(e)(4) will be required for site supervisory personnel.

Documentation of B&R Environmental introductory, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.1.2 Requirements for Subcontractors

Identified B&R Environmental subcontractor personnel must have completed introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) and 8 hours of refresher training meeting the requirements of 29 CFR 1910.120(e)(8) prior to performing field work at the NAS Key West. B&R Environmental subcontractors must certify that each employee has had such training by sending B&R Environmental a letter, on company letterhead, containing the information in the example letter provided in Figure 8-1. This letter will be accompanied by training certificates or some other form of official documentation for all subcontractor personnel participating in site activities.

The following statements must be typed on company letterhead and signed by an officer of the company and accompanied by copies of personnel training certificates:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Mr. Chuck Bryan
Task Order Manager
Brown & Root Environmental
900 Trail Ridge Road
Aiken, South Carolina 29803

Subject: HAZWOPER Training for Naval Air Station Key West (NAS Key West), Key West, Florida

Dear Mr. Bryan:

As an officer of XYZ Corporation, I hereby state that I am aware of the potential hazardous nature of the subject project. I also understand that it is our responsibility to comply with all applicable occupational safety and health regulations, including those stipulated in Title 29 of the Code of Federal Regulations (CFR), Parts 1900 through 1910 and Part 1926.

I also understand that Title 29 CFR 1910.120, entitled "Hazardous Waste Operations and Emergency Response," requires an appropriate level of training for certain employees engaged in hazardous waste operations. In this regard, I hereby state that the following employees have had 40 hours of introductory hazardous waste site training or equivalent work experience as required by 29 CFR 1910.120(e) and have had 8 hours of refresher training as required by 29 CFR 1910.120(e)(8) and site supervisory personnel have had training in accordance with 29 CFR 1910.120(e)(4).

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE.

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name and Title of Company Officer)

Enclosed - Copies of Training Certificates

FIGURE 8-1. EXAMPLE TRAINING LETTER

8.2 SITE-SPECIFIC TRAINING

B&R Environmental will provide site-specific training to all B&R Environmental personnel who will perform work on this project. Site-specific training will include:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Medical surveillance requirements
- Contents of the Health and Safety Plan
- Signs and symptoms of overexposure to site contaminants
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Spill response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Emergency response procedures (evacuation and assembly points)
- Associated hazards and restricted areas within the NAS Key West.

Site-specific training documentation will be established through the use of Figure 8-2.

8.3 MEDICAL SURVEILLANCE

All B&R Environmental personnel participating in project field activities will have had a physical examination meeting the requirements of B&R Environmental's medical surveillance program. Documentation for medical clearances will be maintained in the B&R Environmental Aiken office and made available, as necessary.

8.3.1 Medical Surveillance Requirements for Subcontractors

Identified subcontractors are required to obtain a certificate of their ability to perform hazardous waste site work and to wear respiratory protection. The "Subcontractor Medical Approval Form" provided in Figure 8-3 shall be used to satisfy this requirement, providing it is properly completed and signed by a licensed physician.

My signature below indicates that I am aware of the potential hazardous nature of performing remedial activities at Naval Air Station Key West (NAS Key West), Key West, Florida, and that I have received site-specific training which included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Medical surveillance requirements
- Contents of the Health and Safety Plan
- Signs and symptoms of overexposure to site contaminants
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Spill response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Emergency response procedures (evacuation and assembly points)
- Associated hazards and restricted areas within the NAS Key West.

I further state that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction.

I further state, by the presence of my signature below that, the date of my training (introductory, refresher, and supervisory, as applicable) and my medical surveillance requirements are accurate and correct to the best of my knowledge.

Name	40-Hour General Site Worker Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Date of Medical Surveillance	SIGNATURE

FIGURE 8-2. SITE-SPECIFIC TRAINING DOCUMENTATION

For employees of ______________________________
Company Name

Participant Name: ____________________ Date of Exam: ______________

Part A

The above-named individual has:

1. Undergone a physical examination in accordance with OSHA Standard 29 CFR 1910.120, paragraph (f), and was found to be medically -

   ( ) qualified to perform work at the Naval Air Station Key West; Key West, Florida

   ( ) not qualified to perform work at the Naval Air Station Key West; Key West, Florida

and,

2. Undergone a physical examination in accordance with OSHA 29 CFR 1910.134(b)(10) and was found to be medically -

   ( ) qualified to wear respiratory protection
   ( ) not qualified to wear respiratory protection

My evaluation has been based on the following information, as provided to me by the employer.

( ) A copy of OSHA Standard 29 CFR 1910.120 and appendices.
( ) A description of the employee's duties as they relate to the employee's exposures.
( ) A list of known/suspected contaminants and their concentrations (if known).
( ) A description of any personal protective equipment used or to be used.
( ) Information from previous medical examinations of the employee that is not readily available to the examining physician.

Part B

I, ______________________, have examined ______________________
Physician's Name (print) Participant's Name (print)

and have determined the following information:

FIGURE 8-3. SUBCONTRACTOR MEDICAL APPROVAL FORM

1. Results of the medical examination and tests (excluding finding or diagnoses unrelated to occupational exposure):

____

____

____

2. Any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health:

____

____

____

3. Recommended limitations upon the employee's assigned work:

____

____

____

I have informed this participant of the results of this medical examination and any medical conditions which require further examination of treatment.

Based on the information provided to me, and in view of the activities and hazard potentials involved at the Naval Air Station Key West; Key West, Florida, this participant

( ) may
( ) may not

perform his/her assigned task.

Physician's Signature ____________________

Address ____________________

Phone Number ____________________

NOTE: Copies of test results are maintained and available at:

____
Address

FIGURE 8-3. SUBCONTRACTOR MEDICAL APPROVAL FORM PAGE TWO

Subcontractors who have a company medical surveillance program meeting the requirements of paragraph (f) of OSHA 29 CFR 1910.120 can substitute "Subcontractor Medical Approval Form" with a letter, on company letterhead, containing all of the information in the example letter presented in Figure 8-4 of this HASP.

8.3.2 Requirements for All Field Personnel

Each field team member, including subcontractors and visitors, entering the exclusion zone(s) shall be required to complete and submit a copy of the Medical Data Sheet found in the B&R Environmental Health and Safety Guidance Manual. This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SUBCONTRACTOR EXCEPTIONS

In situations in which the exclusion zone is not entered or when there is no potential for exposure to site contaminants, subcontractor personnel may be exempt from some of the training and medical surveillance requirements. All subcontractors and visiting personnel are required to receive site-specific training (as discussed in Section 8.2) regarding information provided in this HASP. Examples of subcontractors who may be exempt from training and medical surveillance requirements may include surveyors who perform surveying activities at the site perimeters or in areas were there is no potential for exposure to site contaminants, and in this case the subcontractor providing concrete coring services.

The use of the subcontractor exception is strictly limited to the authority of the CLEAN Health and Safety Manager.

The following statements must be typed on company letterhead and signed by an officer of the company:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Mr. Chuck Bryan
Task Order Manager
Brown & Root Environmental
900 Trail Ridge Road
Aiken, South Carolina 29803

Subject: Medical Surveillance for Naval Air Station Key West (NAS Key West), Key West, Florida

Dear Mr. Bryan:

As an officer of XYZ Corporation, I hereby state that the persons listed below participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120, entitled "Hazardous Waste Operations and Emergency Response: Final Rule." I further state that the persons listed below have had physical examinations under this program within the past 12 months and that they have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive- and negative- pressure respiratory protection. I also state that, to my knowledge, no person listed below has any medical restriction that would preclude him/her from working at the NAS Key West, Key West, Florida.

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE.

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name and Title of Company Officer)

FIGURE 8-4. EXAMPLE MEDICAL SURVEILLANCE LETTER

9.0 SITE CONTROL

This section outlines the means by which B&R Environmental will delineate work zones and use these work zones in conjunction with decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a fractured three-zone approach will be used during work at this site. This three zone approach will utilize an exclusion zone, a contamination reduction zone, and a support zone. It is also anticipated that this control measure will be used to control access to site work areas. Use of such controls will restrict the general public, minimize the potential for the spread of contaminants, and protect individuals who are not cleared to enter work areas.

9.1 EXCLUSION ZONE

The exclusion zone will be considered those areas of the site of known or suspected contamination. It is not anticipated that significant amounts of surface contamination are present in the proposed work areas of this site. It is anticipated that this will remain so unless contaminants are brought to the surface by intrusive activities, such as when conducting the soil boring and sampling as slated for this statement of work. Furthermore, once intrusive activities have been completed and surface contamination has been removed, the potential for exposure is again diminished and the area can then be reclassified as part of the contamination reduction zone. Therefore, the exclusion zones for this project will be limited to those areas of the site where active work is being performed plus a designated area surrounding the point of operation (see Table 5-1 for a list of specific operations). The exclusion zone for most site activities will be fragmented to represent the areas where the soils are disturbed through soil boring or sampling activities. All exclusion zones will be delineated using barrier tape, cones, and postings to inform and direct facility personnel.

9.2 EXCLUSION ZONE CLEARANCE

A pre-startup site visit will be conducted by members of the identified field team in an effort to identify proposed subsurface investigation locations, conduct utility clearances, and provide upfront notices concerning scheduled activities within the facility.

In all cases, no subsurface activities will proceed without utility clearance. In the event that a utility is struck during a subsurface investigative activity, the emergency numbers provided in Section 2.7, Table 2-1, will be notified.

When base personnel are working within the proximity of this investigation, they will be moved or their operation temporarily discontinued to remove them from potential hazards associated with this operation.

9.3 CONTAMINATION REDUCTION ZONE

The contamination reduction zone (CRZ) will be a buffer area between the exclusion zone and any area of the site where contamination is not suspected. This area will also serve as a focal point in supporting exclusion zone activities. This area will be delineated using barrier tape, cones, and postings to inform and direct facility personnel. Decontamination will be conducted at a central location. All equipment potentially contaminated will be bagged and taken to that location for decontamination. Given this consideration, equipment required to complete this operation may include hand augers and stainless steel bowls and spatulas for each location.

9.4 SUPPORT ZONE

The support zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. In all cases, the support zones will be established at areas of the site where exposure to site contaminants would not be expected during normal working conditions or foreseeable emergencies.

9.5 SAFE WORK PERMITS

All exclusion zone activities conducted in support of this project will be done so using this HASP as a reference guide and Safe Work Permits to incorporate site-specific information to guide and direct field crews on a task by task basis. An example of the Safe Work Permit to be used during site activities is illustrated in Figure 9-1.

All permits will be issued by the SSO or his/her on site representative in the morning prior to the commencement of on site activities. Safe Work Permits required for this operation will include the following:

- Coring of the concrete
- Subsurface soil sampling
- Hollow stem auger drilling
- Decontamination of the sampling equipment

Permit No. ______________ Date: __________________ Time: From ____________ to ____________

SECTION I: General Job Scope (To be filled in by person performing work)

I. Work limited to the following (description, area, equipment used): ________________________

II. Names: ________________________

III. Onsite Inspection conducted Yes No Initials of Inspector ______________ ______________
B&RE

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D	Level B
Level C	Level A
Detailed on Reverse	

Respiratory equipment required

Full face APR	Escape Pack
Half face APR	SCBA
SKA-PAC SAR	Bottle Trailer
Skid Rig	None

Modifications/Exceptions: ________________________

V. Chemicals of Concern	Action Level(s)	Response Measures
______________	______________	______________
______________	______________	______________

VI. Additional Safety Equipment/Procedures

Hardhat	Yes	No	Hearing Protection (Plugs/Muffs)	Yes	No
Safety Glasses	Yes	No	Safety belt/harness	Yes	No
Chemical/splash goggles	Yes	No	Radio	Yes	No
Splash Shield	Yes	No	Barricades	Yes	No
Splash suits/coveralls	Yes	No	Gloves (Type)	Yes	No
Steel toe/shank Workboots	Yes	No	Work/rest regimen	Yes	No

Modifications/Exceptions: ________________________

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)			Emergency alarms		
Procedure for safe job completion			Evacuation routes		
Contractor tools/equipment inspected			Assembly points		

VIII. Equipment Preparation

	Yes	NA
Equipment drained/depressured		
Equipment purged/cleaned		
Isolation checklist completed		
Electrical lockout required/field switch tested		
Blinds/misalignments/blocks & bleeds in place		
Hazardous materials on walls/behind liners considered		

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) .... Yes No
If yes, fill out appropriate section(s) on safety work permit addendum

X. Special instructions, precautions: ________________________

Permit Issued by: ____________________ Permit Accepted by: ____________________
Job Completed by: ____________________ Date: ____________________

FIGURE 9-1. EXAMPLE SAFE WORK PERMIT

Safe Work Permits are to be completed in accordance with the specifications contained in Table 5-1, and the other sections of the HASP as appropriate.

All personnel identified on the permit as participating in the task will be made aware of its contents by the supervisor accepting the permit. Any problems which occurred throughout the task will be documented by the supervisor on the permit.

All permits will be returned to the FOL or the SSO at the end of the day.

9.6 SITE VISITORS

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by B&R Environmental
- Regulatory personnel (i.e., DOD, EPA, OSHA)
- Southern Division Navy Personnel
- Other authorized visitors

All non-DOD personnel working on this project are required to gain initial access to the base by coordinating with the B&R Environmental FOL or designee and following established base access procedures.

Once access to the base is obtained, all personnel who require site access into areas of ongoing operations will be required to obtain permission from the FOL and the Base Contact. Upon gaining access to the site, all site visitors wishing to observe operations in progress will be escorted by a B&R Environmental representative and shall be required to meet the minimum requirements discussed below:

- All site visitors will be routed to the FOL, who will sign them into the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), the entity which they represent, and the purpose of the visit.

- All site visitors will be required to produce the necessary information supporting clearance to the site. This shall include information attesting to applicable training and medical surveillance as stipulated in Section 8.0 of this document. In addition, to enter the site operational zones during planned activities, all visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this HASP.

Once the site visitors have completed the above items, they will be permitted to enter the operational zone. All visitors are required to observe the protective equipment and site restrictions in effect at the site at the time of their visit. All visitors entering the exclusion zones during ongoing operations will be accompanied by a B&R Environmental representative. Any and all visitors not meeting the requirements, as stipulated in this plan, for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause the termination of all on site activities until the unauthorized visitor is removed from the premises. Removal of unauthorized visitors will be accomplished with support from the Base Contact. If necessary, the Base Contact will be notified of any unauthorized visitors.

9.7 SITE SECURITY

Site security will be accomplished using B&R Environmental field personnel. B&R Environmental will retain complete control over active operational areas. As this activity takes place at a Navy facility open to public access, the first line of security will take place using exclusive zone barriers, site work permits, and any existing barriers at the sites to restrict the general public. The second line of security will take place at the work site referring interested parties to the Base Contact. The Base Contact will serve as a focal point for base personnel, interested parties, and serve as the final line of security and the primary enforcement contact.

9.8 SITE MAP

Once the areas of contamination, access routes, topography, and dispersion routes are determined, a site map will be generated and adjusted as site conditions change. These maps will be posted to illustrate up-to-date collection of contaminants and adjustment of zones and access points.

9.9 BUDDY SYSTEM

Personnel engaged in on site activities will practice the "buddy system" to ensure the safety of all personnel involved in this operation.

9.10 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

B&R Environmental and subcontractor personnel will provide MSDSs for all chemicals brought on site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application of the substances on site. A chemical inventory of all chemicals used on site will be developed using the Health and Safety Guidance Manual. The MSDSs will then be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request.

9.11 COMMUNICATION

As personnel will be working in proximity to one another during field activities, a supported means of communication between field crews members will not be necessary.

External communication will be accomplished by using the telephones at predetermined and approved locations. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of activities at the NAS Key West, the FOL will determine and arrange for telephone communications.

10.0 SPILL CONTAINMENT PROGRAM

Given the nature of planned activities, bulk hazardous materials will not be handled. Provisions for spill containment, therefore, are not necessary.

11.0 CONFINED-SPACE ENTRY

Personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces. A confined space is defined as an area that has one or more of the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, manholes, sewers, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

Additionally, a Permit-Required Confined Space may also have one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly caving walls or by a floor that slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space operations, consult the Health and Safety Guidance Manual or call the HSM.

12.0 MATERIALS AND DOCUMENTATION

12.1 B&R ENVIRONMENTAL FIELD OPERATIONS LEADER REQUIREMENTS

The B&R Environmental Field Operations Leader (FOL) shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets
- Material Safety Data Sheets for all chemicals brought on site, including decontamination solutions, fuels, sample preservatives, calibration gases, etc.
- Follow-up Reports (to be completed by the FOL)
- A full-size OSHA Job Safety and Health Poster (posted in the site trailer)
- Training/Medical Surveillance Documentation Form (Blank)
- First-Aid Supply Usage Form
- Emergency Reference Form (Section 2.0, extra copy for posting)
- Soil Boring Log Forms for logging the soil borings
- Directions to the Hospital

12.2 MATERIALS TO BE POSTED AT THE SITE

The following documentation is to be posted at the site for quick reference purposes. In situations where posting of these documents is not feasible (such as no office trailer), these documents should be separated and be immediately accessible to site personnel.

Chemical Inventory Listing - This list represents all chemicals brought on site, including decontamination solutions, sample preservatives, fuel, calibration gases, etc.. This list should be posted in a central area.

Material Safety Data Sheets (MSDSs) - The MSDSs should also be in a central area accessible to all site personnel. These documents should match all the listings on the chemical inventory list for all substances employed on site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

The OSHA Job Safety & Health Protection Poster - This poster, as directed by 29 CFR 1903.2 (a)(1), should be conspicuously posted in places where notices to employees are normally posted. Each FOL shall ensure that this poster is not defaced, altered, or covered by other material.

Site Clearance Posting - This listing is found within the training section of the HASP (See Figure 8-1). This list identifies all site personnel, dates of training (including site-specific training), and medical surveillance. This lists indicates not only clearance but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

Emergency Phone Numbers and Directions to the Hospital(s) - This list of numbers and the directions will be maintained at all phone communications points and in each site vehicle.

Medical Data Sheets/Cards - Medical Data Sheets will be filled out by all on site personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to all personnel to be carried on their person.

Hearing Conservation Standard (29 CFR 1910.95) - This standard will be posted anytime hearing protection or other noise abatement procedures are employed.

Personnel Monitoring - All results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

Placards and Labels - Where chemical inventories have been separated, because of quantities and incompatibilities, these areas will be conspicuously marked using Department of Transportation (DOT) placards and acceptable [Hazard Communication 29 CFR 1910.1200 (f)] labels.

13.0 ACRONYMS / ABBREVIATIONS

CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CSP	Certified Safety Professional
DRI	Direct Reading Instrument
EBS	Environmental Baseline Survey
FOL	Field Operations Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
IDW	Investigation Derived Waste
NAS	Naval Air Station
N/A	Not Available
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PCB	Polychlorinated Biphenyls
PHSO	Project Health and Safety Officer
PPE	Personal Protective Equipment
SVOCs	Semi-Volatile Organic Compounds
TBD	To be determined
TOM	Task Order Manager
VOCs	Volatile Organic Compounds

14.0 REFERENCES

B&R Environmental (Brown & Root Environmental), 1996. B&RE/Navy Site Visit. November.

B&R Environmental (Brown & Root Environmental), 1997a. B&RE/Navy Site Visit. March.

B&R Environmental (Brown & Root Environmental), 1997b. Partners Site Visit and Teleconference. May.

B&R Environmental (Brown & Root Environmental), 1997c. B&RE Site Visit. July.

B&R Environmental (Brown & Root Environmental), 1997d. Partnering Meeting. July.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1942. Condition Map of NAS Key West. June 30.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957. PWO Drawing of Master Shore Station Development Plan, Dwg. No. P-2530. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1996a. *Predraft EBS Truman Annex; Excess Property.* October.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1996b. *Predraft EBS Realignment Parcels; Environmental Baseline Survey.* October.

USN - NAS (U.S. Navy - Naval Facilities Engineering Command), 1996c. *Predraft EBS Poinciana Housing.* October.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1997. *Draft EBS Truman Annex Outer Mole Pier 8/Bldgs. 149, 1374, 4080.* April.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1994a. *Remedial Action Plan (RAP) for Electric Power Plant Building 103.* August.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1994b. *Remedial Action Plan (RAP) for Berthing Wharf Bldg. 189.* August.

Appendix B

Data Quality Objective Process Documentation

Appendix B

Part 1 - Data Quality Objective Subzone Summaries

TABLE B-1

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Industrial Goals[2]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
INORGANICS						
Aluminum	1,000,000	78,000	3774.57	1,000,000	FDEP Industrial Goals	mg/kg
Antimony	220	31	0.58	220	FDEP Industrial Goals	mg/kg
Arsenic	3.7	0.43	2.66	3.7	FDEP Industrial Goals	mg/kg
Barium	84,000	5,500	21.9	84,000	FDEP Industrial Goals	mg/kg
Beryllium	1	0.15	0.08	1	FDEP Industrial Goals	mg/kg
Cadmium	600	39	0.28	600	FDEP Industrial Goals	mg/kg
Calcium	NA	NA	NA	NA	NA	mg/kg
Chromium	430	390	12.34	430	FDEP Industrial Goals	mg/kg
Cobalt	110,000	4,700	0.46	110,000	FDEP Industrial Goals	mg/kg
Copper	NA	3,100	11.54	3,100	Residential Soil RBCs	mg/kg
Iron	NA	23,000	2334.88	23,000	Residential Soil RBCs	mg/kg
Lead	1,000	NA	33.32	1,000	FDEP Industrial Goals	mg/kg
Magnesium	NA	NA	NA	NA	NA	mg/kg
Manganese	5,500	1,800	35.3	5,500	FDEP Industrial Goals	mg/kg
Mercury	480	23	0.06	480	FDEP Industrial Goals	mg/kg
Nickel	26,000	1,600	3.4	26,000	FDEP Industrial Goals	mg/kg
Potassium	NA	NA	NA	NA	NA	mg/kg
Selenium	9,900	390	1.3	9,900	FDEP Industrial Goals	mg/kg
Silver	9,000	390	NA	9,000	FDEP Industrial Goals	mg/kg
Sodium	NA	NA	NA	NA	NA	mg/kg
Thallium	NA	NA	NA	NA	NA	mg/kg
Tin	670,000	47,000	3.92	670,000	FDEP Industrial Goals	mg/kg
Vanadium	4,800	550	8.32	4,800	FDEP Industrial Goals	mg/kg
Zinc	560,000	23,000	32.18	560,000	FDEP Industrial Goals	mg/kg
PESTICIDES						
4,4'-DDD	17,000	2,700	27.2	17,000	FDEP Industrial Goals	µg/kg
4,4'-DDE	11,000	1,900	83.3	11,000	FDEP Industrial Goals	µg/kg
4,4'-DDT	12,000	1,900	61.24	12,000	FDEP Industrial Goals	µg/kg
Aldrin	200	38	NA	200	FDEP Industrial Goals	µg/kg
alpha-BHC	600	100	NA	600	FDEP Industrial Goals	µg/kg
alpha-chlordane	NA	490	NA	490	Residential Soil RBCs	µg/kg
beta-BHC	2,300	350	NA	2,300	FDEP Industrial Goals	µg/kg
delta-BHC	470,000	NA	NA	470,000	FDEP Industrial Goals	µg/kg
Dieldrin	300	40	NA	300	FDEP Industrial Goals	µg/kg
Endosulfan I	5,900,000	470,000	6.26	5,900,000	FDEP Industrial Goals	µg/kg
Endosulfan II	5,900,000	470,000	NA	5,900,000	FDEP Industrial Goals	µg/kg
Endosulfan sulfate	NA	NA	NA	NA	NA	µg/kg
Endrin	470,000	23,000	11.8	470,000	FDEP Industrial Goals	µg/kg
Endrin aldehyde	480,000	NA	NA	480,000	FDEP Industrial Goals	µg/kg
Endrin ketone	NA	NA	NA	NA	NA	µg/kg
gamma-BHC (lindane)	3,000	490	NA	3,000	FDEP Industrial Goals	µg/kg
gamma-chlordane	NA	490	NA	490	Residential Soil RBCs	µg/kg
Heptachlor	500	140	NA	500	FDEP Industrial Goals	µg/kg

TABLE B-1

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Industrial Goals[2]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
Heptachlor epoxide	300	70	NA	300	FDEP Industrial Goals	µg/kg
Methoxychlor	7,800,000	390,000	59.86	7,800,000	FDEP Industrial Goals	µg/kg
Toxaphene	3,000	580	NA	3,000	FDEP Industrial Goals	µg/kg
POLYCHLORINATED BIPHENYLS						
Aroclor-1016	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
Aroclor-1221	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
Aroclor-1232	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
Aroclor-1242	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
Aroclor-1248	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
Aroclor-1254	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
Aroclor-1260	3,500	320	NA	3,500	FDEP Industrial Goals	µg/kg
SEMIVOLATILE ORGANIC COMPOUNDS						
1,2,4-trichlorobenzene	NA	780,000	NA	780,000	Residential Soil RBCs	µg/kg
1,2-dichlorobenzene	6,000,000	7,000,000	NA	6,000,000	FDEP Industrial Goals	µg/kg
1,3-dichlorobenzene	13,000,000	7,000,000	NA	13,000,000	FDEP Industrial Goals	µg/kg
1,4-dichlorobenzene	1,100	27,000	NA	1,100	FDEP Industrial Goals	µg/kg
2,4,5-trichlorophenol	130,000,000	7,800,000	NA	130,000,000	FDEP Industrial Goals	µg/kg
2,4,6-trichlorophenol	280,000	58,000	NA	280,000	FDEP Industrial Goals	µg/kg
2,4-dichlorophenol	4,000,000	230,000	NA	4,000,000	FDEP Industrial Goals	µg/kg
2,4-dimethylphenol	16,000,000	1,600,000	NA	16,000,000	FDEP Industrial Goals	µg/kg
2,4-dinitrophenol	NA	160,000	NA	160,000	Residential Soil RBCs	µg/kg
2,4-dinitrotoluene	2,000,000	160,000	NA	2,000,000	FDEP Industrial Goals	µg/kg
2,6-dinitrotoluene	1,300,000	78,000	NA	1,300,000	FDEP Industrial Goals	µg/kg
2-chloronaphthalene	4,000,000	NA	NA	4,000,000	FDEP Industrial Goals	µg/kg
2-chlorophenol	3,700,000	390,000	NA	3,700,000	FDEP Industrial Goals	µg/kg
2-methyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	µg/kg
2-methylnaphthalene	8,800,000	NA	NA	8,800,000	FDEP Industrial Goals	µg/kg
2-methylphenol	32,000,000	3,900,000	NA	32,000,000	FDEP Industrial Goals	µg/kg
2-nitroaniline	73,000	4,700	NA	73,000	FDEP Industrial Goals	µg/kg
2-nitrophenol	NA	NA	NA	NA	NA	µg/kg
3 & 4-methylphenol	5,500,000	3,900,000	NA	5,500,000	FDEP Industrial Goals	µg/kg
3,3'-dichlorobenzidine	NA	1,400	NA	1,400	Residential Soil RBCs	µg/kg
3-nitroaniline	NA	230,000	NA	230,000	Residential Soil RBCs	µg/kg
4-bromophenyl phenyl ether	NA	4,500,000	NA	4,500,000	Residential Soil RBCs	µg/kg
4-chloro-3-methylphenol	1,000,000,000	NA	NA	1,000,000,000	FDEP Industrial Goals	µg/kg
4-chloroaniline	3,300,000	310,000	NA	3,300,000	FDEP Industrial Goals	µg/kg
4-chlorophenyl phenyl ether	NA	NA	NA	NA	NA	µg/kg
4-nitroaniline	4,700,000	230,000	NA	4,700,000	FDEP Industrial Goals	µg/kg
4-nitrophenol	NA	4,800,000	NA	4,800,000	Residential Soil RBCs	µg/kg
Acenaphthene	30,000,000	4,700,000	NA	30,000,000	FDEP Industrial Goals	µg/kg
Acenaphthylene	5,600,000	NA	NA	5,600,000	FDEP Industrial Goals	µg/kg
Anthracene	300,000,000	23,000,000	NA	300,000,000	FDEP Industrial Goals	µg/kg
Benzo(a)anthracene	4,900	880	NA	4,900	FDEP Industrial Goals	µg/kg
Benzo(a)pyrene	500	88	NA	500	FDEP Industrial Goals	µg/kg

TABLE B-1

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Industrial Goals[2]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
Benzo(b)fluoranthene	5,000	880	NA	5,000	FDEP Industrial Goals	µg/kg
Benzo(g,h,i)perylene	50,000	NA	NA	50,000	FDEP Industrial Goals	µg/kg
Benzo(k)fluoranthene	48,000	8,800	NA	48,000	FDEP Industrial Goals	µg/kg
Bis(2-chloroethoxy)methane	3,000,000	NA	NA	3,000,000	FDEP Industrial Goals	µg/kg
Bis(2-chloroethyl)ether	900	580	NA	900	FDEP Industrial Goals	µg/kg
Bis(2-ethylhexyl)phthalate	110,000	46,000	NA	110,000	FDEP Industrial Goals	µg/kg
Butyl benzyl phthalate	310,000,000	16,000,000	NA	310,000,000	FDEP Industrial Goals	µg/kg
Carbazole	120,000	32,000	NA	120,000	FDEP Industrial Goals	µg/kg
Chrysene	500,000	88,000	NA	500,000	FDEP Industrial Goals	µg/kg
Di-n-butyl phthalate	140,000,000	7,800,000	NA	140,000,000	FDEP Industrial Goals	µg/kg
Di-n-octyl phthalate	32,000,000	1,600,000	NA	32,000,000	FDEP Industrial Goals	µg/kg
Dibenzo(a,h)anthracene	500	88	NA	500	FDEP Industrial Goals	µg/kg
Dibenzofuran	3,500,000	310,000	NA	3,500,000	FDEP Industrial Goals	µg/kg
Diethyl phthalate	970,000,000	63,000,000	NA	970,000,000	FDEP Industrial Goals	µg/kg
Dimethyl phthalate	1,000,000,000	780,000,000	NA	1E9	FDEP Industrial Goals	µg/kg
Fluoranthene	48,000,000	3,100,000	NA	48,000,000	FDEP Industrial Goals	µg/kg
Fluorene	30,000,000	3,100,000	NA	30,000,000	FDEP Industrial Goals	µg/kg
Hexachlorobenzene	1,600	400	NA	1,600	FDEP Industrial Goals	µg/kg
Hexachlorobutadiene	4,900	8,200	NA	4,900	FDEP Industrial Goals	µg/kg
Hexachlorocyclopentadiene	NA	550,000	NA	550,000	Residential Soil RBCs	µg/kg
Hexachloroethane	120,000	46,000	NA	120,000	FDEP Industrial Goals	µg/kg
Indeno(1,2,3-cd)pyrene	5,000	880	NA	5,000	FDEP Industrial Goals	µg/kg
Isophorone	NA	670,000	NA	670,000	Residential Soil RBCs	µg/kg
n-nitrosodiphenylamine	130,000	130,000	NA	130,000	FDEP Industrial Goals	µg/kg
Naphthalene	12,000,000	3,100,000	NA	12,000,000	FDEP Industrial Goals	µg/kg
Nitrobenzene	250,000	39,000	NA	250,000	FDEP Industrial Goals	µg/kg
Pentachlorophenol	12,000	5300	NA	12,000	FDEP Industrial Goals	µg/kg
Phenanthrene	21,000,000	NA	NA	21,000,000	FDEP Industrial Goals	µg/kg
Phenol	440,000,000	47,000,000	NA	440,000,000	FDEP Industrial Goals	µg/kg
Pyrene	41,000,000	2,300,000	NA	41,000,000	FDEP Industrial Goals	µg/kg
VOLATILE ORGANIC COMPOUNDS						
1,1,1-trichloroethane	4,300,000	2,700,000	NA	4,300,000	FDEP Industrial Goals	µg/kg
1,1,2,2-tetrachloroethane	1,400	3,200	NA	1,400	FDEP Industrial Goals	µg/kg
1,1,2-trichloroethane	3,000	11,000	NA	3,000	FDEP Industrial Goals	µg/kg
1,1-dichloroethane	2,100,000	7,800,000	NA	2,100,000	FDEP Industrial Goals	µg/kg
1,1-dichloroethene	100	1,100	NA	100	FDEP Industrial Goals	µg/kg
1,2-dichloroethane	1,000	7,000	NA	1,000	FDEP Industrial Goals	µg/kg
1,2-dichloropropane	1,200	9,400	NA	1,200	FDEP Industrial Goals	µg/kg
2-butanone	15,000,000	47,000,000	NA	15,000,000	FDEP Industrial Goals	µg/kg
2-hexanone	NA	NA	NA	NA	NA	µg/kg
4-methyl-2-pentanone	3,700,000	6,300,000	NA	3,700,000	FDEP Industrial Goals	µg/kg
Acetone	1,800,000	7,800,000	NA	1,800,000	FDEP Industrial Goals	µg/kg
Benzene	2,000	22,000	NA	2,000	FDEP Industrial Goals	µg/kg
Bis(2-chloroisopropyl)ether	NA	9,100	NA	9,100	Residential Soil RBCs	µg/kg

TABLE B-1

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES NAS KEY WEST

Parameter	FDEP Industrial Goals[2]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
Bromodichloromethane	1,000	10,000	NA	1,000	FDEP Industrial Goals	µg/kg
Bromoform	130,000	81,000	NA	130,000	FDEP Industrial Goals	µg/kg
Bromomethane	NA	110,000	NA	110,000	Residential Soil RBCs	µg/kg
Carbon disulfide	34,000	7,800,000	NA	34,000	FDEP Industrial Goals	µg/kg
Carbon tetrachloride	800	4,900	NA	800	FDEP Industrial Goals	µg/kg
Chlorobenzene	300,000	1,600,000	NA	300,000	FDEP Industrial Goals	µg/kg
Chloroethane	NA	31,000,000	NA	31,000,000	Residential Soil RBCs	µg/kg
Chloroform	800	100,000	NA	800	FDEP Industrial Goals	µg/kg
Chloromethane	300	49,000	NA	300	FDEP Industrial Goals	µg/kg
cis-1,2-dichloroethene	180,000	780,000	NA	180,000	FDEP Industrial Goals	µg/kg
cis-1,3-dichloropropene	400	3,700	NA	400	FDEP Industrial Goals	µg/kg
Dibromochloromethane	1,700	7,600	NA	1,700	FDEP Industrial Goals	µg/kg
Ethylbenzene	10,000,000	7,800,000	NA	10,000,000	FDEP Industrial Goals	µg/kg
Methylene chloride	23,000	85,000	5.6	23,000	FDEP Industrial Goals	µg/kg
Styrene	34,000,000	16,000,000	NA	34,000,000	FDEP Industrial Goals	µg/kg
Tetrachloroethene	28,000	12,000	NA	28,000	FDEP Industrial Goals	µg/kg
Toluene	3,500,000	16,000,000	NA	3,500,000	FDEP Industrial Goals	µg/kg
trans-1,2-dichloroethene	430,000	1,600,000	NA	430,000	FDEP Industrial Goals	µg/kg
trans-1,3-dichloropropene	400	3,700	NA	400	FDEP Industrial Goals	µg/kg
Trichloroethene	9,300	58,000	NA	9,300	FDEP Industrial Goals	µg/kg
Vinyl chloride	7	340	NA	7	FDEP Industrial Goals	µg/kg
Xylenes, total	92,000,000	160,000,000	NA	92,000,000	FDEP Industrial Goals	µg/kg

1 Florida Residential Soil Cleanup Goals (FDEP 1995b and 1996a).
2 Residential Soil Risk-Based Concentrations (EPA, 1997).
3 As agreed by the NAS Key West Partnering Team, 2x average background values are presented here for inorganics, while average background values are presented here for pesticides. This data is based on a subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites as NAS Key West.

TABLE B-2

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Residential Goals[1]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
INORGANICS						
Aluminum	75,000	78,000	3774.57	75,000	FDEP Residential Goals	mg/kg
Antimony	26	31	0.58	26	FDEP Residential Goals	mg/kg
Arsenic	0.8	0.43	2.66	2.66	2x Avg Background	mg/kg
Barium	5,200	5,500	21.9	5,200	FDEP Residential Goals	mg/kg
Beryllium	0.2	0.15	0.08	0.2	FDEP Residential Goals	mg/kg
Cadmium	37	39	0.28	37	FDEP Residential Goals	mg/kg
Calcium	NA	NA	NA	NA	NA	mg/kg
Chromium	290	390	12.34	290	FDEP Residential Goals	mg/kg
Cobalt	4,700	4,700	0.46	4,700	FDEP Residential Goals	mg/kg
Copper	NA	3,100	11.54	3,100	Residential Soil RBCs	mg/kg
Iron	NA	23,000	2334.88	23,000	Residential Soil RBCs	mg/kg
Lead	500	NA	33.32	500	FDEP Residential Goals	mg/kg
Magnesium	NA	NA	NA	NA	NA	mg/kg
Manganese	370	1,800	35.3	370	FDEP Residential Goals	mg/kg
Mercury	23	23	0.06	23	FDEP Residential Goals	mg/kg
Nickel	1,500	1,600	3.4	1,500	FDEP Residential Goals	mg/kg
Potassium	NA	NA	NA	NA	NA	mg/kg
Selenium	390	390	1.3	390	FDEP Residential Goals	mg/kg
Silver	390	390	NA	390	FDEP Residential Goals	mg/kg
Sodium	NA	NA	NA	NA	NA	mg/kg
Thallium	NA	NA	NA	NA	NA	mg/kg
Tin	44,000	47,000	3.92	44,000	FDEP Residential Goals	mg/kg
Vanadium	490	550	8.32	490	FDEP Residential Goals	mg/kg
Zinc	23,000	23,000	32.18	23,000	FDEP Residential Goals	mg/kg
PESTICIDES						
4,4'-DDD	4,500	2,700	27.2	4,500	FDEP Residential Goals	µg/kg
4,4'-DDE	3,000	1,900	83.3	3,000	FDEP Residential Goals	µg/kg
4,4'-DDT	3,100	1,900	61.24	3,100	FDEP Residential Goals	µg/kg
Aldrin	60	38	NA	60	FDEP Residential Goals	µg/kg
alpha-BHC	200	100	NA	200	FDEP Residential Goals	µg/kg
alpha-chlordane	NA	490	NA	490	Residential Soil RBCs	µg/kg
beta-BHC	600	350	NA	600	FDEP Residential Goals	µg/kg
delta-BHC	23,000	NA	NA	23,000	FDEP Residential Goals	µg/kg
Dieldrin	70	40	NA	70	FDEP Residential Goals	µg/kg
Endosulfan I	390,000	470,000	6.26	390,000	FDEP Residential Goals	µg/kg
Endosulfan II	390,000	470,000	NA	390,000	FDEP Residential Goals	µg/kg
Endosulfan sulfate	NA	NA	NA	NA	NA	µg/kg
Endrin	23,000	23,000	11.8	23,000	FDEP Residential Goals	µg/kg
Endrin aldehyde	23,000	NA	NA	23,000	FDEP Residential Goals	µg/kg
Endrin ketone	NA	NA	NA	NA	NA	µg/kg
gamma-BHC (lindane)	800	490	NA	800	FDEP Residential Goals	µg/kg
gamma-chlordane	NA	490	NA	490	Residential Soil RBCs	µg/kg
Heptachlor	200	140	NA	200	FDEP Residential Goals	µg/kg

TABLE B-2

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Residential Goals[1]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
Heptachlor epoxide	100	70	NA	100	FDEP Residential Goals	µg/kg
Methoxychlor	380,000	390,000	59.86	380,000	FDEP Residential Goals	µg/kg
Toxaphene	900	580	NA	900	FDEP Residential Goals	µg/kg
POLYCHLORINATED BIPHENYLS						
Aroclor-1016	900	320	NA	900	FDEP Residential Goals	µg/kg
Aroclor-1221	900	320	NA	900	FDEP Residential Goals	µg/kg
Aroclor-1232	900	320	NA	900	FDEP Residential Goals	µg/kg
Aroclor-1242	900	320	NA	900	FDEP Residential Goals	µg/kg
Aroclor-1248	900	320	NA	900	FDEP Residential Goals	µg/kg
Aroclor-1254	900	320	NA	900	FDEP Residential Goals	µg/kg
Aroclor-1260	900	320	NA	900	FDEP Residential Goals	µg/kg
SEMIVOLATILE ORGANIC COMPOUNDS						
1,2,4-trichlorobenzene	NA	780,000	NA	780,000	Residential Soil RBCs	µg/kg
1,2-dichlorobenzene	820,000	7,000,000	NA	820,000	FDEP Residential Goals	µg/kg
1,3-dichlorobenzene	1,700,000	7,000,000	NA	1,700,000	FDEP Residential Goals	µg/kg
1,4-dichlorobenzene	7,500	27,000	NA	7,500	FDEP Residential Goals	µg/kg
2,4,5-trichlorophenol	7,100,000	7,800,000	NA	7,100,000	FDEP Residential Goals	µg/kg
2,4,6-trichlorophenol	87,000	58,000	NA	87,000	FDEP Residential Goals	µg/kg
2,4-dichlorophenol	220,000	230,000	NA	220,000	FDEP Residential Goals	µg/kg
2,4-dimethylphenol	1,200,000	1,600,000	NA	1,200,000	FDEP Residential Goals	µg/kg
2,4-dinitrophenol	NA	160,000	NA	160,000	Residential Soil RBCs	µg/kg
2,4-dinitrotoluene	130,000	160,000	NA	130,000	FDEP Residential Goals	µg/kg
2,6-dinitrotoluene	71,000	78,000	NA	71,000	FDEP Residential Goals	µg/kg
2-chloronaphthalene	560,000	NA	NA	560,000	FDEP Residential Goals	µg/kg
2-chlorophenol	280,000	390,000	NA	280,000	FDEP Residential Goals	µg/kg
2-methyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	µg/kg
2-methylnaphthalene	960,000	NA	NA	960,000	FDEP Residential Goals	µg/kg
2-methylphenol	2,600,000	3,900,000	NA	2,600,000	FDEP Residential Goals	µg/kg
2-nitroaniline	4,000	4,700	NA	4,000	FDEP Residential Goals	µg/kg
2-nitrophenol	NA	NA	NA	NA	NA	µg/kg
3 & 4-methylphenol	340,000	3,900,000	NA	340,000	FDEP Residential Goals	µg/kg
3,3'-dichlorobenzidine	NA	1,400	NA	1,400	Residential Soil RBCs	µg/kg
3-nitroaniline	NA	230,000	NA	230,000	Residential Soil RBCs	µg/kg
4-bromophenyl phenyl ether	NA	4,500,000	NA	4,500,000	Residential Soil RBCs	µg/kg
4-chloro-3-methylphenol	1.40E+08	NA	NA	1.4E+08	FDEP Residential Goals	µg/kg
4-chloroaniline	240,000	310,000	NA	240,000	FDEP Residential Goals	µg/kg
4-chlorophenyl phenyl ether	NA	NA	NA	NA	NA	µg/kg
4-nitroaniline	230,000	230,000	NA	230,000	FDEP Residential Goals	µg/kg
4-nitrophenol	NA	4,800,000	NA	4,800,000	Residential Soil RBCs	µg/kg
Acenaphthene	2,800,000	4,700,000	NA	2,800,000	FDEP Residential Goals	µg/kg
Acenaphthylene	670,000	NA	NA	670,000	FDEP Residential Goals	µg/kg
Anthracene	20,000,000	23,000,000	NA	20,000,000	FDEP Residential Goals	µg/kg
Benzo(a)anthracene	1,400	880	NA	1,400	FDEP Residential Goals	µg/kg
Benzo(a)pyrene	100	88	NA	100	FDEP Residential Goals	µg/kg

TABLE B-2

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Residential Goals[1]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
Benzo(b)fluoranthene	1,400	880	NA	1,400	FDEP Residential Goals	µg/kg
Benzo(g,h,i)perylene	14,000	NA	NA	14,000	FDEP Residential Goals	µg/kg
Benzo(k)fluoranthene	14,000	8,800	NA	14,000	FDEP Residential Goals	µg/kg
Bis(2-chloroethoxy)methane	170,000	NA	NA	170,000	FDEP Residential Goals	µg/kg
Bis(2-chloroethyl)ether	500	580	NA	500	FDEP Residential Goals	µg/kg
Bis(2-ethylhexyl)phthalate	48,000	46,000	NA	48,000	FDEP Residential Goals	µg/kg
Butyl benzyl phthalate	15,000,000	16,000,000	NA	15,000,000	FDEP Residential Goals	µg/kg
Carbazole	42,000	32,000	NA	42,000	FDEP Residential Goals	µg/kg
Chrysene	140,000	88,000	NA	140,000	FDEP Residential Goals	µg/kg
Di-n-butyl phthalate	7,300,000	7,800,000	NA	7,300,000	FDEP Residential Goals	µg/kg
Di-n-octyl phthalate	1,500,000	1,600,000	NA	1,500,000	FDEP Residential Goals	µg/kg
Dibenzo(a,h)anthracene	100	88	NA	100	FDEP Residential Goals	µg/kg
Dibenzofuran	240,000	310,000	NA	240,000	FDEP Residential Goals	µg/kg
Diethyl phthalate	56,000,000	63,000,000	NA	56,000,000	FDEP Residential Goals	µg/kg
Dimethyl phthalate	630,000,000	780,000,000	NA	6.3E+08	FDEP Residential Goals	µg/kg
Fluoranthene	2,900,000	3,100,000	NA	2,900,000	FDEP Residential Goals	µg/kg
Fluorene	2,400,000	3,100,000	NA	2,400,000	FDEP Residential Goals	µg/kg
Hexachlorobenzene	600	400	NA	600	FDEP Residential Goals	µg/kg
Hexachlorobutadiene	3,100	8,200	NA	3,100	FDEP Residential Goals	µg/kg
Hexachlorocyclopentadiene	NA	550,000	NA	550,000	Residential Soil RBCs	µg/kg
Hexachloroethane	27,000	46,000	NA	27,000	FDEP Residential Goals	µg/kg
Indeno(1,2,3-cd)pyrene	1,400	880	NA	1,400	FDEP Residential Goals	µg/kg
Isophorone	NA	670,000	NA	670,000	Residential Soil RBCs	µg/kg
n-nitrosodiphenylamine	73,000	130,000	NA	73,000	FDEP Residential Goals	µg/kg
Naphthalene	1,300,000	3,100,000	NA	1,300,000	FDEP Residential Goals	µg/kg
Nitrobenzene	22,000	39,000	NA	22,000	FDEP Residential Goals	µg/kg
Pentachlorophenol	5,400	5300	NA	5,400	FDEP Residential Goals	µg/kg
Phenanthrene	1,700,000	NA	NA	1,700,000	FDEP Residential Goals	µg/kg
Phenol	34,000,000	47,000,000	NA	34,000,000	FDEP Residential Goals	µg/kg
Pyrene	2,200,000	2,300,000	NA	2,200,000	FDEP Residential Goals	µg/kg
VOLATILE ORGANIC COMPOUNDS						
1,1,1-trichloroethane	610,000	2,700,000	NA	610,000	FDEP Residential Goals	µg/kg
1,1,2,2-tetrachloroethane	900	3,200	NA	900	FDEP Residential Goals	µg/kg
1,1,2-trichloroethane	2,000	11,000	NA	2,000	FDEP Residential Goals	µg/kg
1,1-dichloroethane	310,000	7,800,000	NA	310,000	FDEP Residential Goals	µg/kg
1,1-dichloroethene	100	1,100	NA	100	FDEP Residential Goals	µg/kg
1,2-dichloroethane	700	7,000	NA	700	FDEP Residential Goals	µg/kg
1,2-dichloropropane	800	9,400	NA	800	FDEP Residential Goals	µg/kg
2-butanone	2,200,000	47,000,000	NA	2,200,000	FDEP Residential Goals	µg/kg
2-hexanone	NA	NA	NA	NA	NA	µg/kg
4-methyl-2-pentanone	520,000	6,300,000	NA	520,000	FDEP Residential Goals	µg/kg
Acetone	260,000	7,800,000	NA	260,000	FDEP Residential Goals	µg/kg
Benzene	1,400	22,000	NA	1,400	FDEP Residential Goals	µg/kg
Bis(2-chloroisopropyl)ether	NA	9,100	NA	9,100	Residential Soil RBCs	µg/kg

TABLE B-2

SELECTION OF SOIL ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Residential Goals[1]	Residential Soil RBCs[2]	2x Average BG[3]	Selected Action Level	Source of Action Level	Units
Bromodichloromethane	700	10,000	NA	700	FDEP Residential Goals	µg/kg
Bromoform	65,000	81,000	NA	65,000	FDEP Residential Goals	µg/kg
Bromomethane	NA	110,000	NA	110,000	Residential Soil RBCs	µg/kg
Carbon disulfide	5,200	7,800,000	NA	5,200	FDEP Residential Goals	µg/kg
Carbon tetrachloride	600	4,900	NA	600	FDEP Residential Goals	µg/kg
Chlorobenzene	44,000	1,600,000	NA	44,000	FDEP Residential Goals	µg/kg
Chloroethane	NA	31,000,000	NA	31,000,000	Residential Soil RBCs	µg/kg
Chloroform	600	100,000	NA	600	FDEP Residential Goals	µg/kg
Chloromethane	200	49,000	NA	200	FDEP Residential Goals	µg/kg
cis-1,2-dichloroethene	26,000	780,000	NA	26,000	FDEP Residential Goals	µg/kg
cis-1,3-dichloropropene	300	3,700	NA	300	FDEP Residential Goals	µg/kg
Dibromochloromethane	1,200	7,600	NA	1200	FDEP Residential Goals	µg/kg
Ethylbenzene	1,400,000	7,800,000	NA	1,400,000	FDEP Residential Goals	µg/kg
Methylene chloride	16,000	85,000	5.6	16,000	FDEP Residential Goals	µg/kg
Styrene	4,100,000	16,000,000	NA	4,100,000	FDEP Residential Goals	µg/kg
Tetrachloroethene	12,000	12,000	NA	12,000	FDEP Residential Goals	µg/kg
Toluene	520,000	16,000,000	NA	520,000	FDEP Residential Goals	µg/kg
trans-1,2-dichloroethene	62,000	1,600,000	NA	62,000	FDEP Residential Goals	µg/kg
trans-1,3-dichloropropene	300	3,700	NA	300	FDEP Residential Goals	µg/kg
Trichloroethene	6,500	58,000	NA	6,500	FDEP Residential Goals	µg/kg
Vinyl chloride	5	340	NA	5	FDEP Residential Goals	µg/kg
Xylenes, total	13,000,000	160,000,000	NA	13,000,000	FDEP Residential Goals	µg/kg

1 Florida Residential Soil Cleanup Goals (FDEP 1995b and 1996a).
2 Residential Soil Risk-Based Concentrations (EPA, 1997).
3 As agreed by the NAS Key West Partnering Team, 2x average background values are presented here for inorganics, while average background values are presented here for pesticides. This data is based on a subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites as NAS Key West.

TABLE B-3

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Industrial Soil Action Level	Selected Action Level	Source of Selected Action Level	Units
INORGANICS														
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	2663.78	1,000,000	2,664	2x Avg Background	mg/kg
Antimony	NA	12	NA	NA	NA	NA	NA	NA	150	NA	220	12	EPA Region IV	mg/kg
Arsenic	7.24	7.24	NA	NA	8.2	70	NA	NA	8.2	5.44	3.7	7.24	FDEP Criteria	mg/kg
Barium	NA	NA	NA	NA	NA	NA	NA	40[8]	NA	19.06	84,000	40	Chem and Tox	mg/kg
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1	1	0.1	2x Avg Background	mg/kg
Cadmium	0.676	1	NA	NA	1.2	9.6	NA	NA	1.2	0.34	600	0.676	FDEP Criteria	mg/kg
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Chromium	52.3	52.3	NA	NA	81	370	NA	NA	81	9.22	430	52.3	FDEP Criteria	mg/kg
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.48	110,000	0.48	2x Avg Background	mg/kg
Copper	18.7	18.7	NA	NA	34	270	NA	NA	34	18.42	3,100	18.7	FDEP Criteria	mg/kg
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,398	23,000	2,398	2x Avg Background	mg/kg
Lead	30.2	30.2	NA	NA	46.7	218	NA	NA	46.7	34.18	1,000	34.18	2x Avg Background	mg/kg
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Manganese	NA	NA	NA	NA	NA	NA	NA	460[10]	NA	30.78	5,500	460	Tox. Benchmarks	mg/kg
Mercury	0.13	0.13	NA	NA	0.15	0.71	NA	NA	0.15	0.1	480	0.13	FDEP Criteria	mg/kg
Nickel	15.9	15.9	NA	NA	20.9	51.6	NA	NA	20.9	4.14	26,000	15.9	FDEP Criteria	mg/kg
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.42	9,900	1.42	2x Avg Background	mg/kg
Silver	0.733	2	NA	NA	1	3.7	NA	NA	1	0.44	9,000	0.733	FDEP Criteria	mg/kg
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.98	670,000	1.98	2x Avg Background	mg/kg
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.44	4,800	10.44	2x Avg Background	mg/kg
Zinc	124	124	NA	NA	150	410	NA	NA	150	46.66	560,000	124	FDEP Criteria	mg/kg
PESTICIDES														
4,4'-DDD	1.22	3.3	NA	NA	NA	NA	NA	NA	16	1.78	17,000	1.78	Average BG	µg/kg
4,4'-DDE	2.07	3.3	NA	NA	2.2	27	NA	NA	2.2	1.87	11,000	2.07	FDEP Criteria	µg/kg
4,4'-DDT	3.89	3.3	NA	NA	1.58	46	NA	NA	1.58	1.76	12,000	1.76	Average BG	µg/kg
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	200	200	FDEP Industrial Goals	µg/kg
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.05	600	1.05	Average BG	µg/kg
alpha-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	490	490	Residential Soil RBCs	µg/kg
beta-BHC	NA	NA	NA	NA	NA	NA	NA	5[10]	NA	NA	2,300	5	Tox. Benchmarks	µg/kg
delta-BHC	NA	NA	NA	NA	NA	NA	NA	3[10]	NA	0.99	470,000	3	Tox. Benchmarks	µg/kg
Dieldrin	0.715	3.3	52	95	NA	NA	NA	NA	NA	NA	300	0.715	FDEP Criteria	µg/kg
Endosulfan I	NA	NA	NA	NA	NA	NA	2.9	NA	NA	1.2	5,900,000	2.9	USEPA SQB	µg/kg
Endosulfan II	NA	NA	NA	NA	NA	NA	14	NA	NA	NA	5,900,000	14	USEPA SQB	µg/kg
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
Endrin	NA	3.3	20	3.5	NA	NA	NA	NA	NA	1.56	470,000	3.3	EPA Region IV	µg/kg
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	480,000	480,000	FDEP Industrial Goals	µg/kg
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
gamma-BHC (lindane)	0.32	3.3	NA	NA	NA	NA	3.7	NA	NA	1.22	3,000	1.22	Average BG	µg/kg

TABLE B-3

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Industrial Soil Action Level	Selected Action Level	Source of Selected Action Level	Units
gamma-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	490	490	Residential Soil RBCs	µg/kg
Heptachlor	NA	NA	NA	NA	NA	NA	NA	4.9[(10)]	NA	0.92	500	4.9	Tox. Benchmarks	µg/kg
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	300	300	FDEP Industrial Goals	µg/kg
Methoxychlor	NA	NA	NA	NA	NA	NA	19	NA	NA	11.7	7,800,000	19	USEPA SQB	µg/kg
Toxaphene	NA	NA	NA	NA	NA	NA	28	NA	NA	NA	3,000	28	USEPA SQB	µg/kg
POLYCHLORINATED BIPHENYLS														
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	3,500	22.7	REG III BTAGs	µg/kg
SEMIVOLATILE ORGANIC COMPOUNDS														
1,2,4-trichlorobenzene	NA	NA	NA	NA	NA	NA	9,200	NA	NA	NA	780,000	9,200	USEPA SQB	µg/kg
1,2-dichlorobenzene	NA	NA	NA	NA	NA	NA	340	NA	35	NA	6,000,000	35	REG III BTAGs	µg/kg
1,3-dichlorobenzene	NA	NA	NA	NA	NA	NA	1,700	NA	NA	NA	13,000,000	1,700	USEPA SQB	µg/kg
1,4-dichlorobenzene	NA	NA	NA	NA	NA	NA	350	NA	110	NA	1,100	110	REG III BTAGs	µg/kg
2,4,5-trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	130,000,000	1.3E+08	FDEP Industrial Goals	µg/kg
2,4,6-trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	280,000	280,000	FDEP Industrial Goals	µg/kg
2,4-dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,000,000	4,000,000	FDEP Industrial Goals	µg/kg
2,4-dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	29	NA	16,000,000	29	REG III BTAGs	µg/kg
2,4-dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	160,000	160,000	Residential Soil RBCs	µg/kg
2,4-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,000,000	2,000,000	FDEP Industrial Goals	µg/kg
2,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,300,000	1,300,000	FDEP Industrial Goals	µg/kg
2-chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,000,000	4,000,000	FDEP Industrial Goals	µg/kg
2-chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,700,000	3,700,000	FDEP Industrial Goals	µg/kg
2-methyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
2-methylnaphthalene	20.2	330	NA	NA	70	670	NA	NA	70	NA	8,800,000	20.2	FDEP Criteria	µg/kg
2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	63	NA	32,000,000	63	REG III BTAGs	µg/kg
2-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	73,000	73,000	FDEP Industrial Goals	µg/kg
2-nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
3 & 4-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5,500,000	5,500,000	FDEP Industrial Goals	µg/kg
3,3'-dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,400	1,400	Residential Soil RBCs	µg/kg
3-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	230,000	230,000	Residential Soil RBCs	µg/kg
4-bromophenyl phenyl ether	NA	NA	NA	NA	NA	NA	1,300	NA	NA	NA	4,500,000	1,300	USEPA SQB	µg/kg
4-chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000,000,000	1E+09	FDEP Industrial Goals	µg/kg
4-chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,300,000	3,300,000	FDEP Industrial Goals	µg/kg
4-chlorophenyl phenyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
4-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,700,000	4,700,000	FDEP Industrial Goals	µg/kg
4-nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,800,000	4,800,000	Residential Soil RBCs	µg/kg
Acenaphthene	6.71	330	620	1,100	16	500	NA	NA	16	NA	30,000,000	6.71	FDEP Criteria	µg/kg

TABLE B-3

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Industrial Soil Action Level	Selected Action Level	Source of Selected Action Level	Units
Acenaphthylene	5.87	330	NA	NA	44	640	NA	NA	44	NA	5,600,000	5.87	FDEP Criteria	µg/kg
Anthracene	46.9	330	NA	NA	85.3	1,100	NA	NA	85.3	NA	300,000,000	46.9	FDEP Criteria	µg/kg
Benzo(a)anthracene	74.8	330	NA	NA	261	1,600	NA	NA	261	NA	4,900	74.8	FDEP Criteria	µg/kg
Benzo(a)pyrene	88.8	330	NA	NA	430	1,600	NA	NA	430	NA	500	88.8	FDEP Criteria	µg/kg
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	3,200	NA	5,000	3,200	REG III BTAGs	µg/kg
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	670	NA	50,000	670	REG III BTAGs	µg/kg
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	48,000	48,000	FDEP Industrial Goals	µg/kg
Bis(2-chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,000,000	3,000,000	FDEP Industrial Goals	µg/kg
Bis(2-chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	900	900	FDEP Industrial Goals	µg/kg
Bis(2-ethylhexyl)phthalate	182	182	NA	NA	NA	NA	NA	890,000,000[9]	1,300	NA	110,000	182	FDEP Criteria	µg/kg
Butyl benzyl phthalate	NA	NA	NA	NA	NA	NA	11,000	NA	63	NA	310,000,000	63	REG III BTAGs	µg/kg
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	120,000	120,000	FDEP Industrial Goals	µg/kg
Chrysene	108	330	NA	NA	384	2,800	NA	NA	384	NA	500,000	108	FDEP Criteria	µg/kg
Di-n-butyl phthalate	NA	NA	NA	NA	NA	NA	11,000	NA	1,400	NA	140,000,000	1,400	REG III BTAGs	µg/kg
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	6,200	NA	32,000,000	6,200	REG III BTAGs	µg/kg
Dibenzo(a,h)anthracene	6.22	330	NA	NA	63.4	260	NA	NA	63.4	NA	500	6.22	FDEP Criteria	µg/kg
Dibenzofuran	NA	NA	NA	NA	NA	NA	2,000	NA	540	NA	3,500,000	540	REG III BTAGs	µg/kg
Diethyl phthalate	NA	NA	NA	NA	NA	NA	630	NA	200	NA	970,000,000	200	REG III BTAGs	µg/kg
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	71	NA	1E9	71	REG III BTAGs	µg/kg
Fluoranthene	113	330	2,900	1,400	600	5,100	NA	NA	600	NA	48,000,000	113	FDEP Criteria	µg/kg
Fluorene	21.2	330	NA	NA	19	540	540	NA	19	NA	30,000,000	19	ER-L	µg/kg
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	22	NA	1,600	22	REG III BTAGs	µg/kg
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	11	NA	4,900	11	REG III BTAGs	µg/kg
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	550,000	550,000	Residential Soil RBCs	µg/kg
Hexachloroethane	NA	NA	NA	NA	NA	NA	1,000	NA	NA	NA	120,000	1,000	USEPA SQB	µg/kg
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	600	NA	5,000	600	REG III BTAGs	µg/kg
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	670,000	670,000	Residential Soil RBCs	µg/kg
n-nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	28	NA	130,000	28	REG III BTAGs	µg/kg
Naphthalene	34.6	330	NA	NA	160	2,100	480	NA	160	NA	12,000,000	34.6	FDEP Criteria	µg/kg
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	250,000	250,000	FDEP Industrial Goals	µg/kg
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	360	NA	12,000	360	REG III BTAGs	µg/kg
Phenanthrene	86.7	330	850	1,100	240	1,500	NA	NA	240	NA	21,000,000	86.7	FDEP Criteria	µg/kg
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	420	NA	440,000,000	420	REG III BTAGs	µg/kg
Pyrene	153	330	NA	NA	665	2,600	NA	NA	665	NA	41,000,000	153	FDEP Criteria	µg/kg
VOLATILE ORGANIC COMPOUNDS														
1,1,1-trichloroethane	NA	NA	NA	NA	NA	NA	170	NA	31	NA	4,300,000	31	REG III BTAGs	µg/kg
1,1,2,2-tetrachloroethane	NA	NA	NA	NA	NA	NA	940	NA	NA	NA	1,400	940	USEPA SQB	µg/kg
1,1,2-trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	31	NA	3,000	31	REG III BTAGs	µg/kg
1,1-dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,100,000	2,100,000	FDEP Industrial Goals	µg/kg
1,1-dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100	100	FDEP Industrial Goals	µg/kg
1,2-dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000	1,000	FDEP Industrial Goals	µg/kg
1,2-dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,200	1,200	FDEP Industrial Goals	µg/kg

TABLE B-3

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE INDUSTRIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Industrial Soil Action Level	Selected Action Level	Source of Selected Action Level	Units
2-butanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15,000,000	1.5E7	FDEP Industrial Goals	µg/kg
2-hexanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
4-methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,700,000	3,700,000	FDEP Industrial Goals	µg/kg
Acetone	NA	NA	NA	NA	NA	NA	NA	64[(9)]	NA	NA	1,800,000	64	Ontario Guidelines	µg/kg
Benzene	NA	NA	NA	NA	NA	NA	57	NA	NA	NA	2,000	57	USEPA SQB	µg/kg
Bis(2-chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9,100	9,100	Residential Soil RBCs	µg/kg
Bromodichloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000	1,000	FDEP Industrial Goals	µg/kg
Bromoform	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	130,000	130,000	FDEP Industrial Goals	µg/kg
Bromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	110,000	110,000	Residential Soil RBCs	µg/kg
Carbon disulfide	NA	NA	NA	NA	NA	NA	NA	13[(9)]	NA	NA	34,000	13	Ontario Guidelines	µg/kg
Carbon tetrachloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	800	800	FDEP Industrial Goals	µg/kg
Chlorobenzene	NA	NA	NA	NA	NA	NA	820	NA	NA	NA	300,000	820	USEPA SQB	µg/kg
Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	31,000,000	31,000,000	Residential Soil RBCs	µg/kg
Chloroform	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	800	800	FDEP Industrial Goals	µg/kg
Chloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	300	3000	FDEP Industrial Goals	µg/kg
cis-1,2-dichloroethene	NA	NA	NA	NA	NA	NA	NA	23[(10)]	NA	NA	180,000	23	Tox. Benchmarks	µg/kg
cis-1,3-dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	400	400	FDEP Industrial Goals	µg/kg
Dibromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,700	1,700	FDEP Industrial Goals	µg/kg
Ethylbenzene	NA	NA	NA	NA	NA	NA	3,600	NA	10	NA	10,000,000	10	REG III BTAGs	µg/kg
Methylene chloride	NA	NA	NA	NA	NA	NA	NA	427[(9)]	NA	NA	23,000	427	Ontario Guidelines	µg/kg
Styrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	34,000,000	3,400,000	FDEP Industrial Goals	µg/kg
Tetrachloroethene	NA	NA	NA	NA	NA	NA	530	NA	57	NA	28,000	57	REG III BTAGs	µg/kg
Toluene	NA	NA	NA	NA	NA	NA	670	NA	NA	NA	3,500,000	670	USEPA SQB	µg/kg
trans-1,2-dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	430,000	430,000	FDEP Industrial Goals	µg/kg
trans-1,3-dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	400	400	FDEP Industrial Goals	µg/kg
Trichloroethene	NA	NA	NA	NA	NA	NA	1,600	NA	NA	NA	9,300	1,600	USEPA SQB	µg/kg
Vinyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7	7	FDEP Industrial Goals	µg/kg
Xylenes, total	NA	NA	NA	NA	NA	NA	25	NA	40	NA	92,000,000	25	USEPA SQB	µg/kg

1 Florida Sediment Quality Assessment Guidelines (FDEP, 1994a).
2 EPA Region IV Sediment Quality Screening Values (EPA, 1995b).
3 EPA Freshwater Sediment Quality Criteria (EPA, 1996b).
4 EPA Saltwater Sediment Quality Criteria (EPA, 1996b).
5 Effects Range-Low Guidelines (Long et al., 1995).
6 Effects Range-Medium Guidelines (Long et al., 1995).
7 EPA Sediment Quality Benchmarks (EPA, 1996b).
8 From *Sediments: Chemistry and Toxicity of In-Place Pollutants* (Baudo et al., 1990).
9 Guidelines for Protection and Management of Sediment Quality in Ontario (OME, 1992).
10 Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment (Hull and Suter, 1994).
11 40 CFR Part 264 Proposed RCRA Action Levels.
12 EPA Region III BioTechnical Assistance Group Screening Levels for Sediment(EPA, 1995a).
13 Residential Soil Risk-Based Screening Concentrations (EPA, 1997).
14 As agreed by the NAS Key West Partnering Team, 2x average background values are presented here for inorganics, while average background values are presented here for pesticides. This data is based on a subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites as NAS Key West.

TABLE B-4

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Residential Soil Action Level	Selected Action Level	Source of Action Level	Units
INORGANICS														
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	2663.78	75,000	2,664	2x Average BG	mg/kg
Antimony	NA	12	NA	NA	NA	NA	NA	NA	150	NA	26	12	EPA Region IV	mg/kg
Arsenic	7.24	7.24	NA	NA	8.2	70	NA	NA	8.2	5.44	2.66	7.24	FDEP Criteria	mg/kg
Barium	NA	NA	NA	NA	NA	NA	NA	40[(8)]	NA	19.06	5,200	40	Chem and Tox	mg/kg
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1	0.2	0.1	2x Average BG	mg/kg
Cadmium	0.676	1	NA	NA	1.2	9.6	NA	NA	1.2	0.34	37	0.676	FDEP Criteria	mg/kg
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Chromium	52.3	52.3	NA	NA	81	370	NA	NA	81	9.22	290	52.3	FDEP Criteria	mg/kg
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.48	4,700	0.48	2x Average BG	mg/kg
Copper	18.7	18.7	NA	NA	34	270	NA	NA	34	18.42	3,100	18.7	FDEP Criteria	mg/kg
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,398	23,000	2,398	2x Average BG	mg/kg
Lead	30.2	30.2	NA	NA	46.7	218	NA	NA	46.7	34.18	500	34.18	2x Average BG	mg/kg
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Manganese	NA	NA	NA	NA	NA	NA	NA	460[(10)]	NA	30.78	370	460	Tox. Benchmarks	mg/kg
Mercury	0.13	0.13	NA	NA	0.15	0.71	NA	NA	0.15	0.1	23	0.13	FDEP Criteria	mg/kg
Nickel	15.9	15.9	NA	NA	20.9	51.6	NA	NA	20.9	4.14	1,500	15.9	FDEP Criteria	mg/kg
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.42	390	1.42	2x Average BG	mg/kg
Silver	0.733	2	NA	NA	1	3.7	NA	NA	1	0.44	390	0.733	FDEP Criteria	mg/kg
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/kg
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.98	44,000	1.98	2x Average BG	mg/kg
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.44	490	10.44	2x Average BG	mg/kg
Zinc	124	124	NA	NA	150	410	NA	NA	150	46.66	23,000	124	FDEP Criteria	mg/kg
PESTICIDES														
4,4'-DDD	1.22	3.3	NA	NA	NA	NA	NA	NA	16	1.78	4,500	1.78	Average BG	µg/kg
4,4'-DDE	2.07	3.3	NA	NA	2.2	27	NA	NA	2.2	1.87	3,000	2.07	FDEP Criteria	µg/kg
4,4'-DDT	3.89	3.3	NA	NA	1.58	46	NA	NA	1.58	1.76	3,100	1.76	Average BG	µg/kg
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	60	60	FDEP Residential Goals	µg/kg
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.05	200	1.05	Average BG	µg/kg
alpha-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	490	490	Residential Soil RBCs	µg/kg
beta-BHC	NA	NA	NA	NA	NA	NA	NA	5[(10)]	NA	NA	600	5	Tox. Benchmarks	µg/kg
delta-BHC	NA	NA	NA	NA	NA	NA	NA	3[(10)]	NA	0.99	23,000	3	Tox. Benchmarks	µg/kg
Dieldrin	0.715	3.3	52	95	NA	NA	NA	NA	NA	NA	70	0.715	FDEP Criteria	µg/kg
Endosulfan I	NA	NA	NA	NA	NA	NA	2.9	NA	NA	1.2	390,000	2.9	USEPA SQB	µg/kg
Endosulfan II	NA	NA	NA	NA	NA	NA	14	NA	NA	NA	390,000	14	USEPA SQB	µg/kg
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
Endrin	NA	3.3	20	3.5	NA	NA	NA	NA	NA	1.56	23,000	3.3	EPA Region IV	µg/kg
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	23,000	23,000	FDEP Residential Goals	µg/kg
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
gamma-BHC (lindane)	0.32	3.3	NA	NA	NA	NA	3.7	NA	NA	1.22	800	1.22	Average BG	µg/kg

TABLE B-4

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Residential Soil Action Level	Selected Action Level	Source of Action Level	Units
gamma-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	490	490	Residential Soil RBCs	µg/kg
Heptachlor	NA	NA	NA	NA	NA	NA	NA	4.9[(10)]	NA	0.92	200	4.9	Tox. Benchmarks	µg/kg
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100	100	FDEP Residential Goals	µg/kg
Methoxychlor	NA	NA	NA	NA	NA	NA	19	NA	NA	11.7	380,000	19	FDEP Residential Goals	µg/kg
Toxaphene	NA	NA	NA	NA	NA	NA	28	NA	NA	NA	900	28	USEPA SQB	µg/kg
POLYCHLORINATED BIPHENYLS														
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA	22.7	NA	900	22.7	REG III BTAGs	µg/kg
SEMIVOLATILE ORGANIC COMPOUNDS														
1,2,4-trichlorobenzene	NA	NA	NA	NA	NA	NA	9,200	NA	NA	NA	780,000	9,200	USEPA SQB	µg/kg
1,2-dichlorobenzene	NA	NA	NA	NA	NA	NA	340	NA	35	NA	820,000	35	REG III BTAGs	µg/kg
1,3-dichlorobenzene	NA	NA	NA	NA	NA	NA	1,700	NA	NA	NA	1,700,000	1,700	USEPA SQB	µg/kg
1,4-dichlorobenzene	NA	NA	NA	NA	NA	NA	350	NA	110	NA	7,500	110	REG III BTAGs	µg/kg
2,4,5-trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,100,000	7,800,000	FDEP Residential Goals	µg/kg
2,4,6-trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	87,000	87,000	FDEP Residential Goals	µg/kg
2,4-dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	220,000	220,000	FDEP Residential Goals	µg/kg
2,4-dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	29	NA	1,200,000	29	REG III BTAGs	µg/kg
2,4-dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	160,000	160,000	Residential Soil RBCs	µg/kg
2,4-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	130,000	130,000	FDEP Residential Goals	µg/kg
2,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	71,000	71,000	FDEP Residential Goals	µg/kg
2-chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	560,000	560,000	FDEP Residential Goals	µg/kg
2-chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	280,000	280,000	FDEP Residential Goals	µg/kg
2-methyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
2-methylnaphthalene	20.2	330	NA	NA	70	670	NA	NA	70	NA	960,000	20.2	FDEP Criteria	µg/kg
2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	63	NA	2,600,000	63	REG III BTAGs	µg/kg
2-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,000	4,000	FDEP Residential Goals	µg/kg
2-nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
3 & 4-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	340,000	340,000	FDEP Residential Goals	µg/kg
3,3'-dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,400	1,400	Residential Soil RBCs	µg/kg
3-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	230,000	230,000	Residential Soil RBCs	µg/kg
4-bromophenyl phenyl ether	NA	NA	NA	NA	NA	NA	1,300	NA	NA	NA	4,500,000	1,300	USEPA SQB	µg/kg
4-chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.4E+08	140,000,000	FDEP Residential Goals	µg/kg
4-chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	240,000	240,000	FDEP Residential Goals	µg/kg
4-chlorophenyl phenyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
4-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	230,000	230,000	FDEP Residential Goals	µg/kg
4-nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,800,000	4,800,000	Residential Soil RBCs	µg/kg
Acenaphthene	6.71	330	620	1,100	16	500	NA	NA	16	NA	2,800,000	6.71	FDEP Criteria	µg/kg

TABLE B-4

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Residential Soil Action Level	Selected Action Level	Source of Action Level	Units
Acenaphthylene	5.87	330	NA	NA	44	640	NA	NA	44	NA	670,000	5.87	FDEP Criteria	µg/kg
Anthracene	46.9	330	NA	NA	85.3	1,100	NA	NA	85.3	NA	20,000,000	46.9	FDEP Criteria	µg/kg
Benzo(a)anthracene	74.8	330	NA	NA	261	1,600	NA	NA	261	NA	1,400	74.8	FDEP Criteria	µg/kg
Benzo(a)pyrene	88.8	330	NA	NA	430	1,600	NA	NA	430	NA	100	88.8	FDEP Criteria	µg/kg
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	3,200	NA	1,400	3,200	REG III BTAGs	µg/kg
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	670	NA	14,000	670	REG III BTAGs	µg/kg
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	14,000	14,000	FDEP Residential Goals	µg/kg
Bis(2-chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	170,000	170,000	FDEP Residential Goals	µg/kg
Bis(2-chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	500	500	FDEP Residential Goals	µg/kg
Bis(2-ethylhexyl)phthalate	182	182	NA	NA	NA	NA	NA	890,000,000[(9)]	1,300	NA	48,000	182	FDEP Criteria	µg/kg
Butyl benzyl phthalate	NA	NA	NA	NA	NA	NA	11,000	NA	63	NA	15,000,000	63	REG III BTAGs	µg/kg
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	42,000	42,000	FDEP Residential Goals	µg/kg
Chrysene	108	330	NA	NA	384	2,800	NA	NA	384	NA	140,000	108	FDEP Criteria	µg/kg
Di-n-butyl phthalate	NA	NA	NA	NA	NA	NA	11,000	NA	1,400	NA	7,300,000	1,400	REG III BTAGs	µg/kg
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	6,200	NA	1,500,000	6,200	REG III BTAGs	µg/kg
Dibenzo(a,h)anthracene	6.22	330	NA	NA	63.4	260	NA	NA	63.4	NA	100	6.22	FDEP Criteria	µg/kg
Dibenzofuran	NA	NA	NA	NA	NA	NA	2,000	NA	540	NA	240,000	540	REG III BTAGs	µg/kg
Diethyl phthalate	NA	NA	NA	NA	NA	NA	630	NA	200	NA	56,000,000	200	REG III BTAGs	µg/kg
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	71	NA	6.3E+08	71	REG III BTAGs	µg/kg
Fluoranthene	113	330	2,900	1,400	600	5,100	NA	NA	600	NA	2,900,000	113	FDEP Criteria	µg/kg
Fluorene	21.2	330	NA	NA	19	540	540	NA	19	NA	2,400,000	19	ER-L	µg/kg
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	22	NA	600	22	REG III BTAGs	µg/kg
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	11	NA	3,100	11	REG III BTAGs	µg/kg
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	550,000	550,000	Residential Soil RBCs	µg/kg
Hexachloroethane	NA	NA	NA	NA	NA	NA	1,000	NA	NA	NA	27,000	1,000	USEPA SQB	µg/kg
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	600	NA	1,400	600	REG III BTAGs	µg/kg
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	670,000	670,000	Residential Soil RBCs	µg/kg
n-nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	28	NA	73,000	28	REG III BTAGs	µg/kg
Naphthalene	34.6	330	NA	NA	160	2,100	480	NA	160	NA	1,300,000	34.6	FDEP Criteria	µg/kg
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22,000	22,000	FDEP Residential Goals	µg/kg
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	360	NA	5,400	360	REG III BTAGs	µg/kg
Phenanthrene	86.7	330	850	1,100	240	1,500	NA	NA	240	NA	1,700,000	86.7	FDEP Criteria	µg/kg
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	420	NA	34,000,000	420	REG III BTAGs	µg/kg
Pyrene	153	330	NA	NA	665	2,600	NA	NA	665	NA	2,200,000	153	FDEP Criteria	µg/kg
VOLATILE ORGANIC COMPOUNDS														
1,1,1-trichloroethane	NA	NA	NA	NA	NA	NA	170	NA	31	NA	610,000	31	REG III BTAGs	µg/kg
1,1,2,2-tetrachloroethane	NA	NA	NA	NA	NA	NA	940	NA	NA	NA	900	940	USEPA SQB	µg/kg
1,1,2-trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	31	NA	2,000	31	REG III BTAGs	µg/kg
1,1-dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	310,000	310,000	FDEP Residential Goals	µg/kg
1,1-dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100	100	FDEP Residential Goals	µg/kg
1,2-dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	700	700	FDEP Residential Goals	µg/kg
1,2-dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	800	800	FDEP Residential Goals	µg/kg

TABLE B-4

SELECTION OF SEDIMENT ACTION LEVELS FOR POTENTIAL FUTURE RESIDENTIAL SITES
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV[2]	EPA SQC Fresh[3]	EPA SQC Marine[4]	ER-L[5]	ER-M[6]	EPA SQB[7]	OTHER	Reg III BTAG Levels[12]	2x Average BG[14]	Residential Soil Action Level	Selected Action Level	Source of Action Level	Units
2-butanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,200,000	2,200,000	FDEP Residential Goals	µg/kg
2-hexanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/kg
4-methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	520,000	520,000	FDEP Residential Goals	µg/kg
Acetone	NA	NA	NA	NA	NA	NA	NA	64[9]	NA	NA	260,000	64	Ontario Guidelines	µg/kg
Benzene	NA	NA	NA	NA	NA	NA	57	NA	NA	NA	1,400	57	USEPA SQB	µg/kg
Bis(2-chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9,100	9,100	Residential Soil RBCs	µg/kg
Bromodichloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	700	700	FDEP Residential Goals	µg/kg
Bromoform	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	65,000	65,000	FDEP Residential Goals	µg/kg
Bromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	110,000	110,000	Residential Soil RBCs	µg/kg
Carbon disulfide	NA	NA	NA	NA	NA	NA	NA	13[9]	NA	NA	5,200	13	Ontario Guidelines	µg/kg
Carbon tetrachloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	600	600	FDEP Residential Goals	µg/kg
Chlorobenzene	NA	NA	NA	NA	NA	NA	820	NA	NA	NA	44,000	820	USEPA SQB	µg/kg
Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	31,000,000	31,000,000	Residential Soil RBCs	µg/kg
Chloroform	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	600	600	FDEP Residential Goals	µg/kg
Chloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	200	200	FDEP Residential Goals	µg/kg
cis-1,2-dichloroethene	NA	NA	NA	NA	NA	NA	NA	23[10]	NA	NA	26,000	23	Tox. Benchmarks	µg/kg
cis-1,3-dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	300	300	FDEP Residential Goals	µg/kg
Dibromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1200	1,200	FDEP Residential Goals	µg/kg
Ethylbenzene	NA	NA	NA	NA	NA	NA	3,600	NA	10	NA	1,400,000	10	REG III BTAGs	µg/kg
Methylene chloride	NA	NA	NA	NA	NA	NA	NA	427[9]	NA	NA	16,000	427	Ontario Guidelines	µg/kg
Styrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,100,000	4,100,000	FDEP Residential Goals	µg/kg
Tetrachloroethene	NA	NA	NA	NA	NA	NA	530	NA	57	NA	12,000	57	REG III BTAGs	µg/kg
Toluene	NA	NA	NA	NA	NA	NA	670	NA	NA	NA	520,000	670	USEPA SQB	µg/kg
trans-1,2-dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	62,000	62,000	FDEP Residential Goals	µg/kg
trans-1,3-dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	300	300	FDEP Residential Goals	µg/kg
Trichloroethene	NA	NA	NA	NA	NA	NA	1,600	NA	NA	NA	6,500	1,600	USEPA SQB	µg/kg
Vinyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	5	FDEP Residential Goals	µg/kg
Xylenes, total	NA	NA	NA	NA	NA	NA	25	NA	40	NA	13,000,000	25	USEPA SQB	µg/kg

1 Florida Sediment Quality Assessment Guidelines (FDEP, 1994a).
2 EPA Region IV Sediment Quality Screening Values (EPA, 1995b).
3 EPA Freshwater Sediment Quality Criteria (EPA, 1996b).
4 EPA Saltwater Sediment Quality Criteria (EPA, 1996b).
5 Effects Range-Low Guidelines (Long et al., 1995).
6 Effects Range-Medium Guidelines (Long et al., 1995).
7 EPA Sediment Quality Benchmarks (EPA, 1996b).
8 From *Sediments: Chemistry and Toxicity of In-Place Pollutants* (Baudo et al., 1990).
9 Guidelines for Protection and Management of Sediment Quality in Ontario (OME, 1992).
10 Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment (Hull and Suter, 1994).
11 40 CFR Part 264 Proposed RCRA Action Levels.
12 EPA Region III BioTechnical Assistance Group Screening Levels for Sediment(EPA, 1995a).
13 Residential Soil Risk-Based Screening Concentrations (EPA, 1997).
14 As agreed by the NAS Key West Partnering Team, 2x average background values are presented here for inorganics, while average background values are presented here for pesticides. This data is based on a subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites as NAS Key West.

TABLE B-5

SELECTION OF SURFACE-WATER ACTION LEVELS
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV Marine[2]	EPA Reg IV Fresh[3]	AWQC Marine[4]	AWQC Fresh[5]	EPA Region III Marine[6]	EPA Region III Fresh[7]	2x Average BG[8]	Groundwater Action Level[9]	Selected Action Level	Source of Action Level	Units
INORGANICS												
Aluminum	1,500	NA	87	NA	NA	NA	25	51.94	37,000	1,500	FDEP Criteria	µg/L
Antimony	4,300	NA	160	500	30	500	30	4.9	6	4,300	FDEP Criteria	µg/L
Arsenic	50	36	190	36	190	NA	874	5.08	50	50	FDEP Criteria	µg/L
Barium	NA	NA	NA	NA	NA	10,000	10,000	12.86	2,000	10,000	EPA Reg III Marine	µg/L
Beryllium	0.13	NA	0.53	NA	5.3	1,500	5.3	0.28	4	0.28	2x Average BG	µg/L
Cadmium	9.3	9.3	0.66	9.3	1.1	9.3	0.53	NA	5	9.3	FDEP Criteria	µg/L
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
Chromium	50	50	11	50	11	50	2	NA	100	50	FDEP Criteria	µg/L
Cobalt	NA	NA	NA	NA	NA	NA	35,000	NA	2,200	35,000	EPA Reg III Fresh	µg/L
Copper	2.9	2.9	6.54	2.9	12	2.9	6.5	2.88	1,500	2.9	FDEP Criteria	µg/L
Iron	300	NA	1,000	NA	1,000	NA	320	51.6	11,000	300	FDEP Criteria	µg/L
Lead	5.6	8.5	1.32	8.5	3.2	5.6	3.2	NA	15	5.6	FDEP Criteria	µg/L
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
Manganese	NA	NA	NA	NA	NA	10	14,500	4.4	840	10	EPA Reg III Marine	µg/L
Mercury	0.025	0.025	0.012	0.025	0.012	0.025	0.012	1.26	2	1.26	2x Average BG	µg/L
Nickel	8.3	8.3	87.71	8.3	160	8.3	160	NA	100	8.3	FDEP Criteria	µg/L
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
Selenium	71	71	5	71	5	35	5	NA	50	71	FDEP Criteria	µg/L
Silver	2.3	0.23	0.012	0.92	0.12	0.0001	0.0001	NA	180	2.3	FDEP Criteria	µg/L
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
Thallium	6.3	21.3	4	2,130	40	2,130	40	7.3	4.62	7.3	2x Average BG	µg/L
Tin	NA	NA	NA	NA	NA	0.01	0.026	NA	22,000	0.01	EPA Reg III Marine	µg/L
Vanadium	NA	NA	NA	NA	NA	10,000	10,000	2.18	260	10,000	EPA Reg III Marine	µg/L
Zinc	86	86	58.91	86	110	19	30	4.54	11,000	86	FDEP Criteria	µg/L
PESTICIDES												
4,4'-DDD	NA	0.025	0.0064	3.6	0.6	0.68	0.6	NA	0.28	0.0064	EPA Reg IV Fresh	µg/L
4,4'-DDE	NA	0.14	10.5	14	1,050	14	1,050	NA	0.2	0.14	EPA Reg IV Marine	µg/L
4,4'-DDT	0.00059	0.001	0.001	0.001	0.001	0.001	0.001	NA	0.2	0.00059	FDEP Criteria	µg/L
Aldrin	0.00014	0.13	0.3	1.3	3	1.3	3	NA	0.004	0.00014	FDEP Criteria	µg/L
alpha-BHC	NA	1,400	500	0.34	100	0.34	100	NA	0.011	0.34	AWQC Marine	µg/L
alpha-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	0.052	0.052	Tap Water RBCs	µg/L
beta-BHC	0.046	NA	5,000	0.34	100	0.34	100	NA	0.037	0.046	FDEP Criteria	µg/L
delta-BHC	NA	NA	NA	0.34	100	0.34	100	NA	NA	0.34	AWQC- Marine	µg/L
Dieldrin	0.00014	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	NA	0.0042	0.00014	FDEP Criteria	µg/L
Endosulfan I	0.0087	0.0087	0.056	0.0087	0.056	0.0087	0.056	NA	220	0.0087	FDEP Criteria	µg/L
Endosulfan II	0.0087	0.0087	0.056	0.0087	0.056	0.0087	0.056	NA	220	0.0087	FDEP Criteria	µg/L
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
Endrin	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	NA	2	0.0023	FDEP Criteria	µg/L
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
gamma-BHC (lindane)	0.063	0.016	0.08	0.16	0.08	0.16	0.08	NA	0.2	0.063	FDEP Criteria	µg/L
gamma-chlordane	NA	0.004	NA	NA	NA	NA	NA	NA	0.052	0.004	EPA Reg IV Marine	µg/L
Heptachlor	0.00021	0.0036	0.0038	0.0036	0.0038	0.0036	0.0038	NA	0.4	0.00021	FDEP Criteria	µg/L
Heptachlor epoxide	NA	0.0036	0.0038	0.0036	0.0038	0.0036	0.0038	NA	0.2	0.0036	EPA Reg IV Marine	µg/L
Methoxychlor	0.03	0.03	0.03	0.03	0.03	0.03	0.03	NA	40	0.03	FDEP Criteria	µg/L
Toxaphene	0.0002	NA	0.0002	0.0002	0.0002	0.0002	0.0002	NA	3	0.0002	FDEP Criteria	µg/L

TABLE B-5

SELECTION OF SURFACE-WATER ACTION LEVELS
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV Marine[2]	EPA Reg IV Fresh[3]	AWQC Marine[4]	AWQC Fresh[5]	EPA Region III Marine[6]	EPA Region III Fresh[7]	2x Average BG[8]	Groundwater Action Level[9]	Selected Action Level	Source of Action Level	Units
POLYCHLORINATED BIPHENYLS												
Aroclor-1016	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
Aroclor-1221	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
Aroclor-1232	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
Aroclor-1242	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
Aroclor-1248	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
Aroclor-1254	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
Aroclor-1260	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	NA	0.5	0.000045	FDEP Criteria	µg/L
SEMIVOLATILE ORGANIC COMPOUNDS												
1,2,4-trichlorobenzene	NA	4.5	44.9	NA	NA	129	50	NA	70	4.5	EPA REG IV Marine	µg/L
1,2-dichlorobenzene	NA	19.7	15.8	1,970	763	129	763	NA	600	15.8	EPA Reg IV Fresh	µg/L
1,3-dichlorobenzene	NA	28.5	50.2	1,970	763	NA	763	NA	540	28.5	EPA Reg IV Marine	µg/L
1,4-dichlorobenzene	NA	19.9	11.2	1,970	763	129	763	NA	75	11.2	EPA Reg IV Fresh	µg/L
2,4,5-trichlorophenol	NA	NA	NA	11	63	11	63	NA	3,700	11	AWQC- Marine	µg/L
2,4,6-trichlorophenol	6.5	NA	3.2	NA	970	NA	970	NA	6.1	6.5	FDEP Criteria	µg/L
2,4-dichlorophenol	790	NA	36.5	NA	365	NA	365	NA	110	790	FDEP Criteria	µg/L
2,4-dimethylphenol	NA	NA	21.2	NA	2,120	NA	2,120	NA	730	21.2	EPA Reg IV Fresh	µg/L
2,4-dinitrophenol	14.6	48.5	6.2	NA	NA	4,850	150	NA	73	14.6	FDEP Criteria	µg/L
2,4-dinitrotoluene	9.1	NA	310	370	230	370	230	NA	73	9.1	FDEP Criteria	µg/L
2,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	37	0.05	RCRA ALs	µg/L
2-chloronaphthalene	NA	NA	NA	7.5	1,600	7.5	620	NA	NA	7.5	AWQC- Marine	µg/L
2-chlorophenol	400	NA	43.8	NA	4,380	NA	970	NA	180	400	FDEP Criteria	µg/L
2-methyl-4,6-dinitrophenol	NA	NA	2.3	NA	NA	NA	NA	NA	NA	2.3	EPA Reg IV Fresh	µg/L
2-methylnaphthalene	NA	NA	NA	NA	NA	300	NA	NA	NA	300	EPA Reg III Marine	µg/L
2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	1,800	1,800	Tap Water RBCs	µg/L
2-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	2.2	2.2	Tap Water RBCs	µg/L
2-nitrophenol	NA	NA	3,500	4,850	150	NA	NA	NA	NA	150	AWQC- Fresh	µg/L
3 & 4-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	1,800	1,800	Tap Water RBCs	µg/L
3,3'-dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	0.15	0.15	Tap Water RBCs	µg/L
3-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	110	110	Tap Water RBCs	µg/L
4-bromophenyl phenyl ether	NA	NA	NA	NA	NA	NA	NA	NA	2,100	2,100	Tap Water RBCs	µg/L
4-chloro-3-methylphenol	NA	NA	0.3	NA	30	NA	NA	NA	NA	0.3	EPA Reg IV Fresh	µg/L
4-chloroaniline	NA	NA	NA	NA	NA	29,700	NA	NA	150	29,700	EPA Reg III Marine	µg/L
4-chlorophenyl phenyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	µg/L
4-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	110	110	Tap Water RBCs	µg/L
4-nitrophenol	NA	71.7	82.8	NA	NA	4,850	150	NA	2,300	71.7	EPA REG IV Marine	µg/L
Acenaphthene	2,700	9.7	17	710	520	710	520	NA	2,200	2,700	FDEP Criteria	µg/L
Acenaphthylene	NA	NA	NA	NA	NA	300	NA	NA	NA	300	EPA Reg III Marine	µg/L
Anthracene	110,000	NA	NA	NA	NA	300	0.1	NA	11,000	110,000	FDEP Criteria	µg/L
Benzo(a)anthracene	NA	NA	NA	NA	NA	8.13	6.3	NA	0.092	6.3	EPA Reg III Fresh	µg/L
Benzo(a)pyrene	NA	NA	NA	NA	NA	0.21	NA	NA	0.2	0.21	EPA Reg III Fresh	µg/L
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	300	NA	NA	0.092	300	EPA Reg III Fresh	µg/L
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	300	NA	NA	NA	300	EPA Reg III Marine	µg/L
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	300	NA	NA	0.92	300	EPA Reg III Fresh	µg/L
Bis(2-chloroethoxy)methane	NA	NA	NA	NA	NA	6,400	11,000	NA	NA	6,400	EPA Reg III Marine	µg/L
Bis(2-chloroethyl)ether	NA	NA	2,380	NA	NA	NA	NA	NA	0.0092	2,380	EPA Reg IV Fresh	µg/L
Bis(2-ethylhexyl)phthalate	NA	NA	0.3	360	360	360	30	NA	6	0.3	EPA Reg IV Fresh	µg/L
Butyl benzyl phthalate	NA	29.4	22	NA	NA	3.4	3	NA	7,300	3	EPA Reg III Fresh	µg/L
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	3.4	3.4	Tap Water RBCs	µg/L

SELECTION OF SURFACE-WATER ACTION LEVELS
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV Marine[2]	EPA Reg IV Fresh[3]	AWQC Marine[4]	AWQC Fresh[5]	EPA Region III Marine[6]	EPA Region III Fresh[7]	2x Average BG[8]	Groundwater Action Level[9]	Selected Action Level	Source of Action Level	Units
Chrysene	NA	NA	NA	NA	NA	300	NA	NA	9.2	300	EPA Reg III Fresh	µg/L
Di-n-butyl phthalate	NA	3.4	9.4	NA	NA	3.4	3	NA	3,700	3	EPA Reg III Fresh	µg/L
Di-n-octyl phthalate	NA	NA	NA	NA	NA	3.4	3	NA	730	3	EPA Reg III Fresh	µg/L
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	300	NA	NA	0.0092	300	EPA Reg III Fresh	µg/L
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	150	150	Tap Water RBCs	µg/L
Diethyl phthalate	NA	75.9	521	NA	NA	3.4	3	NA	29,000	3	EPA Reg III Fresh	µg/L
Dimethyl phthalate	NA	580	330	NA	NA	3.4	3	NA	37,000	3	EPA Reg III Fresh	µg/L
Fluoranthene	370	1.6	39.8	16	3,980	16	3,980	NA	1,500	370	FDEP Criteria	µg/L
Fluorene	14,000	NA	NA	NA	NA	300	430	NA	1,500	14,000	FDEP Criteria	µg/L
Hexachlorobenzene	NA	NA	NA	NA	3.68	129	3.68	NA	1	3.68	AWQC Fresh	µg/L
Hexachlorobutadiene	49.7	0.32	0.93	32	9.3	32	9.3	NA	0.14	49.7	FDEP Criteria	µg/L
Hexachlorocyclopentadiene	NA	0.07	0.07	7	5.2	7	5.2	NA	50	0.07	EPA Reg IV Fresh	µg/L
Hexachloroethane	NA	9.4	9.8	940	540	940	540	NA	0.75	9.4	EPA Reg IV Marine	µg/L
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	300	NA	NA	0.092	300	EPA Reg III Fresh	µg/L
Isophorone	NA	129	1,170	12,900	117,000	12,900	117,000	NA	71	129	EPA Reg IV Marine	µg/L
n-nitrosodiphenylamine	NA	33,000	58.5	NA	NA	3,300,000	5,850	NA	14	58.5	EPA Reg IV Fresh	µg/L
Naphthalene	NA	23.5	62	2,350	620	2,300	100	NA	1,500	23.5	EPA Reg IV Marine	µg/L
Nitrobenzene	NA	66.8	270	6,680	27,000	6,680	27,000	NA	3.4	66.8	EPA Reg IV Marine	µg/L
Pentachlorophenol	7.9	7.9	13	7.9	13	7.9	13	NA	1	7.9	FDEP Criteria	µg/L
Phenanthrene	NA	NA	NA	4.6	6.3	4.6	6.3	NA	NA	4.6	AWQC- Marine	µg/L
Phenol	300	58	256	5,800	2,560	5,800	79	NA	22,000	300	FDEP Criteria	µg/L
Pyrene	11,000	NA	NA	NA	NA	300	NA	NA	1,100	11,000	FDEP Criteria	µg/L
VOLATILE ORGANIC COMPOUNDS												
1,1,1-trichloroethane	NA	312	528	31,200	NA	31,200	9,400	NA	200	312	EPA Reg IV Marine	µg/L
1,1,2,2-tetrachloroethane	10.8	90.2	240	9,020	2,400	6,230	2,400	NA	0.052	10.8	FDEP Criteria	µg/L
1,1,2-trichloroethane	NA	NA	940	NA	9,400	31,200	9,400	NA	5	940	EPA Reg IV Fresh	µg/L
1,1-dichloroethane	NA	NA	NA	NA	NA	320,000	160,000	NA	810	160,000	EPA Reg III Fresh	µg/L
1,1-dichloroethene	3.2	2,240	303	224,000	11,600	224,000	11,600	NA	7	3.2	FDEP Criteria	µg/L
1,2-dichloroethane	NA	1,130	2,000	113,000	20,000	113,000	20,000	NA	3	1,130	EPA Reg IV Marine	µg/L
1,2-dichloropropane	NA	2,400	525	3,040	5,700	3,040	5,700	NA	5	525	EPA Reg IV Fresh	µg/L
2-butanone	NA	NA	NA	NA	NA	NA	3,220,000	NA	1,900	3,220,000	EPA Reg III Fresh	µg/L
2-hexanone	NA	NA	NA	NA	NA	NA	428,000	NA	NA	428,000	EPA Reg III Fresh	µg/L
4-methyl-2-pentanone	NA	NA	NA	NA	NA	NA	460,000	NA	2,900	460,000	EPA Reg III Fresh	µg/L
Acetone	NA	NA	NA	NA	NA	NA	90,000,000	NA	3,700	90,000,000	EPA Reg III Fresh	µg/L
Benzene	71.28	109	53	700	5,300	700	5,300	NA	1	71.28	FDEP Criteria	µg/L
Bis(2-chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	0.26	0.26	Tap Water RBCs	µg/L
Bromodichloromethane	22	NA	NA	NA	NA	6,400	11,000	NA	100	22	FDEP Criteria	µg/L
Bromoform	360	640	293	NA	NA	1,000	11,000	NA	100	360	FDEP Criteria	µg/L
Bromomethane	NA	120	110	NA	NA	NA	NA	NA	8.7	110	EPA Reg IV Fresh	µg/L
Carbon disulfide	NA	NA	NA	NA	NA	2	2	NA	1,000	2	EPA Reg III Marine	µg/L
Carbon tetrachloride	4.42	1,500	352	50,000	35,200	50,000	35,200	NA	3	4.42	FDEP Criteria	µg/L
Chlorobenzene	NA	105	195	129	50	129	50	NA	100	50	AWQC Fresh	µg/L
Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	8,600	8,600	Tap Water RBCs	µg/L
Chloroform	470.8	815	289	NA	1,240	NA	1,240	NA	100	470.8	FDEP Criteria	µg/L
Chloromethane	470.8	2,700	5,500	NA	NA	NA	NA	NA	1.4	470.8	FDEP Criteria	µg/L
cis-1,2-dichloroethene	NA	NA	NA	224,000	11,600	224,000	11,600	NA	70	11,600	EPA Reg III Fresh	µg/L
cis-1,3-dichloropropene	NA	7.9	24.4	790	244	NA	NA	NA	0.077	7.9	EPA Reg IV Marine	µg/L
Dibromochloromethane	34	NA	NA	NA	NA	6,400	11,000	NA	100	34	FDEP Criteria	µg/L
Ethylbenzene	NA	4.3	453	430	32,000	430	32,000	NA	700	4.3	EPA Reg IV Marine	µg/L

TABLE B-5

SELECTION OF SURFACE-WATER ACTION LEVELS
NAS KEY WEST

Parameter	FDEP Criteria[1]	EPA Reg IV Marine[2]	EPA Reg IV Fresh[3]	AWQC Marine[4]	AWQC Fresh[5]	EPA Region III Marine[6]	EPA Region III Fresh[7]	2x Average BG[8]	Groundwater Action Level[9]	Selected Action Level	Source of Action Level	Units
Methylene chloride	1,580	2,560	1,930	NA	NA	6,400	11,000	NA	5	1,580	FDEP Criteria	µg/L
Styrene	NA	NA	NA	NA	NA	NA	NA	NA	100	100	MCL	µg/L
Tetrachloroethene	8.85	45	84	450	840	450	840	NA	3	8.85	FDEP Criteria	µg/L
Toluene	NA	37	175	5,000	17,500	1,050	17,000	NA	1,000	37	EPA Reg IV Marine	µg/L
trans-1,2-dichloroethene	NA	NA	1,350	224,000	11,600	224,000	11,600	NA	100	1,350	EPA Reg IV Fresh	µg/L
trans-1,3-dichloropropene	NA	7.9	24.4	790	244	NA	NA	NA	0.077	7.9	EPA Reg IV Marine	µg/L
Trichloroethene	80.7	NA	NA	2,000	21,900	2,000	21,900	NA	3	80.7	FDEP Criteria	µg/L
Vinyl chloride	NA	NA	NA	NA	NA	224,000	11,600	NA	1	11,600	EPA Reg III Fresh	µg/L
Xylenes, total	NA	NA	NA	NA	NA	6,000	6,000	NA	10,000	6,000	EPA Reg III Marine	µg/L

1 Florida Surface Water Quality Standards (FDEP, 1996b).
2 EPA Region IV Saltwater Surface Water Screening Values (EPA, 1995b).
3 EPA Region IV Freshwater Surface Water Screening Values (EPA, 1995b).
4 EPA Ambient Water Quality Criteria-- Saltwater (EPA, 1991).
5 EPA Ambient Water Quality Criteria--Freshwater (EPA, 1991).
6 EPA Region III Biotechnical Assistance Group Marine Surface Water Screening Levels (EPA, 1995a).
7 EPA Region III Biotechnical Assistance Group Freshwater Surface Water Screening Levels (EPA, 1995a).
8 Twice the average background concentration based on a subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites as NAS Key West.
9 See Table A-6.

TABLE B-6

SELECTION OF GROUNDWATER ACTION LEVELS
NAS KEY WEST

Parameter	MCL[1]	Florida MCL[2]	Tap Water RBCs[3]	2x Average BG[4]	Selected Level Action	Source of Selected Action Level	Units
INORGANICS							
Aluminum	NA	NA	37,000	NA	37,000	Tap Water RBCs	µg/L
Antimony	6	6	15	NA	6	MCL	µg/L
Arsenic	50	50	0.045	9.9	50	MCL	µg/L
Barium	2,000	2,000	2,600	19.16	2,000	MCL	µg/L
Beryllium	4	4	0.016	NA	4	MCL	µg/L
Cadmium	5	5	18	NA	5	MCL	µg/L
Calcium	NA	NA	NA	NA	NA	NA	µg/L
Chromium	100	100	180	1.92	100	MCL	µg/L
Cobalt	NA	NA	2,200	NA	2,200	Tap Water RBCs	µg/L
Copper	NA	NA	1,500	3.36	1,500	Tap Water RBCs	µg/L
Cyanide	200	200	730	2.94	200	MCL	µg/L
Iron	NA	NA	11,000	83.44	11,000	Tap Water RBCs	µg/L
Lead	15	15	NA	NA	15	MCL	µg/L
Magnesium	NA	NA	NA	NA	NA	NA	µg/L
Manganese	NA	NA	840	7.56	840	Tap Water RBCs	µg/L
Mercury	2	2	11	0.2	2	MCL	µg/L
Nickel	100	100	730	NA	100	MCL	µg/L
Potassium	NA	NA	NA	NA	NA	NA	µg/L
Selenium	50	50	180	4.3	50	MCL	µg/L
Silver	NA	NA	180	2.06	180	Tap Water RBCs	µg/L
Sodium	NA	160,000	NA	NA	160,000	Fl MCL	µg/L
Thallium	2	2	NA	4.62	4.62	2x Average BG	µg/L
Tin	NA	NA	22,000	NA	22,000	Tap Water RBCs	µg/L
Vanadium	NA	NA	260	3.8	260	Tap Water RBCs	µg/L
Zinc	NA	NA	11,000	2.34	11,000	Tap Water RBCs	µg/L
PESTICIDES							
4,4'-DDD	NA	NA	0.28	NA	0.28	Tap Water RBCs	µg/L
4,4'-DDE	NA	NA	0.2	NA	0.2	Tap Water RBCs	µg/L
4,4'-DDT	NA	NA	0.2	NA	0.2	Tap Water RBCs	µg/L
Aldrin	NA	NA	0.004	NA	0.004	Tap Water RBCs	µg/L
alpha-BHC	NA	NA	0.011	NA	0.011	Tap Water RBCs	µg/L
alpha-chlordane	NA	NA	0.052	NA	0.052	Tap Water RBCs	µg/L
beta-BHC	NA	NA	0.037	NA	0.037	Tap Water RBCs	µg/L
delta-BHC	NA	NA	NA	NA	NA	NA	µg/L
Dieldrin	NA	NA	0.0042	NA	0.0042	Tap Water RBCs	µg/L
Endosulfan I	NA	NA	220	NA	220	Tap Water RBCs	µg/L
Endosulfan II	NA	NA	220	NA	220	Tap Water RBCs	µg/L
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	µg/L
Endrin	2	2	11	NA	2	MCL	µg/L
Endrin aldehyde	NA	NA	NA	NA	NA	NA	µg/L
Endrin ketone	NA	NA	NA	NA	NA	NA	µg/L
gamma-BHC (lindane)	0.2	0.2	0.052	NA	0.2	MCL	µg/L
gamma-chlordane	NA	NA	0.052	NA	0.052	Tap Water RBCs	µg/L

TABLE B-6

SELECTION OF GROUNDWATER ACTION LEVELS
NAS KEY WEST

Parameter	MCL[1]	Florida MCL[2]	Tap Water RBCs[3]	2x Average BG[4]	Selected Level Action	Source of Selected Action Level	Units
Heptachlor	0.4	0.4	0.0023	NA	0.4	MCL	µg/L
Heptachlor epoxide	0.2	0.2	0.0012	NA	0.2	MCL	µg/L
Methoxychlor	40	40	180	NA	40	MCL	µg/L
Toxaphene	3	3	0.061	NA	3	MCL	µg/L
POLYCHLORINATED BIPHENYLS							
Aroclor-1016	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
Aroclor-1221	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
Aroclor-1232	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
Aroclor-1242	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
Aroclor-1248	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
Aroclor-1254	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
Aroclor-1260	0.5	0.5	0.0335	NA	0.5	MCL	µg/L
SEMIVOLATILE ORGANIC COMPOUNDS							
1,2,4-trichlorobenzene	70	70	190	NA	70	MCL	µg/L
1,2-dichlorobenzene	600	600	270	NA	600	MCL	µg/L
1,3-dichlorobenzene	NA	NA	540	NA	540	Tap Water RBCs	µg/L
1,4-dichlorobenzene	75	75	0.44	NA	0.44	MCL	µg/L
2,4,5-trichlorophenol	NA	NA	3,700	NA	3,700	Tap Water RBCs	µg/L
2,4,6-trichlorophenol	NA	NA	6.1	NA	6.1	Tap Water RBCs	µg/L
2,4-dichlorophenol	NA	NA	110	NA	110	Tap Water RBCs	µg/L
2,4-dimethylphenol	NA	NA	730	NA	730	Tap Water RBCs	µg/L
2,4-dinitrophenol	NA	NA	73	NA	73	Tap Water RBCs	µg/L
2,4-dinitrotoluene	NA	NA	73	NA	73	Tap Water RBCs	µg/L
2,6-dinitrotoluene	NA	NA	37	NA	37	Tap Water RBCs	µg/L
2-chloronaphthalene	NA	NA	NA	NA	NA	NA	µg/L
2-chlorophenol	NA	NA	180	NA	180	Tap Water RBCs	µg/L
2-methyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	NA	µg/L
2-methylnaphthalene	NA	NA	NA	NA	NA	NA	µg/L
2-methylphenol	NA	NA	1,800	NA	1,800	Tap Water RBCs	µg/L
2-nitroaniline	NA	NA	2.2	NA	2.2	Tap Water RBCs	µg/L
2-nitrophenol	NA	NA	NA	NA	NA	NA	µg/L
3 and 4-methylphenol	NA	NA	1,800	NA	1,800	Tap Water RBCs	µg/L
3,3'-dichlorobenzidine	NA	NA	0.15	NA	0.15	Tap Water RBCs	µg/L
3-nitroaniline	NA	NA	110	NA	110	Tap Water RBCs	µg/L
4-bromophenyl phenyl ether	NA	NA	2,100	NA	2,100	Tap Water RBCs	µg/L
4-chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	µg/L
4-chloroaniline	NA	NA	150	NA	150	Tap Water RBCs	µg/L
4-chlorophenyl phenyl ether	NA	NA	NA	NA	NA	NA	µg/L
4-nitroaniline	NA	NA	110	NA	110	Tap Water RBCs	µg/L
4-nitrophenol	NA	NA	2,300	NA	2,300	Tap Water RBCs	µg/L
Acenaphthene	NA	NA	2,200	NA	2,200	Tap Water RBCs	µg/L
Acenaphthylene	NA	NA	NA	NA	NA	NA	µg/L
Anthracene	NA	NA	11,000	NA	11,000	Tap Water RBCs	µg/L
Benzo(a)anthracene	NA	NA	0.092	NA	0.092	Tap Water RBCs	µg/L

TABLE B-6

SELECTION OF GROUNDWATER ACTION LEVELS
NAS KEY WEST

Parameter	MCL[1]	Florida MCL[2]	Tap Water RBCs[3]	2x Average BG[4]	Selected Level Action	Source of Selected Action Level	Units
Benzo(a)pyrene	0.2	0.2	0.0092	NA	0.2	MCL	µg/L
Benzo(b)fluoranthene	NA	NA	0.092	NA	0.092	Tap Water RBCs	µg/L
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	µg/L
Benzo(k)fluoranthene	NA	NA	0.92	NA	0.92	Tap Water RBCs	µg/L
Bis(2-chloroethoxy)methane	NA	NA	NA	NA	NA	NA	µg/L
Bis(2-chloroethyl)ether	NA	NA	0.0092	NA	0.0092	Tap Water RBCs	µg/L
Bis(2-ethylhexyl)phthalate	6	6	4.8	NA	6	MCL	µg/L
Butyl benzyl phthalate	NA	NA	7,300	NA	7,300	Tap Water RBCs	µg/L
Carbazole	NA	NA	3.4	NA	3.4	Tap Water RBCs	µg/L
Chrysene	NA	NA	9.2	NA	9.2	Tap Water RBCs	µg/L
Di-n-butyl phthalate	NA	NA	3,700	NA	3,700	Tap Water RBCs	µg/L
Di-n-octyl phthalate	NA	NA	730	NA	730	Tap Water RBCs	µg/L
Dibenzo(a,h)anthracene	NA	NA	0.0092	NA	0.0092	Tap Water RBCs	µg/L
Dibenzofuran	NA	NA	150	NA	150	Tap Water RBCs	µg/L
Diethyl phthalate	NA	NA	29,000	NA	29,000	Tap Water RBCs	µg/L
Dimethyl phthalate	NA	NA	370,000	NA	370,000	Tap Water RBCs	µg/L
Fluoranthene	NA	NA	1,500	NA	1,500	Tap Water RBCs	µg/L
Fluorene	NA	NA	1,500	NA	1,500	Tap Water RBCs	µg/L
Hexachlorobenzene	1	1	0.0066	NA	1	MCL	µg/L
Hexachlorobutadiene	NA	NA	0.14	NA	0.14	Tap Water RBCs	µg/L
Hexachlorocyclopentadiene	50	50	0.15	NA	50	MCL	µg/L
Hexachloroethane	NA	NA	0.75	NA	0.75	Tap Water RBCs	µg/L
Indeno(1,2,3-cd)pyrene	NA	NA	0.092	NA	0.092	Tap Water RBCs	µg/L
Isophorone	NA	NA	71	NA	71	Tap Water RBCs	µg/L
n-nitrosodiphenylamine	NA	NA	14	NA	14	Tap Water RBCs	µg/L
Naphthalene	NA	NA	1,500	NA	1,500	Tap Water RBCs	µg/L
Nitrobenzene	NA	NA	3.4	NA	3.4	Tap Water RBCs	µg/L
Pentachlorophenol	1	1	0.56	NA	1	MCL	µg/L
Phenanthrene	NA	NA	NA	NA	NA	NA	µg/L
Phenol	NA	NA	22,000	NA	22,000	Tap Water RBCs	µg/L
Pyrene	NA	NA	1,100	NA	1,100	Tap Water RBCs	µg/L
VOLATILE ORGANIC COMPOUNDS							
1,1,1-trichloroethane	200	200	790	NA	200	MCL	µg/L
1,1,2,2-tetrachloroethane	NA	NA	0.052	NA	0.052	Tap Water RBCs	µg/L
1,1,2-trichloroethane	5	5	0.19	NA	5	MCL	µg/L
1,1-dichloroethane	NA	NA	810	NA	810	Tap Water RBCs	µg/L
1,1-dichloroethene	7	7	0.044	NA	7	MCL	µg/L
1,2-dichloroethane	5	3	0.12	NA	3	Fl MCL	µg/L
1,2-dichloropropane	5	5	0.16	NA	5	MCL	µg/L
2-butanone	NA	NA	1,900	NA	1,900	Tap Water RBCs	µg/L
2-hexanone	NA	NA	NA	NA	NA	NA	µg/L
4-methyl-2-pentanone	NA	NA	2,900	NA	2,900	Tap Water RBCs	µg/L
Acetone	NA	NA	3,700	NA	3,700	Tap Water RBCs	µg/L
Benzene	5	1	0.36	NA	1	Fl MCL	µg/L

TABLE B-6

SELECTION OF GROUNDWATER ACTION LEVELS
NAS KEY WEST

Parameter	MCL[1]	Florida MCL[2]	Tap Water RBCs[3]	2x Average BG[4]	Selected Level Action	Source of Selected Action Level	Units
Bis(2-chloroisopropyl)ether	NA	NA	0.26	NA	0.26	Tap Water RBCs	µg/L
Bromodichloromethane	100	NA	0.17	NA	100	MCL	µg/L
Bromoform	100	NA	2.4	NA	100	MCL	µg/L
Bromomethane	NA	NA	8.7	NA	8.7	Tap Water RBCs	µg/L
Carbon disulfide	NA	NA	1,000	NA	1,000	Tap Water RBCs	µg/L
Carbon tetrachloride	5	3	0.16	NA	3	Fl MCL	µg/L
Chlorobenzene	100	100	39	NA	100	MCL	µg/L
Chloroethane	NA	NA	8,600	NA	8,600	Tap Water RBCs	µg/L
Chloroform	100	NA	0.15	NA	100	MCL	µg/L
Chloromethane	NA	NA	1.4	NA	1.4	Tap Water RBCs	µg/L
cis-1,2-dichloroethene	70	70	61	NA	70	MCL	µg/L
cis-1,3-dichloropropene	NA	NA	0.077	NA	0.077	Tap Water RBCs	µg/L
Dibromochloromethane	100	NA	0.13	NA	100	MCL	µg/L
Ethylbenzene	700	700	1,300	NA	700	MCL	µg/L
Methylene chloride	NA	5	4.1	NA	5	Fl MCL	µg/L
Styrene	100	100	1,600	NA	100	MCL	µg/L
Tetrachloroethene	5	3	1.1	NA	3	Fl MCL	µg/L
Toluene	1,000	1,000	750	NA	1,000	MCL	µg/L
trans-1,2-dichloroethene	100	100	120	NA	100	MCL	µg/L
trans-1,3-dichloropropene	NA	NA	0.077	NA	0.077	Tap Water RBCs	µg/L
Trichloroethene	5	3	1.6	NA	3	Fl MCL	µg/L
Vinyl chloride	2	1	0.019	NA	1	Fl MCL	µg/L
Xylenes, total	10,000	10,000	12,000	NA	10,000	MCL	µg/L

1 Safe Drinking Water Act Maximum Contaminant Levels (EPA, 1996a).
2 Florida Maximum Contaminant Levels (FDEP, 1995a).
3 Tap Water Risk Based Concentrations (EPA, 1997).
4 Twice the average background concentration based on a subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites as NAS Key West.

Appendix B

Part 2 - Base Realignment and Closure Site Investigation Action Levels

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN1-- Soil-- Drainage Area

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (PAHs, solvents, metals) from adjacent site property and possibly offsite pole storage area.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site, Drainage Area in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information

(i) Existing documents (reports, drawings, maps, etc.)

- U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
- U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.

(ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone A - Hawk Missile Site, Drainage Area.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone A - Hawk Missile Site, Drainage Area.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Drainage Area. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs

n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone A - Hawk Missile Site, Drainage Area is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone A - Hawk Missile Site, Drainage Area is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Drainage Area is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Drainage Area is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN4-- Soil-- Sewage Lift Station

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (solvents, metals, oils) from lift station.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site, Sewage Lift Station in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
  - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

  (iii) Current/on-going activities

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone A - Hawk Missile Site, Sewage Lift Station.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

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(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

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The scale of the decision-making will be at the subzone level.

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Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone A - Hawk Missile Site, Sewage Lift Station.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Sewage Lift Station. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

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Benzo(a)pyrene	500	FDEP Industrial Goals
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Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
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1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone A - Hawk Missile Site, Sewage Lift Station is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone A - Hawk Missile Site, Sewage Lift Station is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Sewage Lift Station is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Sewage Lift Station is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN5-- Soil-- Generator Building I-6536

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (solvents, oils, metals) from operations of generator building.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site, Generator Building I-6536 in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
    - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Hawk Missile Site. 1995c.
    - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
    - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.
  (ii) Site visits (reports, drawings, maps, etc.)
    - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone A - Hawk Missile Site, Generator Building I-6536.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone A - Hawk Missile Site, Generator Building I-6536.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Generator Building I-6536. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals

2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals

Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone A - Hawk Missile Site, Generator Building I-6536 is not contaminated.
(ii) Alternative Hypothesis: The soil at Zone A - Hawk Missile Site, Generator Building I-6536 is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Generator Building I-6536 is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Generator Building I-6536 is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN6-- Soil-- Burnt Building I-6530 - former Missile Maintenance Bay

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (battery acid, metals, solvents) from prior use as missile maintenance area and burnt contents of building.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
  - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Hawk Missile Site. 1995c.
  - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.

  (ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals

Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Burnt Building I-6530 - former Missile Maintenance Bay is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN7-- Soil-- Former Transformer Storage Area

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (dielectric fluid) from vandalized Army transformers in the former storage area.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by SVOCs, PCBs, and Inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by SVOCs, PCBs, and Inorganics) whether (1) further study is needed (e.g., additional sampling or place Subzone A in RI/FS or IRA and RI/FS program) or (2) no action will be taken.

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
  - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.
 (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
 (iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of SVOCs, PCBs, and Inorganics in soil at Zone A - Hawk Missile Site, Former Transformer Storage Area.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- PCBs; SW-846 Methods 8081/8082
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of SVOCs, PCBs, and Inorganics being analyzed in the soil at Zone A - Hawk Missile Site, Former Transformer Storage Area.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Former Transformer Storage Area. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
PCB Compounds (ug/kg)		
Aroclor-1016	3500	FDEP Industrial Goals
Aroclor-1221	3500	FDEP Industrial Goals
Aroclor-1232	3500	FDEP Industrial Goals
Aroclor-1242	3500	FDEP Industrial Goals
Aroclor-1248	3500	FDEP Industrial Goals
Aroclor-1254	3500	FDEP Industrial Goals
Aroclor-1260	3500	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals

Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be above the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone A - Hawk Missile Site, Former Transformer Storage Area is contaminated.

(ii) Alternative Hypothesis: The soil at Zone A - Hawk Missile Site, Former Transformer Storage Area is not contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Former Transformer Storage Area is not contaminated when it truly is.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone A - Hawk Missile Site, Former Transformer Storage Area is contaminated when it truly is not.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN9-- Sediment-- Ponds

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in sediment from Zone A. Potential contaminant sources include the storage and/or use of petroleum products, solvents, electrical batteries, lead, hazardous waste, and possible pesticides.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the sediment contaminated by VOCs, SVOCs, Pesticides, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not sediment is contaminated (by VOCs, SVOCs, Pesticides, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site, Ponds in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing sediment analytical data
(c) New sediment analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
  - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Hawk Missile Site. 1995c.
  - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.

  (ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing sediment analytical data

(c) New sediment analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, Pesticides, and inorganics in sediment at Zone A - Hawk Missile Site, Ponds.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Pesticide Compoundss; SW-846 Methods 8081/8081a
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

(b) Guidance action levels

- FDEP Criteria-- Florida Department of Environmental Protection (FDEP), Approach to the Assessment of Sediment Quality in Florida Coastal Waters: Volume 1- Development and Evaluation of Sediment Quality Assessment Guidelines, 1994a.
- USEPA SQC Fresh-- U. S. Environmental Protection Agency (EPA), ECO Update, 1996b.
- USEPA SQC Marine-- U. S. Environmental Protection Agency (EPA), ECO Update, 1996b.
- USEPA SQB-- U. S. Environmental Protection Agency (EPA), ECO Update, 1996b.
- REG III BTAGs-- U. S. Environmental Protection Agency (EPA), EPA Region III BTAG Screening Levels, 1995a.
- Ontario Guidelines-- OME (Ontario Ministry of the Environment), Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, 1992.
- ER-M-- Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, 1995.
- ER-L-- Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, 1995.
- Chem and Tox-- Baudo, R., J. Geisy, and H. Muntau (eds.), Sediments: Chemistry and Toxicity of In-Place Pollutants, 1990.
- EPA Region IV-- U. S. Environmental Protection Agency (EPA), Supplemental Guidance to RAGs: Region 4 Bulletins-- Ecological Risk Assessment, 1995b.
- Tox. Benchmarks-- Hull, R.N., and G.W. Suter, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-associated Biota, 1994.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Pesticide Compounds SW-846 Methods 8081/8081a-- Endosulfan sulfate
- Pesticide Compounds SW-846 Methods 8081/8081a-- Endrin ketone
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Sediment is material that settles to the bottom of a liquid. Therefore, sediment typically will be found with any water body (e.g., standing water, tidal or seasonal) within Zone A - Hawk Missile Site, Ponds.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the sediment within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the sediment within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the sediment.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample sediment could increase the cost of sampling. Special equipment such as a boat and dredge are required to take samples in deep water.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the sediment is less than the action level, sediment will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the sediment exceeds the action level, further study of the sediment will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, Pesticides, and inorganics being analyzed in the sediment at Zone A - Hawk Missile Site, Ponds.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For SVOCs, VOCs, and PCBs, the most conservative guidance concentration will be used, as no legal requirements have been established. For inorganics commonly found in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative guidance is higher, in which case, that value will be adopted. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level unless the most conservative guidance is a higher value. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Ponds. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	2663.78	2x Avg Background
Antimony	12	EPA Region IV
Arsenic	7.24	FDEP Criteria
Barium	40	Chem and Tox
Beryllium	0.1	2x Avg Background
Cadmium	0.676	FDEP Criteria
Calcium	0	NA
Chromium	52.3	FDEP Criteria
Cobalt	0.48	2x Avg Background
Copper	18.7	FDEP Criteria
Iron	2398	2x Avg Background
Lead	34.18	2x Avg Background
Magnesium	0	NA
Manganese	460	Tox. Benchmarks
Mercury	0.13	FDEP Criteria
Nickel	15.9	FDEP Criteria
Potassium	0	NA
Selenium	1.42	2x Avg Background
Silver	0.733	FDEP Criteria
Sodium	0	NA
Thallium	0	NA
Tin	1.98	2x Avg Background
Vanadium	10.44	2x Avg Background
Zinc	124	FDEP Criteria
Pesticide Compounds (ug/kg)		
4,4'-DDD	1.78	Avg Background
4,4'-DDE	2.07	FDEP Criteria
4,4'-DDT	1.76	Avg Background
Aldrin	200	FDEP Industrial Goals
alpha-BHC	1.05	Avg Background
alpha-chlordane	490	Residential Soil RBCs
beta-BHC	5	Tox. Benchmarks
delta-BHC	3	Tox. Benchmarks
Dieldrin	0.715	FDEP Criteria
Endosulfan I	2.9	USEPA SQB
Endosulfan II	14	USEPA SQB
Endosulfan sulfate	0	NA
Endrin	3.3	EPA Region IV
Endrin aldehyde	480000	FDEP Industrial Goals

Endrin ketone	0	NA
gamma-BHC (lindane)	1.22	Avg Background
gamma-chlordane	490	Residential Soil RBCs
Heptachlor	4.9	Tox. Benchmarks
Heptachlor epoxide	300	FDEP Industrial Goals
Methoxychlor	19	USEPA SQB
Toxaphene	28	USEPA SQB
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	9200	USEPA SQB
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	29	REG III BTAGs
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	20.2	FDEP Criteria
2-methylphenol	63	REG III BTAGs
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	1300	USEPA SQB
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	6.71	FDEP Criteria
Acenaphthylene	5.87	FDEP Criteria
Anthracene	46.9	FDEP Criteria
Benzo(a)anthracene	74.8	FDEP Criteria
Benzo(a)pyrene	88.8	FDEP Criteria
Benzo(b)fluoranthene	3200	REG III BTAGs
Benzo(g,h,i)perylene	670	REG III BTAGs
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	182	FDEP Criteria
Butyl benzyl phthalate	63	REG III BTAGs
Carbazole	120000	FDEP Industrial Goals
Chrysene	108	FDEP Criteria
Di-n-butyl phthalate	1400	REG III BTAGs
Di-n-octyl phthalate	6200	REG III BTAGs
Dibenzo(a,h)anthracene	6.22	FDEP Criteria
Dibenzofuran	540	REG III BTAGs
Diethyl phthalate	200	REG III BTAGs
Dimethyl phthalate	71	REG III BTAGs

Fluoranthene	113	FDEP Criteria
Fluorene	19	ER-L
Hexachlorobenzene	22	REG III BTAGs
Hexachlorobutadiene	11	REG III BTAGs
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	1000	USEPA SQB
Indeno(1,2,3-cd)pyrene	600	REG III BTAGs
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	28	REG III BTAGs
Naphthalene	34.6	FDEP Criteria
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	360	REG III BTAGs
Phenanthrene	86.7	FDEP Criteria
Phenol	420	REG III BTAGs
Pyrene	153	FDEP Criteria
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	31	REG III BTAGs
1,1,2,2-tetrachloroethane	940	USEPA SQB
1,1,2-trichloroethane	31	REG III BTAGs
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	64	Ontario Guidelines
Benzene	57	USEPA SQB
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	13	Ontario Guidelines
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	820	USEPA SQB
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	23	Tox. Benchmarks
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10	REG III BTAGs
Methylene chloride	427	Ontario Guidelines
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	57	REG III BTAGs
Toluene	670	USEPA SQB
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	1600	USEPA SQB
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	25	USEPA SQB

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The sediment at Zone A - Hawk Missile Site, Ponds is not contaminated.

(ii) Alternative Hypothesis: The sediment at Zone A - Hawk Missile Site, Ponds is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the sediment at Zone A - Hawk Missile Site, Ponds is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the sediment at Zone A - Hawk Missile Site, Ponds is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For sediment, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of sediment samples is six.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the sediment is contaminated in excess of the action levels. Six discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN10-- Surface water-- Ponds

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in surface water (petroleum, battery acid, Pb) from Zone A runoff to surface water bodies.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the surface water contaminated by SVOCs and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
(i) Additional sampling
(ii) RI/FS
(iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not surface water is contaminated (by SVOCs and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site, Ponds in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing surface water analytical data
(c) New surface water analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information

(i) Existing documents (reports, drawings, maps, etc.)

- U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
- U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Hawk Missile Site. 1995c.
- U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.

(ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing surface water analytical data

(c) New surface water analytical data

Through the following analytical methods, the planning team needs to obtain measurements of SVOCs and inorganics in surface water at Zone A - Hawk Missile Site, Ponds.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Criteria-- Florida Department of Environmental Protection (FDEP), Surface Water Quality Standards, 1996b.

(b) Guidance action levels

- EPA Reg III Marine-- U. S. Environmental Protection Agency (EPA), EPA Region III BTAG Screening Levels, 1995a.
- EPA Reg III Fresh-- U. S. Environmental Protection Agency (EPA), EPA Region III BTAG Screening Levels, 1995a.
- EPA Reg IV Marine-- U. S. Environmental Protection Agency (EPA), Supplemental Guidance to RAGs: Region 4 Bulletins-- Ecological Risk Assessment, 1995b.
- EPA Reg IV Fresh-- U. S. Environmental Protection Agency (EPA), Supplemental Guidance to RAGs: Region 4 Bulletins-- Ecological Risk Assessment, 1995b.
- National AWQC- Fresh-- U. S. Environmental Protection Agency (EPA), Water Quality Criteria Summary, 1991.
- National AWQC- Marine-- U. S. Environmental Protection Agency (EPA), Water Quality Criteria Summary, 1991.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Surface water is assumed to be a homogeneous body of water found on the land surface. Therefore, surface water typically will be found in low-lying areas, and will be designated as a subzone.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the surface water within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the surface water within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the surface water.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample surface water could increase the cost of sampling. Special equipment such as a boat is required to take samples in deep water.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the surface water is less than the action level, surface water will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the surface water exceeds the action level, further study of the surface water will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of SVOCs and inorganics being analyzed in the surface water at Zone A - Hawk Missile Site, Ponds.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site, Ponds. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	1500	FDEP Criteria
Antimony	4300	FDEP Criteria
Arsenic	50	FDEP Criteria
Barium	10000	EPA Reg III Marine
Beryllium	0.28	2x Avg Background
Cadmium	9.3	FDEP Criteria
Calcium	0	NA
Chromium	50	FDEP Criteria
Cobalt	35000	EPA REG III Fresh
Copper	2.9	FDEP Criteria
Iron	300	FDEP Criteria
Lead	5.6	FDEP Criteria
Magnesium	0	NA
Manganese	10	EPA Reg III Marine
Mercury	1.26	2x Avg Background
Nickel	8.3	FDEP Criteria
Potassium	0	NA
Selenium	71	FDEP Criteria
Silver	2.3	FDEP Criteria
Sodium	160000	Fl MCL
Thallium	7.3	2x Avg Background
Tin	0.01	EPA Reg III Marine
Vanadium	10000	EPA Reg III Marine
Zinc	86	FDEP Criteria
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	4.5	EPA REG IV Marine
2,4,5-trichlorophenol	11	National AWQC- Marine
2,4,6-trichlorophenol	6.5	FDEP Criteria
2,4-dichlorophenol	790	FDEP Criteria
2,4-dimethylphenol	21.2	EPA Reg IV Fresh
2,4-dinitrophenol	14.6	FDEP Criteria
2,4-dinitrotoluene	9.1	FDEP Criteria
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	7.5	National AWQC- Marine
2-chlorophenol	400	FDEP Criteria
2-methyl-4,6-dinitrophenol	2.3	EPA Reg IV Fresh
2-methylnaphthalene	300	EPA Reg III Marine
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	150	National AWQC- Fresh
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0.3	EPA Reg IV Fresh
4-chloroaniline	29700	EPA Reg III Marine
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	71.7	EPA REG IV Marine
Acenaphthene	2700	FDEP Criteria
Acenaphthylene	300	EPA Reg III Marine
Anthracene	110000	FDEP Criteria
Benzo(a)anthracene	6.3	EPA REG III Fresh
Benzo(a)pyrene	0.21	EPA Reg III Marine
Benzo(b)fluoranthene	300	EPA Reg III Marine
Benzo(g,h,i)perylene	300	EPA Reg III Marine
Benzo(k)fluoranthene	300	EPA Reg III Marine
Bis(2-chloroethoxy)methane	6400	EPA Reg III Marine
Bis(2-chloroethyl)ether	2380	EPA Reg IV Fresh
Bis(2-ethylhexyl)phthalate	0.3	EPA Reg IV Fresh
Butyl benzyl phthalate	3	EPA REG III Fresh
Carbazole	3.4	Tap Water RBCs
Chrysene	300	EPA Reg III Marine
Di-n-butyl phthalate	3	EPA REG III Fresh
Di-n-octyl phthalate	3	EPA REG III Fresh
Dibenzo(a,h)anthracene	300	EPA Reg III Marine
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	3	EPA REG III Fresh
Dimethyl phthalate	3	EPA REG III Fresh
Fluoranthene	370	FDEP Criteria
Fluorene	14000	FDEP Criteria
Hexachlorobenzene	3.68	National AWQC- Fresh
Hexachlorobutadiene	49.7	FDEP Criteria

Hexachlorocyclopentadiene	0.07	EPA Reg IV Fresh
Hexachloroethane	9.4	EPA REG IV Marine
Indeno(1,2,3-cd)pyrene	300	EPA Reg III Marine
Isophorone	129	EPA REG IV Marine
n-nitrosodiphenylamine	58.5	EPA Reg IV Fresh
Naphthalene	23.5	EPA REG IV Marine
Nitrobenzene	66.8	EPA REG IV Marine
Pentachlorophenol	7.9	FDEP Criteria
Phenanthrene	4.6	National AWQC- Marine
Phenol	300	FDEP Criteria
Pyrene	11000	FDEP Criteria

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The surface water at Zone A - Hawk Missile Site, Ponds is not contaminated.

(ii) Alternative Hypothesis: The surface water at Zone A - Hawk Missile Site, Ponds is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the surface water at Zone A - Hawk Missile Site, Ponds is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the surface water at Zone A - Hawk Missile Site, Ponds is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for surface water, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size.Based on this analysis, the optimal number of surface water samples is seven.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the surface water is contaminated in excess of the action levels. Seven discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone A - Hawk Missile Site

Subzone GRYZNA-SZN11-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater from Zone A. Potential contaminant sources include the storage and/or use of petroleum products, solvents, electrical batteries, lead, and electrical transformers.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone A - Hawk Missile Site. in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
  - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Hawk Missile Site. 1995c.
  - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. 1963b.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone A - Hawk Missile Site.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL– U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL– Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone A - Hawk Missile Site.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone A - Hawk Missile Site. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	Fl MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs

Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs
Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone A - Hawk Missile Site. is not contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone A - Hawk Missile Site. is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone A - Hawk Missile Site. is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone A - Hawk Missile Site. is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone B - East Martello Battery

Subzone GRYZNB-SZN1-- Soil-- East Martello Battery

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (petroleum, solvents, fuels, lead) from past uses as defense battery.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone B - East Martello Battery, East Martello Battery in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Drawing; Battery Sites; International Airport Electrical Site Plan, Dwg. No. 1022223. 1963a.
  - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of East Martello Battery. 1995b.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Drawing of Master Shore Station Development Plan, Dwg No. P-2530. 1957a.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Drawing; Master Shore Station Development Plan Utilities Sanitary Sewerage and Gas Distribution, Dwg No. P-2578 - 752933. 1957b.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Y&D Drawing, Dwg. No. 91645. 1997b.

  (ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone B - East Martello Battery, East Martello Battery.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone B - East Martello Battery, East Martello Battery.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone B - East Martello Battery, East Martello Battery. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals

Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone B - East Martello Battery, East Martello Battery is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone B - East Martello Battery, East Martello Battery is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone B - East Martello Battery, East Martello Battery is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone B - East Martello Battery, East Martello Battery is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone B - East Martello Battery
Subzone GRYZNB-SZN3-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (solvents, fuels, lead) from past uses as defense battery and trailer park.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone B - East Martello Battery. in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    – U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of East Martello Battery. 1995b.
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Drawing of Master Shore Station Development Plan, Dwg No. P-2530. 1957a.
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Drawing; Master Shore Station Development Plan Utilities Sanitary Sewerage and Gas Distribution, Dwg No. P-2578 - 752933. 1957b.
  (ii) Site visits (reports, drawings, maps, etc.)
    – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
    – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone B - East Martello Battery.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL-- U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL-- Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal

results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone B - East Martello Battery.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone B - East Martello Battery. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	FI MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs
Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs

Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone B - East Martello Battery. is not contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone B - East Martello Battery. is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone B - East Martello Battery. is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone B - East Martello Battery. is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone C - Truman Annex DRMO Waste Storage Area

Subzone GRYZNC-SZN1-- Soil-- Building 261 Hazardous Material Storage (former DRMO)

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (solvents, fuels, pesticides) from past waste storage activities.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, Pesticides, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, Pesticides, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO) in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Truman Pier. 1996.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

  (iii) Current/on-going activities
(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, Pesticides, and inorganics in soil at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO).

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Pesticide Compoundss; SW-846 Methods 8081/8081a
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Pesticide Compounds SW-846 Methods 8081/8081a-- Endosulfan sulfate
- Pesticide Compounds SW-846 Methods 8081/8081a-- Endrin ketone
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, Pesticides, and inorganics being analyzed in the soil at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO).

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO). Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals
Pesticide Compounds (ug/kg)		
4,4'-DDD	4500	FDEP Residential Goals
4,4'-DDE	3000	FDEP Residential Goals
4,4'-DDT	3100	FDEP Residential Goals
Aldrin	60	FDEP Residential Goals
alpha-BHC	200	FDEP Residential Goals
alpha-chlordane	490	Residential Soil RBCs
beta-BHC	600	FDEP Residential Goals
delta-BHC	23000	FDEP Residential Goals
Dieldrin	70	FDEP Residential Goals
Endosulfan I	390000	FDEP Residential Goals
Endosulfan II	390000	FDEP Residential Goals
Endosulfan sulfate	0	NA
Endrin	23000	FDEP Residential Goals
Endrin aldehyde	23000	FDEP Residential Goals
Endrin ketone	0	NA
gamma-BHC (lindane)	800	FDEP Residential Goals
gamma-chlordane	490	Residential Soil RBCs
Heptachlor	200	FDEP Residential Goals
Heptachlor epoxide	100	FDEP Residential Goals
Methoxychlor	380000	FDEP Residential Goals
Toxaphene	900	FDEP Residential Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	7100000	FDEP Residential Goals
2,4,6-trichlorophenol	87000	FDEP Residential Goals
2,4-dichlorophenol	220000	FDEP Residential Goals
2,4-dimethylphenol	1200000	FDEP Residential Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	130000	FDEP Residential Goals
2,6-dinitrotoluene	71000	FDEP Residential Goals
2-chloronaphthalene	560000	FDEP Residential Goals
2-chlorophenol	280000	FDEP Residential Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	960000	FDEP Residential Goals
2-methylphenol	2600000	FDEP Residential Goals
2-nitroaniline	4000	FDEP Residential Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	340000	FDEP Residential Goals

3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1.4E+08	FDEP Residential Goals
4-chloroaniline	240000	FDEP Residential Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	230000	FDEP Residential Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	2800000	FDEP Residential Goals
Acenaphthylene	670000	FDEP Residential Goals
Anthracene	20000000	FDEP Residential Goals
Benzo(a)anthracene	1400	FDEP Residential Goals
Benzo(a)pyrene	100	FDEP Residential Goals
Benzo(b)fluoranthene	1400	FDEP Residential Goals
Benzo(g,h,i)perylene	14000	FDEP Residential Goals
Benzo(k)fluoranthene	14000	FDEP Residential Goals
Bis(2-chloroethoxy)methane	170000	FDEP Residential Goals
Bis(2-chloroethyl)ether	500	FDEP Residential Goals
Bis(2-ethylhexyl)phthalate	48000	FDEP Residential Goals
Butyl benzyl phthalate	15000000	FDEP Residential Goals
Carbazole	42000	FDEP Residential Goals
Chrysene	140000	FDEP Residential Goals
Di-n-butyl phthalate	7300000	FDEP Residential Goals
Di-n-octyl phthalate	1500000	FDEP Residential Goals
Dibenzo(a,h)anthracene	100	FDEP Residential Goals
Dibenzofuran	240000	FDEP Residential Goals
Diethyl phthalate	56000000	FDEP Residential Goals
Dimethyl phthalate	6.3E+08	FDEP Residential Goals
Fluoranthene	2900000	FDEP Residential Goals
Fluorene	2400000	FDEP Residential Goals
Hexachlorobenzene	600	FDEP Residential Goals
Hexachlorobutadiene	3100	FDEP Residential Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	27000	FDEP Residential Goals
Indeno(1,2,3-cd)pyrene	1400	FDEP Residential Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	73000	FDEP Residential Goals
Naphthalene	1300000	FDEP Residential Goals
Nitrobenzene	22000	FDEP Residential Goals
Pentachlorophenol	5400	FDEP Residential Goals
Phenanthrene	1700000	FDEP Residential Goals
Phenol	34000000	FDEP Residential Goals
Pyrene	2200000	FDEP Residential Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	610000	FDEP Residential Goals
1,1,2,2-tetrachloroethane	900	FDEP Residential Goals
1,1,2-trichloroethane	2000	FDEP Residential Goals
1,1-dichloroethane	310000	FDEP Residential Goals
1,1-dichloroethene	100	FDEP Residential Goals
1,2-dichloroethane	700	FDEP Residential Goals
1,2-dichloropropane	800	FDEP Residential Goals
2-butanone	2200000	FDEP Residential Goals
2-hexanone	0	NA
4-methyl-2-pentanone	520000	FDEP Residential Goals
Acetone	260000	FDEP Residential Goals
Benzene	1400	FDEP Residential Goals
Bromodichloromethane	700	FDEP Residential Goals
Bromoform	65000	FDEP Residential Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	5200	FDEP Residential Goals
Carbon tetrachloride	600	FDEP Residential Goals
Chlorobenzene	44000	FDEP Residential Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	600	FDEP Residential Goals
Chloromethane	200	FDEP Residential Goals
cis-1,2-dichloroethene	26000	FDEP Residential Goals
cis-1,3-dichloropropene	300	FDEP Residential Goals
Dibromochloromethane	1200	FDEP Residential Goals
Ethylbenzene	1400000	FDEP Residential Goals
Methylene chloride	16000	FDEP Residential Goals
Styrene	4100000	FDEP Residential Goals
Tetrachloroethene	12000	FDEP Residential Goals
Toluene	520000	FDEP Residential Goals
trans-1,2-dichloroethene	62000	FDEP Residential Goals
trans-1,3-dichloropropene	300	FDEP Residential Goals
Trichloroethene	6500	FDEP Residential Goals
Vinyl chloride	5	FDEP Residential Goals
Xylenes, total	13000000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO) is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO) is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO) is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone C - Truman Annex DRMO Waste Storage Area, Building 261 Hazardous Material Storage (former DRMO) is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone C - Truman Annex DRMO Waste Storage Area

Subzone GRYZNC-SZN3-- Soil-- Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (fuels, oil, metal) from past oil and metal storage activities.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

  (iii) Current/on-going activities

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are r equired to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	7100000	FDEP Residential Goals
2,4,6-trichlorophenol	87000	FDEP Residential Goals
2,4-dichlorophenol	220000	FDEP Residential Goals
2,4-dimethylphenol	1200000	FDEP Residential Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	130000	FDEP Residential Goals
2,6-dinitrotoluene	71000	FDEP Residential Goals
2-chloronaphthalene	560000	FDEP Residential Goals
2-chlorophenol	280000	FDEP Residential Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	960000	FDEP Residential Goals
2-methylphenol	2600000	FDEP Residential Goals
2-nitroaniline	4000	FDEP Residential Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	340000	FDEP Residential Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1.4E+08	FDEP Residential Goals
4-chloroaniline	240000	FDEP Residential Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	230000	FDEP Residential Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	2800000	FDEP Residential Goals
Acenaphthylene	670000	FDEP Residential Goals
Anthracene	20000000	FDEP Residential Goals
Benzo(a)anthracene	1400	FDEP Residential Goals
Benzo(a)pyrene	100	FDEP Residential Goals
Benzo(b)fluoranthene	1400	FDEP Residential Goals
Benzo(g,h,i)perylene	14000	FDEP Residential Goals
Benzo(k)fluoranthene	14000	FDEP Residential Goals
Bis(2-chloroethoxy)methane	170000	FDEP Residential Goals
Bis(2-chloroethyl)ether	500	FDEP Residential Goals
Bis(2-ethylhexyl)phthalate	48000	FDEP Residential Goals
Butyl benzyl phthalate	15000000	FDEP Residential Goals
Carbazole	42000	FDEP Residential Goals
Chrysene	140000	FDEP Residential Goals
Di-n-butyl phthalate	7300000	FDEP Residential Goals
Di-n-octyl phthalate	1500000	FDEP Residential Goals
Dibenzo(a,h)anthracene	100	FDEP Residential Goals
Dibenzofuran	240000	FDEP Residential Goals
Diethyl phthalate	56000000	FDEP Residential Goals

Dimethyl phthalate	6.3E+08	FDEP Residential Goals
Fluoranthene	2900000	FDEP Residential Goals
Fluorene	2400000	FDEP Residential Goals
Hexachlorobenzene	600	FDEP Residential Goals
Hexachlorobutadiene	3100	FDEP Residential Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	27000	FDEP Residential Goals
Indeno(1,2,3-cd)pyrene	1400	FDEP Residential Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	73000	FDEP Residential Goals
Naphthalene	1300000	FDEP Residential Goals
Nitrobenzene	22000	FDEP Residential Goals
Pentachlorophenol	5400	FDEP Residential Goals
Phenanthrene	1700000	FDEP Residential Goals
Phenol	34000000	FDEP Residential Goals
Pyrene	2200000	FDEP Residential Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	610000	FDEP Residential Goals
1,1,2,2-tetrachloroethane	900	FDEP Residential Goals
1,1,2-trichloroethane	2000	FDEP Residential Goals
1,1-dichloroethane	310000	FDEP Residential Goals
1,1-dichloroethene	100	FDEP Residential Goals
1,2-dichloroethane	700	FDEP Residential Goals
1,2-dichloropropane	800	FDEP Residential Goals
2-butanone	2200000	FDEP Residential Goals
2-hexanone	0	NA
4-methyl-2-pentanone	520000	FDEP Residential Goals
Acetone	260000	FDEP Residential Goals
Benzene	1400	FDEP Residential Goals
Bromodichloromethane	700	FDEP Residential Goals
Bromoform	65000	FDEP Residential Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	5200	FDEP Residential Goals
Carbon tetrachloride	600	FDEP Residential Goals
Chlorobenzene	44000	FDEP Residential Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	600	FDEP Residential Goals
Chloromethane	200	FDEP Residential Goals
cis-1,2-dichloroethene	26000	FDEP Residential Goals
cis-1,3-dichloropropene	300	FDEP Residential Goals
Dibromochloromethane	1200	FDEP Residential Goals
Ethylbenzene	1400000	FDEP Residential Goals
Methylene chloride	16000	FDEP Residential Goals
Styrene	4100000	FDEP Residential Goals
Tetrachloroethene	12000	FDEP Residential Goals
Toluene	520000	FDEP Residential Goals
trans-1,2-dichloroethene	62000	FDEP Residential Goals
trans-1,3-dichloropropene	300	FDEP Residential Goals
Trichloroethene	6500	FDEP Residential Goals
Vinyl chloride	5	FDEP Residential Goals
Xylenes, total	13000000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Oil Container (pre1942) and Scrap Metal and Refugee Item Storage Areas is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone C - Truman Annex DRMO Waste Storage Area

Subzone GRYZNC-SZN4-- Soil-- Former Scrap Metal Storage Area (former DRMO)

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metal debris) from past metal storage activities.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
(i) Additional sampling
(ii) RI/FS
(iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO) in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
(i) Existing documents (reports, drawings, maps, etc.)
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.

(ii) Site visits (reports, drawings, maps, etc.)
- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of inorganics in soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO).

- Metals; SW-846 Methods 6010a/6010b and 7000a series

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
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- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of inorganics being analyzed in the soil at Zone C - Truman Annex DRMO

Waste Storage Area, Former Scrap Metal Storage Area (former DRMO).

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO). Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)

Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
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Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO) is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO) is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO) is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone C - Truman Annex DRMO Waste Storage Area, Former Scrap Metal Storage Area (former DRMO) is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone C - Truman Annex DRMO Waste Storage Area
Subzone GRYZNC-SZN6-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (fuels, oils, metals, solvents) from past metal, waste storage activities.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone C - Truman Annex DRMO Waste Storage Area. in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.
  (ii) Site visits (reports, drawings, maps, etc.)
    – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
    – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone C - Truman Annex DRMO Waste Storage Area.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL– U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL– Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal

results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone C - Truman Annex DRMO Waste Storage Area.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone C - Truman Annex DRMO Waste Storage Area. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	Fl MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs
Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs

Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	Fl MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	Fl MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	Fl MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	Fl MCL
Styrene	100	MCL
Tetrachloroethene	3	Fl MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	Fl MCL
Vinyl chloride	1	Fl MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone C - Truman Annex DRMO Waste Storage Area. is not contaminated.
(ii) Alternative Hypothesis: The groundwater at Zone C - Truman Annex DRMO Waste Storage Area. is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone C - Truman Annex DRMO Waste Storage Area. is contaminated when it truly is not.
(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone C - Truman Annex DRMO Waste Storage Area. is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone D - Truman Annex Seminole Battery

Subzone GRYZND-SZN1-- Soil-- Seminole Battery

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (used oils, cleaning agents, solvents, fuel and metals) from past activities including storage of hazardous materials and vehicles.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone D - Truman Annex Seminole Battery, Seminole Battery in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.
  (ii) Site visits (reports, drawings, maps, etc.)
    – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
    – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing soil analytical data
(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone D - Truman Annex Seminole Battery, Seminole Battery.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone D - Truman Annex Seminole Battery, Seminole Battery.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone D - Truman Annex Seminole Battery, Seminole Battery. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	7100000	FDEP Residential Goals
2,4,6-trichlorophenol	87000	FDEP Residential Goals
2,4-dichlorophenol	220000	FDEP Residential Goals
2,4-dimethylphenol	1200000	FDEP Residential Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	130000	FDEP Residential Goals
2,6-dinitrotoluene	71000	FDEP Residential Goals
2-chloronaphthalene	560000	FDEP Residential Goals
2-chlorophenol	280000	FDEP Residential Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	960000	FDEP Residential Goals
2-methylphenol	2600000	FDEP Residential Goals
2-nitroaniline	4000	FDEP Residential Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	340000	FDEP Residential Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1.4E+08	FDEP Residential Goals
4-chloroaniline	240000	FDEP Residential Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	230000	FDEP Residential Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	2800000	FDEP Residential Goals
Acenaphthylene	670000	FDEP Residential Goals
Anthracene	20000000	FDEP Residential Goals
Benzo(a)anthracene	1400	FDEP Residential Goals
Benzo(a)pyrene	100	FDEP Residential Goals
Benzo(b)fluoranthene	1400	FDEP Residential Goals
Benzo(g,h,i)perylene	14000	FDEP Residential Goals
Benzo(k)fluoranthene	14000	FDEP Residential Goals
Bis(2-chloroethoxy)methane	170000	FDEP Residential Goals
Bis(2-chloroethyl)ether	500	FDEP Residential Goals
Bis(2-ethylhexyl)phthalate	48000	FDEP Residential Goals
Butyl benzyl phthalate	15000000	FDEP Residential Goals
Carbazole	42000	FDEP Residential Goals
Chrysene	140000	FDEP Residential Goals
Di-n-butyl phthalate	7300000	FDEP Residential Goals
Di-n-octyl phthalate	1500000	FDEP Residential Goals
Dibenzo(a,h)anthracene	100	FDEP Residential Goals
Dibenzofuran	240000	FDEP Residential Goals
Diethyl phthalate	56000000	FDEP Residential Goals
Dimethyl phthalate	6.3E+08	FDEP Residential Goals
Fluoranthene	2900000	FDEP Residential Goals
Fluorene	2400000	FDEP Residential Goals
Hexachlorobenzene	600	FDEP Residential Goals
Hexachlorobutadiene	3100	FDEP Residential Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	27000	FDEP Residential Goals

Indeno(1,2,3-cd)pyrene	1400	FDEP Residential Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	73000	FDEP Residential Goals
Naphthalene	1300000	FDEP Residential Goals
Nitrobenzene	22000	FDEP Residential Goals
Pentachlorophenol	5400	FDEP Residential Goals
Phenanthrene	1700000	FDEP Residential Goals
Phenol	34000000	FDEP Residential Goals
Pyrene	2200000	FDEP Residential Goals
Volatile Organic Compounds (ug/kg)		
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1,1,2,2-tetrachloroethane	900	FDEP Residential Goals
1,1,2-trichloroethane	2000	FDEP Residential Goals
1,1-dichloroethane	310000	FDEP Residential Goals
1,1-dichloroethene	100	FDEP Residential Goals
1,2-dichloroethane	700	FDEP Residential Goals
1,2-dichloropropane	800	FDEP Residential Goals
2-butanone	2200000	FDEP Residential Goals
2-hexanone	0	NA
4-methyl-2-pentanone	520000	FDEP Residential Goals
Acetone	260000	FDEP Residential Goals
Benzene	1400	FDEP Residential Goals
Bromodichloromethane	700	FDEP Residential Goals
Bromoform	65000	FDEP Residential Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	5200	FDEP Residential Goals
Carbon tetrachloride	600	FDEP Residential Goals
Chlorobenzene	44000	FDEP Residential Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	600	FDEP Residential Goals
Chloromethane	200	FDEP Residential Goals
cis-1,2-dichloroethene	26000	FDEP Residential Goals
cis-1,3-dichloropropene	300	FDEP Residential Goals
Dibromochloromethane	1200	FDEP Residential Goals
Ethylbenzene	1400000	FDEP Residential Goals
Methylene chloride	16000	FDEP Residential Goals
Styrene	4100000	FDEP Residential Goals
Tetrachloroethene	12000	FDEP Residential Goals
Toluene	520000	FDEP Residential Goals
trans-1,2-dichloroethene	62000	FDEP Residential Goals
trans-1,3-dichloropropene	300	FDEP Residential Goals
Trichloroethene	6500	FDEP Residential Goals
Vinyl chloride	5	FDEP Residential Goals
Xylenes, total	13000000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

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(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone D - Truman Annex Seminole Battery, Seminole Battery is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone D - Truman Annex Seminole Battery, Seminole Battery is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone D - Truman Annex Seminole Battery, Seminole Battery is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone D - Truman Annex Seminole Battery, Seminole Battery is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone D - Truman Annex Seminole Battery

Subzone GRYZND-SZN2-- Soil-- Former Grease Racks

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination (lubricants and grease) in soil from the former grease racks

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone D - Truman Annex Seminole Battery, Former Grease Racks in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2538; Master Shore Station Development Plan; Utilities Sanitary Sewerage and Gas Distribution, Dwg. No. P-2538 - 752893. 1957d.
    - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.
  (ii) Site visits (reports, drawings, maps, etc.)
    - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
    - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone D - Truman Annex Seminole Battery, Former Grease Racks.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone D - Truman Annex Seminole Battery, Former Grease Racks.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone D - Truman Annex Seminole Battery, Former Grease Racks. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
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2-hexanone	0	NA
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Acetone	260000	FDEP Residential Goals
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Ethylbenzene	1400000	FDEP Residential Goals
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The range of parameters is expected to be below the selected action levels.

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(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone D - Truman Annex Seminole Battery, Former Grease Racks is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone D - Truman Annex Seminole Battery, Former Grease Racks is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone D - Truman Annex Seminole Battery, Former Grease Racks is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone D - Truman Annex Seminole Battery, Former Grease Racks is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

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The planning team has assumed a 5 percent decision error rate.

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Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

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The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

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Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone D - Truman Annex Seminole Battery

Subzone GRYZND-SZN3-- Groundwater-- Seminole Battery

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (fuels, oils, metals, solvents) from past military activities related to Seminole Battery and operation of former gas stations.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone D - Truman Annex Seminole Battery, Seminole Battery in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
  – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.
 (ii) Site visits (reports, drawings, maps, etc.)
  – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
 (iii) Current/on-going activities
(b) Existing groundwater analytical data
(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone D - Truman Annex Seminole Battery, Seminole Battery.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL– U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL– Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone D - Truman Annex Seminole Battery, Seminole Battery.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone D - Truman Annex Seminole Battery, Seminole Battery. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	Fl MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs
Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs
Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs

Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone D - Truman Annex Seminole Battery, Seminole Battery is not contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone D - Truman Annex Seminole Battery, Seminole Battery is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone D - Truman Annex Seminole Battery, Seminole Battery is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone D - Truman Annex Seminole Battery, Seminole Battery is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone E - Truman Annex Buildings 102, 103 and 104

Subzone GRYZNE-SZN1-- Soil-- Former Building Sites South End of Zone E

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metals, solvents, fuels) from former building operations and demolition debris.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
(i) Additional sampling
(ii) RI/FS
(iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
(i) Existing documents (reports, drawings, maps, etc.)
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
- U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.

(ii) Site visits (reports, drawings, maps, etc.)
- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.

- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals

Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites South End of Zone E is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone E - Truman Annex Buildings 102, 103 and 104

Subzone GRYZNE-SZN2-- Soil-- Former Building 136

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (debris, lead, metals, solvents, oils) from building operations from Plate and Mold Shop and demolished Building 136 buried onsite.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) further study is needed (e.g., additional sampling or place Subzone E in RI/FS or IRA and RI/FS program) or (2) no action will be taken.

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.

- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals

Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals

Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be above the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136 is contaminated.

(ii) Alternative Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136 is not contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136 is not contaminated when it truly is.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building 136 is contaminated when it truly is not.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone E - Truman Annex Buildings 102, 103 and 104
Subzone GRYZNE-SZN3-- Soil-- Buildings 102 and 104

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (acids, solvents, fuel) from building operations.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and Inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

No hypothesis was made

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
 - U.S. Navy - Naval Facilities Engineering Command (USN - NFEC). Contamination Assessment Report (CAR) Addendum for Electric Power Plant Building 103. 1993a.
 - U.S. Navy - Naval Facilities Engineering Command (USN - NFEC). Contamination Assessment Report (CAR) for Electric Power Plant Building 103. 1992a.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.

- U.S. Navy - Naval Facilities Engineering Command (USN - NFEC). Remedial Action Plan (RAP) for Electric Power Plant Building 103. 1994c.

(ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and Inorganics in soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 102 and 104.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and Inorganics being analyzed in the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 102 and 104.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 102 and 104. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals

Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

No hypothesis made.

No hypothesis made.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. No hypothesis made.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. No hypothesis made.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone E - Truman Annex Buildings 102, 103 and 104

Subzone GRYZNE-SZN4-- Soil-- Transformer Site near Building 675

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (PCBs) from former transformer site.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by SVOCs, PCBs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by SVOCs, PCBs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675 in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
  – U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
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 (ii) Site visits (reports, drawings, maps, etc.)
  – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
  – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
 (iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of SVOCs, PCBs, and inorganics in soil at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- PCBs; SW-846 Methods 8081/8082
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals– Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals– Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
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- FDEP Residential Goals– Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series– Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

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Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

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(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

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The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

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Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of SVOCs, PCBs, and inorganics being analyzed in the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

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Chromium	430	FDEP Industrial Goals
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Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
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Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
PCB Compounds (ug/kg)		
Aroclor-1016	3500	FDEP Industrial Goals
Aroclor-1221	3500	FDEP Industrial Goals
Aroclor-1232	3500	FDEP Industrial Goals
Aroclor-1242	3500	FDEP Industrial Goals
Aroclor-1248	3500	FDEP Industrial Goals
Aroclor-1254	3500	FDEP Industrial Goals
Aroclor-1260	3500	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
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2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
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3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals

Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675 is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675 is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675 is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Transformer Site near Building 675 is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone E - Truman Annex Buildings 102, 103 and 104

Subzone GRYZNE-SZN5-- Soil-- Former Building Sites North End of Zone E

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metals, solvents, fuels) from former building operations and their demolition debris.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.

- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals

Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Former Building Sites North End of Zone E is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone E - Truman Annex Buildings 102, 103 and 104
Subzone GRYZNE-SZN7-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (fuels, pcbs, oils, metals, solvents) from past industrial naval activities, demolition debris and possible releases from former and existing buildings.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) further study is needed (e.g., additional sampling or place Subzone E in RI/FS or IRA and RI/FS program) or (2) no action will be taken.

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.
  (ii) Site visits (reports, drawings, maps, etc.)
    – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
    – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone E - Truman Annex Buildings 102, 103 and 104.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL– U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL– Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal

results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone E - Truman Annex Buildings 102, 103 and 104.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	FI MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs

2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs
Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs

Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be above the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.

(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.

(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone E - Truman Annex Buildings 102, 103 and 104. is contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone E - Truman Annex Buildings 102, 103 and 104. is not contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone E - Truman Annex Buildings 102, 103 and 104. is not contaminated when it truly is.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone E - Truman Annex Buildings 102, 103 and 104. is contaminated when it truly is not.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone E - Truman Annex Buildings 102, 103 and 104
Subzone GRYZNE-SZN9-- Soil-- Buildings 103

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (fuel, oils, PCBs) from Building 103 used as a Power Plant.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, PCBs, and Inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
(i) Additional sampling
(ii) RI/FS
(iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, PCBs, and Inorganics) whether (1) further study is needed (e.g., additional sampling or place Subzone E in RI/FS or IRA and RI/FS program) or (2) no action will be taken.

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
(i) Existing documents (reports, drawings, maps, etc.)
(ii) Site visits (reports, drawings, maps, etc.)
(iii) Current/on-going activities
(b) Existing soil analytical data
(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, PCBs, and Inorganics in soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- PCBs; SW-846 Methods 8081/8082
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c

- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, PCBs, and Inorganics being analyzed in the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
PCB Compounds (ug/kg)		
Aroclor-1016	3500	FDEP Industrial Goals
Aroclor-1221	3500	FDEP Industrial Goals
Aroclor-1232	3500	FDEP Industrial Goals
Aroclor-1242	3500	FDEP Industrial Goals
Aroclor-1248	3500	FDEP Industrial Goals
Aroclor-1254	3500	FDEP Industrial Goals
Aroclor-1260	3500	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals

Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be above the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103 is contaminated.

(ii) Alternative Hypothesis: The soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103 is not contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103 is not contaminated when it truly is.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone E - Truman Annex Buildings 102, 103 and 104, Buildings 103 is contaminated when it truly is not.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone F - Truman Annex Building 223

Subzone GRYZNF-SZN1-- Soil-- Former Lube Area

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (fuels, used oils, solvents, metals from operations) from AST tanks (east side) supporting former garage facilities.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone F - Truman Annex Building 223, Former Lube Area in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
    – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.
  (ii) Site visits (reports, drawings, maps, etc.)
    – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  (iii) Current/on-going activities
(b) Existing soil analytical data
(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone F - Truman Annex Building 223, Former Lube Area.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone F - Truman Annex Building 223, Former Lube Area.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone F - Truman Annex Building 223, Former Lube Area. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	7100000	FDEP Residential Goals
2,4,6-trichlorophenol	87000	FDEP Residential Goals
2,4-dichlorophenol	220000	FDEP Residential Goals
2,4-dimethylphenol	1200000	FDEP Residential Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	130000	FDEP Residential Goals
2,6-dinitrotoluene	71000	FDEP Residential Goals
2-chloronaphthalene	560000	FDEP Residential Goals
2-chlorophenol	280000	FDEP Residential Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	960000	FDEP Residential Goals
2-methylphenol	2600000	FDEP Residential Goals
2-nitroaniline	4000	FDEP Residential Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	340000	FDEP Residential Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1.4E+08	FDEP Residential Goals
4-chloroaniline	240000	FDEP Residential Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	230000	FDEP Residential Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	2800000	FDEP Residential Goals
Acenaphthylene	670000	FDEP Residential Goals
Anthracene	20000000	FDEP Residential Goals
Benzo(a)anthracene	1400	FDEP Residential Goals
Benzo(a)pyrene	100	FDEP Residential Goals
Benzo(b)fluoranthene	1400	FDEP Residential Goals
Benzo(g,h,i)perylene	14000	FDEP Residential Goals
Benzo(k)fluoranthene	14000	FDEP Residential Goals
Bis(2-chloroethoxy)methane	170000	FDEP Residential Goals
Bis(2-chloroethyl)ether	500	FDEP Residential Goals
Bis(2-ethylhexyl)phthalate	48000	FDEP Residential Goals
Butyl benzyl phthalate	15000000	FDEP Residential Goals
Carbazole	42000	FDEP Residential Goals
Chrysene	140000	FDEP Residential Goals
Di-n-butyl phthalate	7300000	FDEP Residential Goals
Di-n-octyl phthalate	1500000	FDEP Residential Goals
Dibenzo(a,h)anthracene	100	FDEP Residential Goals
Dibenzofuran	240000	FDEP Residential Goals
Diethyl phthalate	56000000	FDEP Residential Goals
Dimethyl phthalate	6.3E+08	FDEP Residential Goals
Fluoranthene	2900000	FDEP Residential Goals
Fluorene	2400000	FDEP Residential Goals
Hexachlorobenzene	600	FDEP Residential Goals
Hexachlorobutadiene	3100	FDEP Residential Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	27000	FDEP Residential Goals

Indeno(1,2,3-cd)pyrene	1400	FDEP Residential Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	73000	FDEP Residential Goals
Naphthalene	1300000	FDEP Residential Goals
Nitrobenzene	22000	FDEP Residential Goals
Pentachlorophenol	5400	FDEP Residential Goals
Phenanthrene	1700000	FDEP Residential Goals
Phenol	34000000	FDEP Residential Goals
Pyrene	2200000	FDEP Residential Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	610000	FDEP Residential Goals
1,1,2,2-tetrachloroethane	900	FDEP Residential Goals
1,1,2-trichloroethane	2000	FDEP Residential Goals
1,1-dichloroethane	310000	FDEP Residential Goals
1,1-dichloroethene	100	FDEP Residential Goals
1,2-dichloroethane	700	FDEP Residential Goals
1,2-dichloropropane	800	FDEP Residential Goals
2-butanone	2200000	FDEP Residential Goals
2-hexanone	0	NA
4-methyl-2-pentanone	520000	FDEP Residential Goals
Acetone	260000	FDEP Residential Goals
Benzene	1400	FDEP Residential Goals
Bromodichloromethane	700	FDEP Residential Goals
Bromoform	65000	FDEP Residential Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	5200	FDEP Residential Goals
Carbon tetrachloride	600	FDEP Residential Goals
Chlorobenzene	44000	FDEP Residential Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	600	FDEP Residential Goals
Chloromethane	200	FDEP Residential Goals
cis-1,2-dichloroethene	26000	FDEP Residential Goals
cis-1,3-dichloropropene	300	FDEP Residential Goals
Dibromochloromethane	1200	FDEP Residential Goals
Ethylbenzene	1400000	FDEP Residential Goals
Methylene chloride	16000	FDEP Residential Goals
Styrene	4100000	FDEP Residential Goals
Tetrachloroethene	12000	FDEP Residential Goals
Toluene	520000	FDEP Residential Goals
trans-1,2-dichloroethene	62000	FDEP Residential Goals
trans-1,3-dichloropropene	300	FDEP Residential Goals
Trichloroethene	6500	FDEP Residential Goals
Vinyl chloride	5	FDEP Residential Goals
Xylenes, total	13000000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.

(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone F - Truman Annex Building 223, Former Lube Area is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone F - Truman Annex Building 223, Former Lube Area is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone F - Truman Annex Building 223, Former Lube Area is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone F - Truman Annex Building 223, Former Lube Area is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone F - Truman Annex Building 223

Subzone GRYZNF-SZN3-- Soil-- Building 223 Equipment Repair Shop

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metals, fuels, solvents) from use of building as an equipment repair shop, plumbing shop and neighboring hazardous waste storage area.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.
  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals– Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals– Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals– Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals– Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series– Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	7100000	FDEP Residential Goals
2,4,6-trichlorophenol	87000	FDEP Residential Goals
2,4-dichlorophenol	220000	FDEP Residential Goals
2,4-dimethylphenol	1200000	FDEP Residential Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	130000	FDEP Residential Goals
2,6-dinitrotoluene	71000	FDEP Residential Goals
2-chloronaphthalene	560000	FDEP Residential Goals
2-chlorophenol	280000	FDEP Residential Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	960000	FDEP Residential Goals
2-methylphenol	2600000	FDEP Residential Goals
2-nitroaniline	4000	FDEP Residential Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	340000	FDEP Residential Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1.4E+08	FDEP Residential Goals
4-chloroaniline	240000	FDEP Residential Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	230000	FDEP Residential Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	2800000	FDEP Residential Goals
Acenaphthylene	670000	FDEP Residential Goals
Anthracene	20000000	FDEP Residential Goals
Benzo(a)anthracene	1400	FDEP Residential Goals
Benzo(a)pyrene	100	FDEP Residential Goals
Benzo(b)fluoranthene	1400	FDEP Residential Goals
Benzo(g,h,i)perylene	14000	FDEP Residential Goals
Benzo(k)fluoranthene	14000	FDEP Residential Goals
Bis(2-chloroethoxy)methane	170000	FDEP Residential Goals
Bis(2-chloroethyl)ether	500	FDEP Residential Goals
Bis(2-ethylhexyl)phthalate	48000	FDEP Residential Goals
Butyl benzyl phthalate	15000000	FDEP Residential Goals
Carbazole	42000	FDEP Residential Goals
Chrysene	140000	FDEP Residential Goals
Di-n-butyl phthalate	7300000	FDEP Residential Goals
Di-n-octyl phthalate	1500000	FDEP Residential Goals
Dibenzo(a,h)anthracene	100	FDEP Residential Goals
Dibenzofuran	240000	FDEP Residential Goals
Diethyl phthalate	56000000	FDEP Residential Goals
Dimethyl phthalate	6.3E+08	FDEP Residential Goals
Fluoranthene	2900000	FDEP Residential Goals
Fluorene	2400000	FDEP Residential Goals

Hexachlorobenzene	600	FDEP Residential Goals
Hexachlorobutadiene	3100	FDEP Residential Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	27000	FDEP Residential Goals
Indeno(1,2,3-cd)pyrene	1400	FDEP Residential Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	73000	FDEP Residential Goals
Naphthalene	1300000	FDEP Residential Goals
Nitrobenzene	22000	FDEP Residential Goals
Pentachlorophenol	5400	FDEP Residential Goals
Phenanthrene	1700000	FDEP Residential Goals
Phenol	34000000	FDEP Residential Goals
Pyrene	2200000	FDEP Residential Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	610000	FDEP Residential Goals
1,1,2,2-tetrachloroethane	900	FDEP Residential Goals
1,1,2-trichloroethane	2000	FDEP Residential Goals
1,1-dichloroethane	310000	FDEP Residential Goals
1,1-dichloroethene	100	FDEP Residential Goals
1,2-dichloroethane	700	FDEP Residential Goals
1,2-dichloropropane	800	FDEP Residential Goals
2-butanone	2200000	FDEP Residential Goals
2-hexanone	0	NA
4-methyl-2-pentanone	520000	FDEP Residential Goals
Acetone	260000	FDEP Residential Goals
Benzene	1400	FDEP Residential Goals
Bromodichloromethane	700	FDEP Residential Goals
Bromoform	65000	FDEP Residential Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	5200	FDEP Residential Goals
Carbon tetrachloride	600	FDEP Residential Goals
Chlorobenzene	44000	FDEP Residential Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	600	FDEP Residential Goals
Chloromethane	200	FDEP Residential Goals
cis-1,2-dichloroethene	26000	FDEP Residential Goals
cis-1,3-dichloropropene	300	FDEP Residential Goals
Dibromochloromethane	1200	FDEP Residential Goals
Ethylbenzene	1400000	FDEP Residential Goals
Methylene chloride	16000	FDEP Residential Goals
Styrene	4100000	FDEP Residential Goals
Tetrachloroethene	12000	FDEP Residential Goals
Toluene	520000	FDEP Residential Goals
trans-1,2-dichloroethene	62000	FDEP Residential Goals
trans-1,3-dichloropropene	300	FDEP Residential Goals
Trichloroethene	6500	FDEP Residential Goals
Vinyl chloride	5	FDEP Residential Goals
Xylenes, total	13000000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop is not contaminated.
(ii) Alternative Hypothesis: The soil at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone F - Truman Annex Building 223, Building 223 Equipment Repair Shop is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone F - Truman Annex Building 223
Subzone GRYZNF-SZN7-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (fuels, oils, metals) from past operation of a waste oil ASTat Bldg. 1287, Electrical Maintenance Shop (Bldg. 223),former gas station (Bldg. 1276), and former lube area (adjacent to building 1287).

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone F - Truman Annex Building 223. in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Closure Report on Building 1276. 1995a.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Closure Report on Building 1287. 1996b.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P- 2536; Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. 1957e.

  (ii) Site visits (reports, drawings, maps, etc.)
  - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  - Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

  (iii) Current/on-going activities

(iii) Current/on-going activities

(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone F - Truman Annex Building 223.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL-- U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL-- Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone F - Truman Annex Building 223.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone F - Truman Annex Building 223. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	FI MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs
Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs

Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs
Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	Fl MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	Fl MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	Fl MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	Fl MCL
Styrene	100	MCL
Tetrachloroethene	3	Fl MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	Fl MCL
Vinyl chloride	1	Fl MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone F - Truman Annex Building 223. is not contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone F - Truman Annex Building 223. is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone F - Truman Annex Building 223. is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone F - Truman Annex Building 223. is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone G - Poinciana Housing

Subzone GRYZNG-SZN1-- Soil-- Poinciana Plaza Housing

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (lead) from resident structures and automobile releases.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone G - Poinciana Housing, Poinciana Plaza Housing in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
  – U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Poinciana Housing. 1995a.
  – CAPE Environmental Management, Inc.. Lead-Based Paint Survey of the Naval Family Housing Located at Poinciana Plaza. 1997.
  – U.S. Navy - Naval Facilities Engineering Command (USN - NFEC). Predraft EBS Poinciana Housing. 1996a.
 (ii) Site visits (reports, drawings, maps, etc.)
  – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
  – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
 (iii) Current/on-going activities
(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of inorganics in soil at Zone G - Poinciana Housing, Poinciana Plaza Housing.

- Metals; SW-846 Methods 6010a/6010b and 7000a series

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of inorganics being analyzed in the soil at Zone G - Poinciana Housing, Poi nciana Plaza Housing.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone G - Poinciana Housing, Poinciana Plaza Housing. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)

Aluminum	75000	FDEP Residential Goals
Antimony	26	FDEP Residential Goals
Arsenic	2.66	2x Avg Background
Barium	5200	FDEP Residential Goals
Beryllium	0.2	FDEP Residential Goals
Cadmium	37	FDEP Residential Goals
Calcium	0	NA
Chromium	290	FDEP Residential Goals
Cobalt	4700	FDEP Residential Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	500	FDEP Residential Goals
Magnesium	0	NA
Manganese	370	FDEP Residential Goals
Mercury	23	FDEP Residential Goals
Nickel	1500	FDEP Residential Goals
Potassium	0	NA
Selenium	390	FDEP Residential Goals
Silver	390	FDEP Residential Goals
Sodium	0	NA
Thallium	0	NA
Tin	44000	FDEP Residential Goals
Vanadium	490	FDEP Residential Goals
Zinc	23000	FDEP Residential Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone G - Poinciana Housing, Poinciana Plaza Housing is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone G - Poinciana Housing, Poinciana Plaza Housing is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone G - Poinciana Housing, Poinciana Plaza Housing is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone G - Poinciana Housing, Poinciana Plaza Housing is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone G - Poinciana Housing

Subzone GRYZNG-SZN2-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (lead, petroleum, solvents) from resident structures and automobiles releases.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone G - Poinciana Housing. in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
    – U.S. Navy - Naval Facilities Engineering Command (USN - NFEC). Predraft EBS Poinciana Housing. 1996a.
  (ii) Site visits (reports, drawings, maps, etc.)
    – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
    – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities
(b) Existing groundwater analytical data
(c) New groundwater analytical data
  Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone G - Poinciana Housing.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL– U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL– Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone G - Poinciana Housing.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone G - Poinciana Housing. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	Fl MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs
Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs
Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs

Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone G - Poinciana Housing. is not contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone G - Poinciana Housing. is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone G - Poinciana Housing. is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone G - Poinciana Housing. is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone H - Trumbo Point Piers D-1 & D-3
Subzone GRYZNH-SZN6-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination (solvents, metals) in groundwater at east end of Pier D-1 from leaky bilge line and from past use of Pier D-1 & D-3.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs and inorganics) whether (1) further study is needed (e.g., additional sampling or place Subzone H in RI/FS or IRA and RI/FS program) or (2) no action will be taken.

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
 - U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Trumbo Point Pier. 1995d.
 - U.S. Navy, Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment (USN - SUPSHIP). Predraft EBS Realignment Parcels; Environmental Baseline Survey. 1996.
 - U.S. Navy - Naval Facilities Engineering Command (USN - NFEC). Preliminary Contamination Assessment Report (CAR) for Trumbo Point Fuel Farm. 1994a.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. P-2573; Master Shore Station Development Plan Utilities Electrical Distribution, Dwg. No. P-2573 - 752928. 1957g.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg. (no dwg no.); Update of Master Shore Station Development Plan Utilities and Sanitary Sewerage and Gas Distribution, P-2538 - no dwg no.. 1983.

 (ii) Site visits (reports, drawings, maps, etc.)

(ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs and inorganics in groundwater at Zone H - Trumbo Point Piers D-1 & D-3.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL-- U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL-- Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs and inorganics being analyzed in the groundwater at Zone H - Trumbo Point Piers D-1 & D-3.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone H - Trumbo Point Piers D-1 & D-3. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	FI MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be above the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone H - Trumbo Point Piers D-1 & D-3. is contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone H - Trumbo Point Piers D-1 & D-3. is not contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone H - Trumbo Point Piers D-1 & D-3. is not contaminated when it truly is.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone H - Trumbo Point Piers D-1 & D-3. is contaminated when it truly is not.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

Zone K - Water Front Maintenance Facilities

Subzone GRYZNK-SZN1-- Soil-- Building 149 Port Operations and Hazardous Waste Storage Area

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metals, solvents, fuels, acids, used oils) from hazardous waste storage area activities and Bldg. 149 handling of hazardous materials.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.

 (ii) Site visits (reports, drawings, maps, etc.)

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals

Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals
Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area is not contaminated.
(ii) Alternative Hypothesis: The soil at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area is contaminated when it truly is not.
(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone K - Water Front Maintenance Facilities, Building 149 Port Operations and Hazardous Waste Storage Area is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone K - Water Front Maintenance Facilities

Subzone GRYZNK-SZN2-- Soil-- Remainder Public Works Maintenance Facilities

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metals, solvents, fuels, acids) from former building uses, former fuel lines and demolition debris.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
 - U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.

 (ii) Site visits (reports, drawings, maps, etc.)
 - Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in soil at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c-- 4-chlorophenyl phenyl ether
- Volatile Organic Compounds SW-846 Methods 8260a/8260b-- 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the soil at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)		
Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals
Semivolatile Organic Compounds (ug/kg)		
1,2,4-trichlorobenzene	780000	Residential Soil RBCs
2,4,5-trichlorophenol	1.3E+08	FDEP Industrial Goals
2,4,6-trichlorophenol	280000	FDEP Industrial Goals
2,4-dichlorophenol	4000000	FDEP Industrial Goals
2,4-dimethylphenol	16000000	FDEP Industrial Goals
2,4-dinitrophenol	160000	Residential Soil RBCs
2,4-dinitrotoluene	2000000	FDEP Industrial Goals
2,6-dinitrotoluene	1300000	FDEP Industrial Goals
2-chloronaphthalene	4000000	FDEP Industrial Goals
2-chlorophenol	3700000	FDEP Industrial Goals
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	8800000	FDEP Industrial Goals
2-methylphenol	32000000	FDEP Industrial Goals
2-nitroaniline	73000	FDEP Industrial Goals
2-nitrophenol	0	NA
3 & 4-methylphenol	5500000	FDEP Industrial Goals
3,3'-dichlorobenzidine	1400	Residential Soil RBCs
3-nitroaniline	230000	Residential Soil RBCs
4-bromophenyl phenyl ether	4500000	Residential Soil RBCs
4-chloro-3-methylphenol	1E+09	FDEP Industrial Goals
4-chloroaniline	3300000	FDEP Industrial Goals
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	4700000	FDEP Industrial Goals
4-nitrophenol	4800000	Residential Soil RBCs
Acenaphthene	30000000	FDEP Industrial Goals
Acenaphthylene	5600000	FDEP Industrial Goals
Anthracene	3E+08	FDEP Industrial Goals
Benzo(a)anthracene	4900	FDEP Industrial Goals
Benzo(a)pyrene	500	FDEP Industrial Goals
Benzo(b)fluoranthene	5000	FDEP Industrial Goals
Benzo(g,h,i)perylene	50000	FDEP Industrial Goals
Benzo(k)fluoranthene	48000	FDEP Industrial Goals
Bis(2-chloroethoxy)methane	3000000	FDEP Industrial Goals
Bis(2-chloroethyl)ether	900	FDEP Industrial Goals
Bis(2-ethylhexyl)phthalate	110000	FDEP Industrial Goals
Butyl benzyl phthalate	3.1E+08	FDEP Industrial Goals
Carbazole	120000	FDEP Industrial Goals
Chrysene	500000	FDEP Industrial Goals

Di-n-butyl phthalate	1.4E+08	FDEP Industrial Goals
Di-n-octyl phthalate	32000000	FDEP Industrial Goals
Dibenzo(a,h)anthracene	500	FDEP Industrial Goals
Dibenzofuran	3500000	FDEP Industrial Goals
Diethyl phthalate	9.7E+08	FDEP Industrial Goals
Dimethyl phthalate	1E+09	FDEP Industrial Goals
Fluoranthene	48000000	FDEP Industrial Goals
Fluorene	30000000	FDEP Industrial Goals
Hexachlorobenzene	1600	FDEP Industrial Goals
Hexachlorobutadiene	4900	FDEP Industrial Goals
Hexachlorocyclopentadiene	550000	Residential Soil RBCs
Hexachloroethane	120000	FDEP Industrial Goals
Indeno(1,2,3-cd)pyrene	5000	FDEP Industrial Goals
Isophorone	670000	Residential Soil RBCs
n-nitrosodiphenylamine	130000	FDEP Industrial Goals
Naphthalene	12000000	FDEP Industrial Goals
Nitrobenzene	250000	FDEP Industrial Goals
Pentachlorophenol	12000	FDEP Industrial Goals
Phenanthrene	21000000	FDEP Industrial Goals
Phenol	4.4E+08	FDEP Industrial Goals
Pyrene	41000000	FDEP Industrial Goals
Volatile Organic Compounds (ug/kg)		
1,1,1-trichloroethane	4300000	FDEP Industrial Goals
1,1,2,2-tetrachloroethane	1400	FDEP Industrial Goals
1,1,2-trichloroethane	3000	FDEP Industrial Goals
1,1-dichloroethane	2100000	FDEP Industrial Goals
1,1-dichloroethene	100	FDEP Industrial Goals
1,2-dichloroethane	1000	FDEP Industrial Goals
1,2-dichloropropane	1200	FDEP Industrial Goals
2-butanone	15000000	FDEP Industrial Goals
2-hexanone	0	NA
4-methyl-2-pentanone	3700000	FDEP Industrial Goals
Acetone	1800000	FDEP Industrial Goals
Benzene	2000	FDEP Industrial Goals
Bromodichloromethane	1000	FDEP Industrial Goals
Bromoform	130000	FDEP Industrial Goals
Bromomethane	110000	Residential Soil RBCs
Carbon disulfide	34000	FDEP Industrial Goals
Carbon tetrachloride	800	FDEP Industrial Goals
Chlorobenzene	300000	FDEP Industrial Goals
Chloroethane	31000000	Residential Soil RBCs
Chloroform	800	FDEP Industrial Goals
Chloromethane	300	FDEP Industrial Goals
cis-1,2-dichloroethene	180000	FDEP Industrial Goals
cis-1,3-dichloropropene	400	FDEP Industrial Goals
Dibromochloromethane	1700	FDEP Industrial Goals
Ethylbenzene	10000000	FDEP Industrial Goals
Methylene chloride	23000	FDEP Industrial Goals
Styrene	34000000	FDEP Industrial Goals
Tetrachloroethene	28000	FDEP Industrial Goals
Toluene	3500000	FDEP Industrial Goals
trans-1,2-dichloroethene	430000	FDEP Industrial Goals
trans-1,3-dichloropropene	400	FDEP Industrial Goals
Trichloroethene	9300	FDEP Industrial Goals
Vinyl chloride	7	FDEP Industrial Goals
Xylenes, total	92000000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities is not contaminated.

(ii) Alternative Hypothesis: The soil at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone K - Water Front Maintenance Facilities, Remainder Public Works Maintenance Facilities is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone K - Water Front Maintenance Facilities

Subzone GRYZNK-SZN3-- Soil-- Building 84

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in soil (metals) from Building 84 used as transportation pool.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the soil contaminated by inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
  (i) Additional sampling
  (ii) RI/FS
  (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not soil is contaminated (by inorganics) whether (1) further study is needed (e.g., additional sampling or place Subzone K in RI/FS or IRA and RI/FS program) or (2) no action will be taken.

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing soil analytical data
(c) New soil analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
  (i) Existing documents (reports, drawings, maps, etc.)
   – U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
   – U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
   – U.S. Navy - Navy Public Works Center (USN - NPWC). Lead and Asbestos Survey of Truman Pier. 1996.
   – U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
  (ii) Site visits (reports, drawings, maps, etc.)
   – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.
   – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
   – Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.
  (iii) Current/on-going activities

(iii) Current/on-going activities

(b) Existing soil analytical data

(c) New soil analytical data

Through the following analytical methods, the planning team needs to obtain measurements of inorganics in soil at Zone K - Water Front Maintenance Facilities, Building 84.

- Metals; SW-846 Methods 6010a/6010b and 7000a series

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Applicability of Soil Cleanup Goals for Florida, 1996a.
- FDEP Industrial Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.
- FDEP Residential Goals-- Florida Department of Environmental Protection (FDEP), Soil Cleanup Goals for Florida, 1995b.

(b) Guidance action levels

- Residential Soil RBCs-- U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Inorganics SW-846 Methods 6010a/6010b and 7000a Series-- Thallium

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Soil is assumed to be a homogeneous layer of the land surface. Therefore, soil typically will be found everywhere there is not an obstruction to the land surface such as a building, significant vegetation, concrete, or water. Soil extends down into the groundwater. In the Key West area, soil is typically found at the surface and is supported by underlying limestone 8 to 12 feet below the land surface.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the soil within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the soil within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the soil.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample soil could increase the cost of sampling. Special equipment such as a direct-push unit or power auger are required to take samples in surface soil.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the soil is less than the action level, soil will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the soil exceeds the action level, further study of the soil will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of inorganics being analyzed in the soil at Zone K - Water Front Maintenance Facilities, Building 84.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone K - Water Front Maintenance Facilities, Building 84. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (mg/kg)

Aluminum	1000000	FDEP Industrial Goals
Antimony	220	FDEP Industrial Goals
Arsenic	3.7	FDEP Industrial Goals
Barium	84000	FDEP Industrial Goals
Beryllium	1	FDEP Industrial Goals
Cadmium	600	FDEP Industrial Goals
Calcium	0	NA
Chromium	430	FDEP Industrial Goals
Cobalt	110000	FDEP Industrial Goals
Copper	3100	Residential Soil RBCs
Iron	23000	Residential Soil RBCs
Lead	1000	FDEP Industrial Goals
Magnesium	0	NA
Manganese	5500	FDEP Industrial Goals
Mercury	480	FDEP Industrial Goals
Nickel	26000	FDEP Industrial Goals
Potassium	0	NA
Selenium	9900	FDEP Industrial Goals
Silver	9000	FDEP Industrial Goals
Sodium	0	NA
Thallium	0	NA
Tin	670000	FDEP Industrial Goals
Vanadium	4800	FDEP Industrial Goals
Zinc	560000	FDEP Industrial Goals

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be above the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The soil at Zone K - Water Front Maintenance Facilities, Building 84 is contaminated.

(ii) Alternative Hypothesis: The soil at Zone K - Water Front Maintenance Facilities, Building 84 is not contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the soil at Zone K - Water Front Maintenance Facilities, Building 84 is not contaminated when it truly is.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the soil at Zone K - Water Front Maintenance Facilities, Building 84 is contaminated when it truly is not.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

For soil, the planning team has selected a gray region of 1.5 times the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. Based on this formula, the optimal number of soil samples is four.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach, a random sample design will be used to determine whether the soil is contaminated in excess of the action levels. Four discrete samples should be collected and analyzed at the laboratory. Sample locations will be randomly generated.

Zone K - Water Front Maintenance Facilities
Subzone GRYZNK-SZN5-- Groundwater

Step 1. State the Problem

(1) Planning Team Members

- Chuck Bryan- Brown and Root Environmental
- Scott Flickinger- Brown and Root Environmental
- Brian Lewis- Brown and Root Environmental
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(2) Decision Makers- NAS Key West Tier I Partnering Team

- Martha Berry- EPA Region IV
- Chuck Bryan- Brown and Root Environmental
- Jorge Caspary- FDEP
- Ron Demes- NAS Key West
- Roy Hoekstra- Bechtel
- Dudley Patrick- SOUTHDIV
- Phillip Williams- NAS Key West

(3) Problem Statement

Potential contamination in groundwater (fuels, oils, metals, solvents) from past industrial naval activities, demolition debris and management of hazardous waste at Zone K.

(4) Available Resources and Deadlines

Budget-	$200,000
Deadline-	9/29/97
Personnel-	Listed above as Planning Team and Decision Makers
Guidance-	DQO Process (EPA QA/G-4); Data Quality Assessment (EPA QA/G-9)
Site Knowledge-	RFI/RI and CMS fieldwork; EBS; RAB Meeting Support
Experience-	Prior workplan review and preparation experience on the part of Planning Team and Decision Makers

Step 2. Identify the Decision

(1) Principal study question

Is the groundwater contaminated by VOCs, SVOCs, and inorganics?

(2) Alternative actions that could result from resolution of the principal question

(a) No further action
(b) Further action
 (i) Additional sampling
 (ii) RI/FS
 (iii) IRA and RI/FS

(3) Decision Statement

Determine whether or not groundwater is contaminated (by VOCs, SVOCs, and inorganics) whether (1) no action will be taken or (2) further study is needed (e.g., additional sampling or place Zone K - Water Front Maintenance Facilities. in RI/FS or IRA and RI/FS program).

Step 3. Identify the Inputs to the Decision

(1) Information needed to resolve the decision

(a) Background information on site
(b) Existing groundwater analytical data
(c) New groundwater analytical data
(d) Statistical analyses

(2) Sources of the information needed to resolve the decision

(a) Background Information
 (i) Existing documents (reports, drawings, maps, etc.)
 – U.S. Navy - Naval Air Station (USN - NAS) Key West. Condition Map of NAS Key West, No drawing number. 1942.
 – U.S. Navy - Naval Air Station (USN - NAS) Key West. Draft EBS Truman Annex Outer Mole Pier 8/Bldgs 149, 1374, 4080. 1997a.
 – U.S. Navy - Naval Air Station (USN - NAS) Key West. Predraft EBS Truman Annex; Excess Property. 1996d.
 – U.S. Navy - Naval Air Station (USN - NAS) Key West. PWO Dwg No. 2534; Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. 1957c.
 (ii) Site visits (reports, drawings, maps, etc.)
 – Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1997a.

- Brown and Root Environmental (B&R Environmental). B&RE/Navy Site Visit. 1996a.
- Brown and Root Environmental (B&R Environmental). Partners Site Visit and Teleconference. 1997b.

(iii) Current/on-going activities

(b) Existing groundwater analytical data

(c) New groundwater analytical data

Through the following analytical methods, the planning team needs to obtain measurements of VOCs, SVOCs, and inorganics in groundwater at Zone K - Water Front Maintenance Facilities.

- Metals; SW-846 Methods 6010a/6010b and 7000a series
- Semivolatile Organic Compounds; SW-846 Methods 8270b/8270c
- Volatile Organic Compounds; SW-846 Methods 8260a/8260b

(d) Statistical Analyses

(i) Student's t-test

(ii) Variance of background data set

(3) Information necessary for establishing action levels

(a) Legal action levels

- MCL– U. S. Environmental Protection Agency (EPA), Drinking Water Regulations and Health Advisories, 1996a.
- FL MCL– Florida Department of Environmental Protection (FDEP), Drinking Water Standards, Monitoring and Reporting, 1995a.

(b) Guidance action levels

- Tap Water RBCs– U. S. Environmental Protection Agency (EPA), Risk-Based Concentration Table, 1997.

(c) Background Concentrations

A subset of applicable background data has been extracted from the Comprehensive Background Report for NAS Key West (Appendix H of the Supplemental RFI/RI for Eight Sites, 1997).

(4) Measurement Methods for Analytical data

The appropriate measurement methods have been selected, as stated above. In order to adequately resolve the decision, method detection limits must be less than action levels. This will be ensured by supplying the selected action levels with the statement of laboratory Statement of Work. In the event that it is not is not technically possible to achieve a low enough MDL for a given parameter with the selected method, the partnering team will evaluate the results on a case-by-case basis, using frequency of detection to determine whether detected concentrations represent significant contamination. Action levels were not available for some parameters, as shown below. Regardless of MDL, these parameters will require an individual evaluation, if detected.

- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-chloronaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methyl-4,6-dinitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-methylnaphthalene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 2-nitrophenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chloro-3-methylphenol
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– 4-chlorophenyl phenyl ether
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Acenaphthylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Benzo(g,h,i)perylene
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Bis(2-chloroethoxy)methane
- Semivolatile Organic Compounds SW-846 Methods 8270b/8270c– Phenanthrene
- Volatile Organic Compounds SW-846 Methods 8260a/8260b– 2-hexanone

Step 4. Define the Study Boundaries

(1) Characteristics that define the population of interest

Groundwater is assumed to be a homogeneous body of water found beneath the land surface. Therefore, groundwater typically will be found beneath the land surface of a soil subzone. The typical depth to groundwater at NAS Key West is three feet.

(2) Spatial boundary of the decision statement

(a) Define the geographic area to which the decision statement applies.

Decisions apply to the groundwater within the subzone.

(b) When appropriate, divide the population into strata that have relatively homogeneous characteristics.

Stratification is not necessary since the groundwater within the subzone is assumed to homogeneous.

(3) Temporal boundary of the decision statement

(a) Determine the timeframe to which the decision applies.

It will be assumed that the sample data represents the current concentration of chemicals present within the groundwater.

(b) Determine when to collect data.

Samples will be collected during the daylight hours.

(4) Scale of the decision statement

The scale of the decision-making will be at the subzone level.

(5) Physical constraints on data collection

The ability to easily sample groundwater could increase the cost of sampling. Special equipment such as a direct-push unit, power auger or drilling rig are required to take samples in groundwater. During the recent RFI/RI, turbidity of groundwater interfered with metal results. Low-flow sampling will be conducted and turbidity closely monitored to minimize this problem.

Step 5. Develop a Decision Rule

Decision Rule

If the mean chemical concentration in the groundwater is less than the action level, groundwater will be considered uncontaminated and no action will be taken. If the mean chemical concentration in the groundwater exceeds the action level, further study of the groundwater will be considered.

The following elements will be considered in the development of the decision rule:

(1) The statistical parameter that characterizes the population of interest

The planning team is interested in the mean concentration of VOCs, SVOCs, and inorganics being analyzed in the groundwater at Zone K - Water Front Maintenance Facilities.

(2) The action levels for the study

Various sources of information were used in defining the appropriate action level for each parameter.For VOCs, SVOCs, and PCBs, the most conservative legal requirement will be adopted as the action level. In the event that no legal level has been established, the most conservative guidance level will be employed. For inorganics commonly detected in background in the vicinity of NAS Key West, twice the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. Likewise for pesticide compounds detected in background, the mean background concentration will be used as the action level, unless the most conservative legal requirement (or guidance value, in the event a legal level has not been established) is higher. In the event that no legal, guidance or background concentrations are available for a parameter, the planning team needs to agree on a reasonable basis for action. Based on the criteria discussed here, action levels have been selected for each of the parameters that will be evaluated at Zone K - Water Front Maintenance Facilities. Parameters which may specifically require the attention of the planning team are identified here with the notation 'NA' and are also presented in Step 3 under 'Measurement methods for analytical data'.

Inorganics (ug/l)		
Aluminum	37000	Tap Water RBCs
Antimony	6	MCL
Arsenic	50	MCL
Barium	2000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Calcium	0	NA
Chromium	100	MCL
Cobalt	2200	Tap Water RBCs
Copper	1500	Tap Water RBCs
Iron	11000	Tap Water RBCs
Lead	15	MCL
Magnesium	0	NA
Manganese	840	Tap Water RBCs
Mercury	2	MCL
Nickel	100	MCL
Potassium	0	NA
Selenium	50	MCL
Silver	180	Tap Water RBCs
Sodium	160000	FI MCL
Thallium	4.62	2x Avg Background
Tin	22000	Tap Water RBCs
Vanadium	260	Tap Water RBCs
Zinc	11000	Tap Water RBCs

Semivolatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	70	MCL
2,4,5-trichlorophenol	3700	Tap Water RBCs
2,4,6-trichlorophenol	6.1	Tap Water RBCs
2,4-dichlorophenol	110	Tap Water RBCs
2,4-dimethylphenol	730	Tap Water RBCs
2,4-dinitrophenol	73	Tap Water RBCs
2,4-dinitrotoluene	73	Tap Water RBCs
2,6-dinitrotoluene	37	Tap Water RBCs
2-chloronaphthalene	0	NA
2-chlorophenol	180	Tap Water RBCs
2-methyl-4,6-dinitrophenol	0	NA
2-methylnaphthalene	0	NA
2-methylphenol	1800	Tap Water RBCs
2-nitroaniline	2.2	Tap Water RBCs
2-nitrophenol	0	NA
3 & 4-methylphenol	1800	Tap Water RBCs
3,3'-dichlorobenzidine	0.15	Tap Water RBCs
3-nitroaniline	110	Tap Water RBCs
4-bromophenyl phenyl ether	2100	Tap Water RBCs
4-chloro-3-methylphenol	0	NA
4-chloroaniline	150	Tap Water RBCs
4-chlorophenyl phenyl ether	0	NA
4-nitroaniline	110	Tap Water RBCs
4-nitrophenol	2300	Tap Water RBCs
Acenaphthene	2200	Tap Water RBCs
Acenaphthylene	0	NA
Anthracene	11000	Tap Water RBCs
Benzo(a)anthracene	0.092	Tap Water RBCs
Benzo(a)pyrene	0.2	MCL
Benzo(b)fluoranthene	0.092	Tap Water RBCs
Benzo(g,h,i)perylene	0	NA
Benzo(k)fluoranthene	0.92	Tap Water RBCs
Bis(2-chloroethoxy)methane	0	NA
Bis(2-chloroethyl)ether	0.0092	Tap Water RBCs

Bis(2-ethylhexyl)phthalate	6	MCL
Butyl benzyl phthalate	7300	Tap Water RBCs
Carbazole	3.4	Tap Water RBCs
Chrysene	9.2	Tap Water RBCs
Di-n-butyl phthalate	3700	Tap Water RBCs
Di-n-octyl phthalate	730	Tap Water RBCs
Dibenzo(a,h)anthracene	0.0092	Tap Water RBCs
Dibenzofuran	150	Tap Water RBCs
Diethyl phthalate	29000	Tap Water RBCs
Dimethyl phthalate	370000	Tap Water RBCs
Fluoranthene	1500	Tap Water RBCs
Fluorene	1500	Tap Water RBCs
Hexachlorobenzene	1	MCL
Hexachlorobutadiene	0.14	Tap Water RBCs
Hexachlorocyclopentadiene	50	MCL
Hexachloroethane	0.75	Tap Water RBCs
Indeno(1,2,3-cd)pyrene	0.092	Tap Water RBCs
Isophorone	71	Tap Water RBCs
n-nitrosodiphenylamine	14	Tap Water RBCs
Naphthalene	1500	Tap Water RBCs
Nitrobenzene	3.4	Tap Water RBCs
Pentachlorophenol	1	MCL
Phenanthrene	0	NA
Phenol	22000	Tap Water RBCs
Pyrene	1100	Tap Water RBCs
Volatile Organic Compounds (ug/l)		
1,1,1-trichloroethane	200	MCL
1,1,2,2-tetrachloroethane	0.052	Tap Water RBCs
1,1,2-trichloroethane	5	MCL
1,1-dichloroethane	810	Tap Water RBCs
1,1-dichloroethene	7	MCL
1,2-dichloroethane	3	FI MCL
1,2-dichloropropane	5	MCL
2-butanone	1900	Tap Water RBCs
2-hexanone	0	NA
4-methyl-2-pentanone	2900	Tap Water RBCs
Acetone	3700	Tap Water RBCs
Benzene	1	FI MCL
Bromodichloromethane	100	MCL
Bromoform	100	MCL
Bromomethane	8.7	Tap Water RBCs
Carbon disulfide	1000	Tap Water RBCs
Carbon tetrachloride	3	FI MCL
Chlorobenzene	100	MCL
Chloroethane	8600	Tap Water RBCs
Chloroform	100	MCL
Chloromethane	1.4	Tap Water RBCs
cis-1,2-dichloroethene	70	MCL
cis-1,3-dichloropropene	0.077	Tap Water RBCs
Dibromochloromethane	100	MCL
Ethylbenzene	700	MCL
Methylene chloride	5	FI MCL
Styrene	100	MCL
Tetrachloroethene	3	FI MCL
Toluene	1000	MCL
trans-1,2-dichloroethene	100	MCL
trans-1,3-dichloropropene	0.077	Tap Water RBCs
Trichloroethene	3	FI MCL
Vinyl chloride	1	FI MCL
Xylenes, total	10000	MCL

Step 6. Specify Tolerable Limits on Decision Errors

(1) Possible range of the parameter of interest

The range of parameters is expected to be below the selected action levels.

(2) Identify the decision errors and choose the null hypothesis

(a) Possible decision errors

(i) Deciding that the subzone is contaminated when it truly is not.
(ii) Deciding that the subzone is not contaminated when it truly is.

(b) True state of nature for each decision error

(i) The true state of nature for decision error (i) is that the subzone is not contaminated.
(ii) The true state of nature for decision error (ii) is that the subzone is contaminated.

(c) Potential consequences of each decision error

(i) The potential consequences of deciding that the subzone is contaminated when it truly is not include the expenditure of money and effort on additional studies, monitoring, or remediation when they are not really necessary. Additionally, the Navy will have to delay realignment of the site until the issue of the potential contamination is properly addressed and resolved.
(ii) The potential consequences of deciding that the subzone is not contaminated when it really is will be that the Navy may realign a property that contains levels of contamination that could possibly endanger human health or the environment. In this situation, the Navy may be liable for future damages and environmental cleanup costs. Also, the reputation of the Navy might be damaged.

(d) Which decision error has more severe consequences near the action level?

Decision error (ii) has more severe consequences near the action level since the risk of jeopardizing human health outweighs the consequences of additional expense to the Navy.

(e) Define the null hypothesis and the alternative hypothesis

(i) Null Hypothesis: The groundwater at Zone K - Water Front Maintenance Facilities. is not contaminated.

(ii) Alternative Hypothesis: The groundwater at Zone K - Water Front Maintenance Facilities. is contaminated.

(f) Assignment of terms "false positive" and "false negative" to the appropriate decision error

(i) A false positive occurs when the null hypothesis is rejected but is actually true. In this case, a false positive decision error occurs when the decision maker decides that the groundwater at Zone K - Water Front Maintenance Facilities. is contaminated when it truly is not.

(ii) A false negative occurs when the null hypothesis is not rejected but is truly false. In this case, a false negative decision error occurs when the decision maker decides that the groundwater at Zone K - Water Front Maintenance Facilities. is not contaminated when it truly is.

(3) Range of possible values of parameters of interest where the consequences of decision errors are relatively minor (gray region)

Since legally binding action levels exist for groundwater, a gray zone above the action level is not acceptable. However, for the purposes of statistical analysis, the planning team has established a gray region of one-half the action level below the action level for each parameter.

(4) Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors

The planning team has assumed a 5 percent decision error rate.

Step 7. Optimize the Design

(1) Review the DQO outputs and existing environmental data

Because the statistician has participated in the DQO process for this problem, there is no need to review the DQO outputs further.

(2) Develop general data collection design alternatives

Simple random sampling will be used except in areas where site history or existing data indicate a likely area of contamination that will require a biased approach to sample design.

(3) For each data collection design alternative, select the optimal sample size that satisfies the DQOs

The formula for determining the sample size is chosen based on the hypothesis test and data collection design. The Gilbert's equation is the standard formula utilized to select the optimal sample size. For groundwater, a minimum of three samples will be taken in order to perform a meaningful statistical analysis of the sample data. Gilbert's equation calculated that two groundwater samples were necessary with a gray region of 1.5 times the action level for each parameter.

(4) Select the most resource-effective data collection design that satisfies the DQOs

Simple random sampling will be performed in the subzone based on the number of samples determined by Gilbert's equation. This is the only method that meets the DQOs established for this project.

(5) Document the operational details and theoretical sampling assumptions of the selected design in the sampling and analysis plan

Approximately nine screening samples will be randomly placed unless site history or existing data indicate a probable area of contamination that would be best delineated through a biased approach. The three permanent monitoring wells will be placed in order to best delineate possible contamination based on the screening sample results.

References

Baudo, R., J. Geisy, and H. Muntau (eds.), 1990. *Sediments: Chemistry and Toxicity of In-Place Pollutants.*

B&R Environmental (Brown & Root Environmental), 1996a. B&RE/Navy Site Visit. November.

B&R Environmental (Brown & Root Environmental), 1997a. B&RE/Navy Site Visit. March.

B&R Environmental (Brown & Root Environmental), 1997b. Partners Site Visit and Teleconference. May.

Code of Federal Regulations, 1990. 40 CFR Part 264 -- Proposed RCRA Action Levels. July 27.

EPA (U. S. Environmental Protection Agency), 1991. *Water Quality Criteria Summary*. May.

EPA (U. S. Environmental Protection Agency), 1995a. *EPA Region III BTAG Screening Levels.*

EPA (U. S. Environmental Protection Agency), 1995b. *Supplemental Guidance to RAGs: Region 4 Bulletins-- Ecological Risk Assessment.*

EPA (U. S. Environmental Protection Agency), 1996a. *Drinking Water Regulations and Health Advisories*. October.

EPA (U. S. Environmental Protection Agency), 1996b. *ECO Update*, EPA 540/F-95/038.

EPA (U. S. Environmental Protection Agency), 1997. *Risk-Based Concentration Table*. March.

FDEP (Florida Department of Environmental Protection), 1994a. *Approach to the Assessment of Sediment Quality in Florida Coastal Waters: Volume 1- Development and Evaluation of Sediment Quality Assessment Guidelines.*

FDEP (Florida Department of Environmental Protection), 1994b. *Groundwater Guidance Concentrations*. June.

FDEP (Florida Department of Environmental Protection), 1995a. *Drinking Water Standards, Monitoring and Reporting, Chapter 62-550.*

FDEP (Florida Department of Environmental Protection), 1995b. *Soil Cleanup Goals for Florida.* September.

FDEP (Florida Department of Environmental Protection), 1996a. *Applicability of Soil Cleanup Goals for Florida*. January.

FDEP (Florida Department of Environmental Protection), 1996b. *Surface Water Quality Standards, Chapter 62-302*. July 16.

Hull, R. N., and G. W. Suter, 1994. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota.*

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder, 1995. *Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments*, 19:81-97.

OME (Ontario Ministry of the Environment), 1992. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.*

USN - NAS (U.S. Navy - Naval Air Station Key West), 1942. Condition Map of NAS Key West. June 30.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957a. PWO Drawing of Master Shore Station Development Plan, Dwg. No. P-2530. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957b. PWO Drawing of Master Shore Station Development Plan Utilities Sanitary Sewerage and Gas Distribution, Dwg. No. P-2578 - 752933. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957c. PWO Drawing No. P-2534 of Master Shore Station Development Plan; Utilities Distilled and Softened Water, Dwg. No. P-2534 - 752889. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957d. PWO Drawing No. P-2538 of Master Shore Station Development Plan; Utilities Sanitary Sewerage and Gas Distribution, Dwg. No. P-2538 - 752893. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957e. PWO Drawing No. P- 2536 of Master Shore Station Development Plan; Utilities Fresh/Salt Water Distribution, Dwg. No. P-2536 - 752891. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957f. PWO Drawing No. P-2542 of Master Shore Station Development Plan; Electrical Distribution, Dwg. No. P-2542. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1957g. PWO Drawing No. P-2573 of Master Shore Station Development Plan; Utilities Electrical Distribution, Dwg. No. P-2573 - 752928. January 31.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1963a. Y&D Drawing of Battery Sites; International Airport Electrical Site Plan; Dwg. No. 1022223. February 17.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1963b. Y&D Drawing of Battery Sites; International Airport Location of Utilities, Dwg. No. 1022184. December 23.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1980. Y&D Drawing, Drawing No. 5074825. November 12.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1983. PWO Drawing Update of Master Shore Station Development Plan; Utilities and Sanitary Sewerage and Gas Distribution, P-2538. June 27.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1994. *Environmental Baseline Survey for Trumbo Road Easement*. September 18.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1995a. *Closure Report on Building 1276*. December 5.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1995b. *UST Closure Report*. September 12.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1996a. *Building 1287 Closure Report*. June.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1996b. Closure Report on Building 1287. June.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1996c. *I01 and I02 Closure Report; Tank Management Plan Inner and Outer Mole Tanks*; Project # 37147. June 17.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1996d. *Predraft EBS Truman Annex; Excess Property*. October.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1997a. *Draft EBS Truman Annex Outer Mole Pier 8/Bldgs. 149, 1374, 4080.* April.

USN - NAS (U.S. Navy - Naval Air Station Key West), 1997b. Y&D Drawing, Dwg. No. 91645. March.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1992a. *Contamination Assessment Report (CAR) for Electric Power Plant Building 103*. September.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1992b. *Contamination Assessment Report (CAR) for Berthing Wharf Bldg. 189*. February.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1993a. *Contamination Assessment Report (CAR) Addendum for Electric Power Plant Building 103*. September.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1993b. *Contamination Assessment Report (CAR) Addendum for Berthing Wharf Bldg. 189*. November.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1994a. *Preliminary Contamination Assessment Report (CAR) for Trumbo Point Fuel Farm*. May.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1994b. *Remedial Action Plan (RAP) for Berthing Wharf Bldg. 189*. August.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1994c. *Remedial Action Plan (RAP) for Electric Power Plant Building 103*. August.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1996a. *Predraft EBS Poinciana Housing*. October.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1996b. *NPWC Pensacola Lead Report*. May 22.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1996c. *Contamination Assessment Report (CAR) for Trumbo Point Fuel Farm*. October.

USN - NFEC (U.S. Navy - Naval Facilities Engineering Command), 1997. *CAPE Lead Report*. March.

USN - NPWC (U.S. Navy - Navy Public Works Center), 1995a. *Lead and Asbestos Survey of Poinciana Housing*. May 22.

USN - NPWC (U.S. Navy - Navy Public Works Center), 1995b. *Lead and Asbestos Survey of East Martello Battery*. May 22.

USN - NPWC (U.S. Navy - Navy Public Works Center), 1995c. *Lead and Asbestos Survey of Hawk Missile Site*. May 22.

USN - NPWC (U.S. Navy - Navy Public Works Center), 1995d. *Lead and Asbestos Survey of Trumbo Point Pier*. May 22.

USN - NPWC (U.S. Navy - Navy Public Works Center), 1996. *Lead and Asbestos Survey of Truman Pier*. May 22.

USN - SUPSHIP (U.S. Navy - Supervisor of Shipbuilding Conversion, and Repair, Environmental Detachment), 1996. *Predraft EBS Realignment Parcels; Environmental Baseline Survey*. October.

Will, M. E. and G. W. Suter, 1995. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil Litter Invertebrates and Heterotrophic Process*.

Appendix B

Part 3 - NAS Key West Base Realignment and Closure Background Data Subset

BRAC Background Samples
Soil Data Set

BG 1

BG1SS-01	BG1SS-01	B&RE	0 ft

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	3620	
Antimony	0.58	U
Arsenic	2.7	U
Barium	13	
Beryllium	0.07	U
Cadmium	0.41	
Chromium	5.8	
Cobalt	0.29	
Copper	5.1	
Cyanide	1.2	U
Iron	1710	
Lead	10.5	
Manganese	33.7	
Mercury	0.07	U
Nickel	2	
Selenium	1.1	U
Silver	0.16	U
Thallium	1	UJ
Tin	4.91	U
Vanadium	3.6	
Zinc	5.9	
Pesticides/PCBs (µg/kg)		
2,4,5-T	54.8	U
2,4,5-TP (silvex)	27.4	U
2,4-D	54.8	U
Chlorobenzilate	2280	U
Dimethoate	2280	U
Dinoseb	455	U
Disulfoton	455	U
Famphur	455	U
Isodrin	455	U
Kepone	455	U
Sulfotep	455	U
Thionazin	455	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	455	U
1,2,4-trichlorobenzene	455	U
1,2-dichlorobenzene	455	U
1,3,5-trinitrobenzene	2280	U
1,3-dichlorobenzene	455	U
1,3-dinitrobenzene	455	U
1,4-dichlorobenzene	455	U
1,4-dioxane	455	U
1,4-naphthoquinone	455	U
1-naphthylamine	455	U
2,3,4,6-tetrachlorophenol	455	U
2,4,5-trichlorophenol	455	U

PARAMETER	RESULT	QUAL
2,4,6-trichlorophenol	455	U
2,4-dichlorophenol	455	U
2,4-dimethylphenol	455	U
2,4-dinitrophenol	910	U
2,4-dinitrotoluene	455	U
2,6-dichlorophenol	455	U
2,6-dinitrotoluene	455	U
2-acetylaminofluorene	455	U
2-chloronaphthalene	455	U
2-chlorophenol	455	U
2-methyl-4,6-dinitrophenol	455	U
2-methylnaphthalene	455	U
2-methylphenol	455	U
2-naphthylamine	455	UR
2-nitroaniline	455	U
2-nitrophenol	455	U
2-picoline	455	U
3 & 4-methylphenol	455	U
3,3'-dichlorobenzidine	2280	U
3,3'-dimethylbenzidine	2280	UR
3-methylcholanthrene	455	U
3-nitroaniline	455	U
4-aminobiphenyl	455	U
4-bromophenyl phenyl ether	455	U
4-chloro-3-methylphenol	455	U
4-chloroaniline	455	UR
4-chlorophenyl phenyl ether	455	U
4-nitroaniline	455	U
4-nitrophenol	455	U
4-nitroquinoline-1-oxide	455	U
5-nitro-o-toluidine	455	U
7,12-dimethylbenz(a)anthracene	455	U
a,a-dimethylphenethylamine	455	UR
Acenaphthene	455	U
Acenaphthylene	455	U
Acetophenone	455	U
Aniline	455	U
Anthracene	455	U
Aramite	455	U
Benzo(a)anthracene	455	U
Benzo(a)pyrene	455	U
Benzo(b)fluoranthene	455	U
Benzo(g,h,i)perylene	455	U
Benzo(k)fluoranthene	455	U
Benzyl alcohol	455	U
Bis(2-chloroethoxy)methane	455	U
Bis(2-chloroethyl)ether	455	U
Bis(2-ethylhexyl)phthalate	455	U
Butyl benzyl phthalate	455	U
Chrysene	455	U

PARAMETER	RESULT	QUAL
Di-n-butyl phthalate	455	U
Di-n-octyl phthalate	455	U
Diallate	455	U
Dibenzo(a,h)anthracene	455	U
Dibenzofuran	455	U
Diethyl phthalate	455	U
Dimethyl phthalate	455	U
Diphenylamine	455	U
Ethyl methacrylate	455	U
Ethyl methanesulfonate	455	U
Fluoranthene	455	U
Fluorene	455	U
Hexachlorobenzene	455	U
Hexachlorobutadiene	455	U
Hexachlorocyclopentadiene	455	U
Hexachloroethane	455	U
Hexachloropropene	455	U
Indeno(1,2,3-cd)pyrene	455	U
Isophorone	455	U
Isosafrole	455	U
Methapyrilene	2280	U
Methyl methanesulfonate	455	U
N-nitroso-di-n-butylamine	455	U
N-nitroso-di-n-propylamine	455	U
N-nitrosodiethylamine	455	U
N-nitrosodimethylamine	455	U
N-nitrosodiphenylamine	455	U
N-nitrosomethylethylamine	455	U
N-nitrosomorpholine	455	U
N-nitrosopiperidine	455	U
N-nitrosopyrrolidine	455	U
Naphthalene	455	U
Nitrobenzene	455	U
o,o,o-triethylphosphorothioate	455	U
o-toluidine	455	U
p-dimethylaminoazobenzene	455	U
p-phenylenediamine	910	U
Pentachlorobenzene	455	U
Pentachloroethane	455	U
Pentachloronitrobenzene	455	U
Pentachlorophenol	455	U
Phenacetin	455	U
Phenanthrene	455	U
Phenol	455	U
Pronamide	455	U
Pyrene	455	U
Pyridine	455	U
Safrole	455	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	3	U

PARAMETER	RESULT	QUAL
1,1,1-trichloroethane	3	U
1,1,2,2-tetrachloroethane	3	U
1,1,2-trichloroethane	3	U
1,1-dichloroethane	3	U
1,1-dichloroethene	3	U
1,2,3-trichloropropane	3	U
1,2-dibromo-3-chloropropane	3	U
1,2-dibromoethane	3	U
1,2-dichloroethane	3	U
1,2-dichloropropane	3	U
2-butanone	7	U
2-chloro-1,3-butadiene	3	U
2-hexanone	7	U
3-chloropropene	14	U
4-methyl-2-pentanone	7	U
Acetone	3	U
Acetonitrile	14	U
Acrolein	27	UR
Acrylonitrile	27	U
Benzene	3	U
Bis(2-chloroisopropyl)ether	27	U
Bromodichloromethane	3	U
Bromoform	3	U
Bromomethane	3	U
Carbon disulfide	7	U
Carbon tetrachloride	3	U
Chlorobenzene	3	U
Chloroethane	3	U
Chloroform	3	U
Chloromethane	4	
Cis-1,3-dichloropropene	3	U
Dibromochloromethane	3	U
Dibromomethane	3	U
Dichlorodifluoromethane	3	U
Ethyl cyanide	27	UR
Ethylbenzene	3	U
Iodomethane	7	U
Isobutanol	27	U
Methacrylonitrile	14	U
Methyl methacrylate	14	U
Methylene chloride	0.11	J
Styrene	3	U
Tetrachloroethene	3	U
Toluene	3	U
Trans-1,2-dichloroethene	3	U
Trans-1,3-dichloropropene	3	U
Trans-1,4-dichloro-2-butene	14	U
Trichloroethene	3	U
Trichlorofluoromethane	3	U
Vinyl acetate	7	U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Vinyl chloride	3	U
Xylenes, total	8	U
BG1SS-02 BG1SS-02 B&RE	**0 ft**	
Inorganics (mg/kg)		
Aluminum	3950	
Antimony	0.49	U
Arsenic	0.95	
Barium	15.6	
Beryllium	0.06	U
Cadmium	0.08	U
Chromium	5.5	
Cobalt	0.32	J
Copper	4.3	J
Cyanide	0.23	U
Iron	1730	
Lead	6.1	J
Manganese	28.1	J
Mercury	0.06	U
Nickel	2.1	
Selenium	0.9	UJ
Silver	0.13	U
Thallium	0.84	UJ
Vanadium	3.7	
Zinc	6.5	J
Pesticides/PCBs (µg/kg)		
2,4,5-T	50	UJ
2,4,5-TP (silvex)	25	UJ
2,4-D	50	UJ
4,4'-DDD	1.6	U
4,4'-DDE	53.3	
4,4'-DDT	2.6	J
Aldrin	0.83	U
alpha-BHC	0.83	U
Aroclor-1016	5.2	U
Aroclor-1221	5.2	U
Aroclor-1232	5.2	U
Aroclor-1242	5.2	U
Aroclor-1248	5.2	U
Aroclor-1254	5.2	U
Aroclor-1260	5.2	U
beta-BHC	0.83	U
Chlordane	10.3	U
Chlorobenzilate	2000	U
delta-BHC	0.83	U
Dieldrin	1.6	U
Dimethoate	2000	UJ
Dinoseb	410	U
Disulfoton	410	U
Endosulfan I	0.83	U
Endosulfan II	1.6	U

PARAMETER	RESULT	QUAL
Endosulfan sulfate	1.6	U
Endrin	1.6	U
Endrin aldehyde	1.6	U
Famphur	410	UJ
gamma-BHC (lindane)	0.83	U
Heptachlor	0.83	U
Heptachlor epoxide	0.83	U
Isodrin	410	U
Kepone	410	UJ
Methoxychlor	8.3	U
Methyl parathion	2.1	U
Parathion	2.1	U
Phorate	2.1	U
Sulfotep	410	U
Thionazin	410	U
Toxaphene	41	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	410	U
1,2,4-trichlorobenzene	410	U
1,2-dichlorobenzene	410	U
1,3,5-trinitrobenzene	2000	UJ
1,3-dichlorobenzene	410	U
1,3-dinitrobenzene	410	U
1,4-dichlorobenzene	410	U
1,4-dioxane	410	UJ
1,4-naphthoquinone	410	UJ
1-naphthylamine	410	U
2,3,4,6-tetrachlorophenol	410	U
2,4,5-trichlorophenol	410	U
2,4,6-trichlorophenol	410	U
2,4-dichlorophenol	410	U
2,4-dimethylphenol	410	U
2,4-dinitrophenol	820	U
2,4-dinitrotoluene	410	U
2,6-dichlorophenol	410	U
2,6-dinitrotoluene	410	U
2-acetylaminofluorene	410	U
2-chloronaphthalene	410	U
2-chlorophenol	410	U
2-methyl-4,6-dinitrophenol	410	U
2-methylnaphthalene	410	U
2-methylphenol	410	U
2-naphthylamine	410	UR
2-nitroaniline	410	U
2-nitrophenol	410	U
2-picoline	410	U
3 & 4-methylphenol	410	U
3,3'-dichlorobenzidine	2000	UJ
3,3'-dimethylbenzidine	2000	UR
3-methylcholanthrene	410	UJ

PARAMETER	RESULT	QUAL
3-nitroaniline	410	UR
4-aminobiphenyl	410	U
4-bromophenyl phenyl ether	410	U
4-chloro-3-methylphenol	410	U
4-chloroaniline	410	UR
4-chlorophenyl phenyl ether	410	U
4-nitroaniline	410	U
4-nitrophenol	820	U
4-nitroquinoline-1-oxide	410	UR
5-nitro-o-toluidine	410	U
7,12-dimethylbenz(a)anthracene	410	UJ
a,a-dimethylphenethylamine	410	U
Acenaphthene	410	U
Acenaphthylene	410	U
Acetophenone	410	U
Aniline	410	U
Anthracene	410	U
Aramite	410	UJ
Benzo(a)anthracene	410	U
Benzo(a)pyrene	410	U
Benzo(b)fluoranthene	410	U
Benzo(g,h,i)perylene	410	U
Benzo(k)fluoranthene	410	U
Benzyl alcohol	410	U
Bis(2-chloroethoxy)methane	410	U
Bis(2-chloroethyl)ether	410	U
Bis(2-ethylhexyl)phthalate	410	U
Butyl benzyl phthalate	410	U
Chrysene	410	U
Di-n-butyl phthalate	410	U
Di-n-octyl phthalate	410	U
Diallate	410	U
Dibenzo(a,h)anthracene	410	UJ
Dibenzofuran	410	U
Diethyl phthalate	410	U
Dimethyl phthalate	410	U
Diphenylamine	410	U
Ethyl methacrylate	410	UJ
Ethyl methanesulfonate	410	U
Fluoranthene	410	U
Fluorene	410	U
Hexachlorobenzene	410	U
Hexachlorobutadiene	410	U
Hexachlorocyclopentadiene	410	U
Hexachloroethane	410	U
Hexachloropropene	410	U
Indeno(1,2,3-cd)pyrene	410	U
Isophorone	410	U
Isosafrole	410	U
Methapyrilene	2000	U

PARAMETER	RESULT	QUAL
Methyl methanesulfonate	410	UJ
N-nitroso-di-n-butylamine	410	U
N-nitroso-di-n-propylamine	410	U
N-nitrosodiethylamine	410	U
N-nitrosodimethylamine	410	UJ
N-nitrosodiphenylamine	410	U
N-nitrosomethylethylamine	410	UJ
N-nitrosomorpholine	410	U
N-nitrosopiperidine	410	UJ
N-nitrosopyrrolidine	410	U
Naphthalene	410	U
Nitrobenzene	410	U
o,o,o-triethylphosphorothioate	410	U
o-toluidine	410	UJ
p-dimethylaminoazobenzene	410	U
p-phenylenediamine	820	UJ
Pentachlorobenzene	410	U
Pentachloroethane	410	U
Pentachloronitrobenzene	410	U
Pentachlorophenol	410	U
Phenacetin	410	U
Phenanthrene	410	U
Phenol	410	U
Pronamide	410	U
Pyrene	410	U
Pyridine	410	U
Safrole	410	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	2	UJ
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	UJ
1,1,2-trichloroethane	2	UJ
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	UJ
1,2-dibromo-3-chloropropane	2	UJ
1,2-dibromoethane	2	UJ
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	6	U
2-chloro-1,3-butadiene	2	UR
2-hexanone	6	UJ
3-chloropropene	12	U
4-methyl-2-pentanone	6	UJ
Acetone	6	U
Acetonitrile	12	U
Acrolein	25	UR
Acrylonitrile	25	U
Benzene		U
Bis(2-chloroisopropyl)ether		UJ

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Bromodichloromethane	2	UJ
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	6	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	UJ
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	25	UR
Ethylbenzene	2	UJ
Iodomethane	6	U
Isobutanol	25	U
Methacrylonitrile	12	U
Methyl methacrylate	12	UJ
Methylene chloride	1	J
Styrene	2	UJ
Tetrachloroethene	2	UJ
Toluene	2	UJ
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	UJ
Trans-1,4-dichloro-2-butene	12	UR
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	6	U
Vinyl chloride	2	U
Xylenes, total	8	UJ
BG1SS-03 BG1SS-03 B&RE 0 ft		
Inorganics (mg/kg)		
Aluminum	4250	
Antimony	0.64	U
Arsenic	2.7	
Barium	17.7	
Beryllium	0.08	U
Cadmium	0.4	U
Chromium	9.5	
Cobalt	0.43	J
Copper	15.6	J
Cyanide	0.18	U
Iron	2250	
Lead	43.5	J
Manganese	30	J
Mercury	0.07	U
Nickel	3.3	
Selenium	1.5	J
Silver	0.17	U

PARAMETER	RESULT	QUAL
Thallium	1.1	UJ
Vanadium	7.8	
Zinc	36.6	J
Pesticides/PCBs (µg/kg)		
2,4,5-T	60.6	U
2,4,5-TP (silvex)	30.3	U
2,4-D	60.6	U
4,4'-DDD	10	U
4,4'-DDE	10	U
4,4'-DDT	10	U
Aldrin	5	U
alpha-BHC	5	U
Aroclor-1016	31.4	U
Aroclor-1221	31.4	U
Aroclor-1232	31.4	U
Aroclor-1242	31.4	U
Aroclor-1248	31.4	U
Aroclor-1254	31.4	U
Aroclor-1260	31.4	U
beta-BHC	5	U
Chlordane	62.7	U
Chlorobenzilate	2500	U
delta-BHC	5	U
Dieldrin	10	U
Dimethoate	2500	UJ
Dinoseb	500	U
Disulfoton	500	U
Endosulfan I	5	U
Endosulfan II	10	U
Endosulfan sulfate	10	U
Endrin	10	U
Endrin aldehyde	10	U
Famphur	500	UJ
gamma-BHC (lindane)	5	U
Heptachlor	5	U
Heptachlor epoxide	5	U
Isodrin	500	U
Kepone	500	UJ
Methoxychlor	50.2	U
Methyl parathion	12.6	U
Parathion	12.6	U
Phorate	12.6	U
Sulfotep	500	U
Thionazin	500	U
Toxaphene	249	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	500	U
1,2,4-trichlorobenzene	500	U
1,2-dichlorobenzene	500	U
1,3,5-trinitrobenzene	2500	UJ

PARAMETER	RESULT	QUAL
1,3-dichlorobenzene	500	U
1,3-dinitrobenzene	500	U
1,4-dichlorobenzene	500	U
1,4-dioxane	500	UJ
1,4-naphthoquinone	500	UJ
1-naphthylamine	500	U
2,3,4,6-tetrachlorophenol	500	U
2,4,5-trichlorophenol	500	U
2,4,6-trichlorophenol	500	U
2,4-dichlorophenol	500	U
2,4-dimethylphenol	500	U
2,4-dinitrophenol	1000	U
2,4-dinitrotoluene	500	U
2,6-dichlorophenol	500	U
2,6-dinitrotoluene	500	U
2-acetylaminofluorene	500	U
2-chloronaphthalene	500	U
2-chlorophenol	500	U
2-methyl-4,6-dinitrophenol	500	U
2-methylnaphthalene	500	U
2-methylphenol	500	U
2-naphthylamine	500	UR
2-nitroaniline	500	U
2-nitrophenol	500	U
2-picoline	500	U
3 & 4-methylphenol	500	U
3,3'-dichlorobenzidine	2500	UJ
3,3'-dimethylbenzidine	2500	UR
3-methylcholanthrene	500	UJ
3-nitroaniline	500	UR
4-aminobiphenyl	500	U
4-bromophenyl phenyl ether	500	U
4-chloro-3-methylphenol	500	U
4-chloroaniline	500	UR
4-chlorophenyl phenyl ether	500	U
4-nitroaniline	500	U
4-nitrophenol	1000	U
4-nitroquinoline-1-oxide	500	UR
5-nitro-o-toluidine	500	U
7,12-dimethylbenz(a)anthracene	500	UJ
a,a-dimethylphenethylamine	500	U
Acenaphthene	500	U
Acenaphthylene	500	U
Acetophenone	500	U
Aniline	500	U
Anthracene	390	J
Aramite	500	UJ
Benzo(a)anthracene	500	U
Benzo(a)pyrene	500	U
Benzo(b)fluoranthene	390	J

PARAMETER	RESULT	QUAL
Benzo(g,h,i)perylene	500	U
Benzo(k)fluoranthene	500	U
Benzyl alcohol	500	U
Bis(2-chloroethoxy)methane	500	U
Bis(2-chloroethyl)ether	500	U
Bis(2-ethylhexyl)phthalate	500	U
Butyl benzyl phthalate	500	U
Chrysene	280	J
Di-n-butyl phthalate	500	U
Di-n-octyl phthalate	500	U
Diallate	500	U
Dibenzo(a,h)anthracene	500	UJ
Dibenzofuran	500	U
Diethyl phthalate	500	U
Dimethyl phthalate	500	U
Diphenylamine	500	U
Ethyl methacrylate	500	UJ
Ethyl methanesulfonate	500	U
Fluoranthene	680	
Fluorene	500	U
Hexachlorobenzene	500	U
Hexachlorobutadiene	500	U
Hexachlorocyclopentadiene	500	U
Hexachloroethane	500	U
Hexachloropropene	500	U
Indeno(1,2,3-cd)pyrene	500	U
Isophorone	500	U
Isosafrole	500	U
Methapyrilene	2500	U
Methyl methanesulfonate	500	UJ
N-nitroso-di-n-butylamine	500	U
N-nitroso-di-n-propylamine	500	U
N-nitrosodiethylamine	500	U
N-nitrosodimethylamine	500	UJ
N-nitrosodiphenylamine	500	U
N-nitrosomethylethylamine	500	UJ
N-nitrosomorpholine	500	U
N-nitrosopiperidine	500	UJ
N-nitrosopyrrolidine	500	U
Naphthalene	500	U
Nitrobenzene	500	U
o,o,o-triethylphosphorothioate	500	U
o-toluidine	500	UJ
p-dimethylaminoazobenzene	500	U
p-phenylenediamine	1000	UJ
Pentachlorobenzene	500	U
Pentachloroethane	500	U
Pentachloronitrobenzene	500	U
Pentachlorophenol	500	U
Phenacetin	500	U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Phenanthrene	500	U
Phenol	500	U
Pronamide	500	U
Pyrene	470	J
Pyridine	500	U
Safrole	500	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	3	UJ
1,1,1-trichloroethane	3	U
1,1,2,2-tetrachloroethane	3	UJ
1,1,2-trichloroethane	3	UJ
1,1-dichloroethane	3	U
1,1-dichloroethene	3	U
1,2,3-trichloropropane	3	UJ
1,2-dibromo-3-chloropropane	3	UJ
1,2-dibromoethane	3	UJ
1,2-dichloroethane	3	U
1,2-dichloropropane	3	U
2-butanone	8	U
2-chloro-1,3-butadiene	3	UR
2-hexanone	8	UJ
3-chloropropene	15	U
4-methyl-2-pentanone	8	UJ
Acetone	8	U
Acetonitrile	15	U
Acrolein	30	UR
Acrylonitrile	30	U
Benzene	4	U
Bis(2-chloroisopropyl)ether	30	UJ
Bromodichloromethane	3	UJ
Bromoform	3	UJ
Bromomethane	3	U
Carbon disulfide	8	U
Carbon tetrachloride	3	U
Chlorobenzene	3	UJ
Chloroethane	3	U
Chloroform	3	U
Chloromethane	3	U
Cis-1,3-dichloropropene	3	UJ
Dibromochloromethane	3	UJ
Dibromomethane	3	U
Dichlorodifluoromethane	3	U
Ethyl cyanide	30	UR
Ethylbenzene	3	UJ
Iodomethane	8	U
Isobutanol	30	U
Methacrylonitrile	15	U
Methyl methacrylate	15	UJ
Methylene chloride	2	J
Styrene	3	UJ

PARAMETER	RESULT	QUAL
Tetrachloroethene	3	UJ
Toluene	3	UJ
Trans-1,2-dichloroethene	3	U
Trans-1,3-dichloropropene	3	UJ
Trans-1,4-dichloro-2-butene	15	UR
Trichloroethene	3	U
Trichlorofluoromethane	3	U
Vinyl acetate	8	U
Vinyl chloride	3	U
Xylenes, total	9	UJ

BG 2

BG2SS-01	BG2SS-01	B&RE	0 ft

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	993	
Antimony	0.58	U
Arsenic	2.7	U
Barium	9.2	
Beryllium	0.07	U
Cadmium	0.09	U
Chromium	3.2	
Cobalt	0.18	U
Copper	1.7	
Cyanide	0.65	U
Iron	532	
Lead	0.4	U
Manganese	15	
Mercury	0.06	U
Nickel	0.63	
Selenium	1.1	U
Silver	0.16	U
Thallium	1	UJ
Tin	4.99	U
Vanadium	4.1	
Zinc	0.63	
Pesticides/PCBs (µg/kg)		
2,4,5-T	51.3	U
2,4,5-TP (silvex)	25.6	U
2,4-D	51.3	U
Chlorobenzilate	2120	U
Dimethoate	2120	U
Dinoseb	423	U
Disulfoton	423	U
Famphur	423	U
Isodrin	423	U
Kepone	423	U
Sulfotep	423	U
Thionazin	423	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	423	U
1,2,4-trichlorobenzene	423	U

PARAMETER	RESULT	QUAL
1,2-dichlorobenzene	423	U
1,3,5-trinitrobenzene	2120	U
1,3-dichlorobenzene	423	U
1,3-dinitrobenzene	423	U
1,4-dichlorobenzene	423	U
1,4-dioxane	423	U
1,4-naphthoquinone	423	U
1-naphthylamine	423	U
2,3,4,6-tetrachlorophenol	423	U
2,4,5-trichlorophenol	423	U
2,4,6-trichlorophenol	423	U
2,4-dichlorophenol	423	U
2,4-dimethylphenol	423	U
2,4-dinitrophenol	846	U
2,4-dinitrotoluene	423	U
2,6-dichlorophenol	423	U
2,6-dinitrotoluene	423	U
2-acetylaminofluorene	423	U
2-chloronaphthalene	423	U
2-chlorophenol	423	U
2-methyl-4,6-dinitrophenol	423	U
2-methylnaphthalene	423	U
2-methylphenol	423	U
2-naphthylamine	423	UR
2-nitroaniline	423	U
2-nitrophenol	423	U
2-picoline	423	U
3 & 4-methylphenol	423	U
3,3'-dichlorobenzidine	2120	U
3,3'-dimethylbenzidine	2120	UR
3-methylcholanthrene	423	U
3-nitroaniline	423	U
4-aminobiphenyl	423	U
4-bromophenyl phenyl ether	423	U
4-chloro-3-methylphenol	423	U
4-chloroaniline	423	UR
4-chlorophenyl phenyl ether	423	U
4-nitroaniline	423	U
4-nitrophenol	423	U
4-nitroquinoline-1-oxide	423	U
5-nitro-o-toluidine	423	U
7,12-dimethylbenz(a)anthracene	423	U
a,a-dimethylphenethylamine	423	UR
Acenaphthene	423	U
Acenaphthylene	423	U
Acetophenone	423	U
Aniline	423	U
Anthracene	423	U
Aramite	423	U
Benzo(a)anthracene	423	U

PARAMETER	RESULT	QUAL
Benzo(a)pyrene	423	U
Benzo(b)fluoranthene	423	U
Benzo(g,h,i)perylene	423	U
Benzo(k)fluoranthene	423	U
Benzyl alcohol	423	U
Bis(2-chloroethoxy)methane	423	U
Bis(2-chloroethyl)ether	423	U
Bis(2-ethylhexyl)phthalate	423	U
Butyl benzyl phthalate	423	U
Chrysene	423	U
Di-n-butyl phthalate	423	U
Di-n-octyl phthalate	423	U
Diallate	423	U
Dibenzo(a,h)anthracene	423	U
Dibenzofuran	423	U
Diethyl phthalate	423	U
Dimethyl phthalate	423	U
Diphenylamine	423	U
Ethyl methacrylate	423	U
Ethyl methanesulfonate	423	U
Fluoranthene	423	U
Fluorene	423	U
Hexachlorobenzene	423	U
Hexachlorobutadiene	423	U
Hexachlorocyclopentadiene	423	U
Hexachloroethane	423	U
Hexachloropropene	423	U
Indeno(1,2,3-cd)pyrene	423	U
Isophorone	423	U
Isosafrole	423	U
Methapyrilene	2120	U
Methyl methanesulfonate	423	U
N-nitroso-di-n-butylamine	423	U
N-nitroso-di-n-propylamine	423	U
N-nitrosodiethylamine	423	U
N-nitrosodimethylamine	423	U
N-nitrosodiphenylamine	423	U
N-nitrosomethylethylamine	423	U
N-nitrosomorpholine	423	U
N-nitrosopiperidine	423	U
N-nitrosopyrrolidine	423	U
Naphthalene	423	U
Nitrobenzene	423	U
o,o,o-triethylphosphorothioate	423	U
o-toluidine	423	U
p-dimethylaminoazobenzene	423	U
p-phenylenediamine	846	U
Pentachlorobenzene	423	U
Pentachloroethane		U
Pentachloronitrobenzene		U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Pentachlorophenol	423	U
Phenacetin	423	U
Phenanthrene	423	U
Phenol	423	U
Pronamide	423	U
Pyrene	423	U
Pyridine	423	U
Safrole	423	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	3	U
1,1,1-trichloroethane	3	U
1,1,2,2-tetrachloroethane	3	U
1,1,2-trichloroethane	3	U
1,1-dichloroethane	3	U
1,1-dichloroethene	3	U
1,2,3-trichloropropane	3	U
1,2-dibromo-3-chloropropane	3	U
1,2-dibromoethane	3	U
1,2-dichloroethane	3	U
1,2-dichloropropane	3	U
2-butanone	6	U
2-chloro-1,3-butadiene	3	U
2-hexanone	6	U
3-chloropropene	13	U
4-methyl-2-pentanone	6	U
Acetone	3	U
Acetonitrile	13	U
Acrolein	26	UR
Acrylonitrile	26	U
Benzene	3	U
Bis(2-chloroisopropyl)ether	26	U
Bromodichloromethane	3	U
Bromoform	3	U
Bromomethane	3	U
Carbon disulfide	6	U
Carbon tetrachloride	3	U
Chlorobenzene	3	U
Chloroethane	3	U
Chloroform	3	U
Chloromethane	3	U
Cis-1,3-dichloropropene	3	U
Dibromochloromethane	3	U
Dibromomethane	3	U
Dichlorodifluoromethane	3	U
Ethyl cyanide	26	UR
Ethylbenzene	3	U
Iodomethane	6	U
Isobutanol	26	U
Methacrylonitrile	13	U
Methyl methacrylate	13	U

PARAMETER	RESULT	QUAL
Methylene chloride	3	U
Styrene	3	U
Tetrachloroethene	3	U
Toluene	3	U
Trans-1,2-dichloroethene	3	U
Trans-1,3-dichloropropene	3	U
Trans-1,4-dichloro-2-butene	13	U
Trichloroethene	3	U
Trichlorofluoromethane	3	U
Vinyl acetate	6	U
Vinyl chloride	3	U
Xylenes, total	8	U
BG2SS-02 BG2SS-02 B&RE	**0 ft**	
Inorganics (mg/kg)		
Aluminum	145	
Antimony	0.42	U
Arsenic	1.8	
Barium	7.3	J
Beryllium	0.05	U
Cadmium	0.07	U
Chromium	1.9	
Cobalt	0.13	U
Copper	4	J
Cyanide	0.07	U
Iron	758	
Lead	34.4	J
Manganese	5.5	J
Mercury	0.05	U
Nickel	0.68	U
Selenium	0.78	UJ
Silver	0.11	U
Thallium	0.74	UJ
Vanadium	2.1	
Zinc	3.8	J
Pesticides/PCBs (µg/kg)		
2,4,5-T	43.5	U
2,4,5-TP (silvex)	21.7	U
2,4-D	43.5	U
4,4'-DDD	1.4	UJ
4,4'-DDE	1.4	UJ
4,4'-DDT	9.3	J
Aldrin	0.72	UJ
alpha-BHC	0.72	UJ
Aroclor-1016	4.5	UJ
Aroclor-1221	4.5	UJ
Aroclor-1232	4.5	UJ
Aroclor-1242	4.5	UJ
Aroclor-1248	4.5	UJ
Aroclor-1254	4.5	UJ
Aroclor-1260	4.5	UJ

PARAMETER	RESULT	QUAL
beta-BHC	0.72	UJ
Chlordane	9	UJ
Chlorobenzilate	1800	U
delta-BHC	0.72	UJ
Dieldrin	1.4	UJ
Dimethoate	1800	UJ
Dinoseb	360	U
Disulfoton	360	U
Endosulfan I	0.72	UJ
Endosulfan II	1.4	UJ
Endosulfan sulfate	1.4	UJ
Endrin	1.4	UJ
Endrin aldehyde	1.4	UJ
Famphur	360	UJ
gamma-BHC (lindane)	0.72	UJ
Heptachlor	0.72	UJ
Heptachlor epoxide	0.72	UJ
Isodrin	360	U
Kepone	360	UJ
Methoxychlor	7.2	UJ
Methyl parathion	2.2	J
Parathion	1.8	UJ
Phorate	1.8	UJ
Sulfotep	360	U
Thionazin	360	U
Toxaphene	35.7	UJ
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	360	U
1,2,4-trichlorobenzene	360	U
1,2-dichlorobenzene	360	U
1,3,5-trinitrobenzene	1800	UJ
1,3-dichlorobenzene	360	U
1,3-dinitrobenzene	360	U
1,4-dichlorobenzene	360	U
1,4-dioxane	360	UJ
1,4-naphthoquinone	360	UJ
1-naphthylamine	360	U
2,3,4,6-tetrachlorophenol	360	U
2,4,5-trichlorophenol	360	U
2,4,6-trichlorophenol	360	U
2,4-dichlorophenol	360	U
2,4-dimethylphenol	360	U
2,4-dinitrophenol	720	U
2,4-dinitrotoluene	360	U
2,6-dichlorophenol	360	U
2,6-dinitrotoluene	360	U
2-acetylaminofluorene	360	U
2-chloronaphthalene	360	U
2-chlorophenol	360	U
2-methyl-4,6-dinitrophenol	360	U

PARAMETER	RESULT	QUAL
2-methylnaphthalene	360	U
2-methylphenol	360	U
2-naphthylamine	360	UR
2-nitroaniline	360	U
2-nitrophenol	360	U
2-picoline	360	U
3 & 4-methylphenol	360	U
3,3'-dichlorobenzidine	1800	UJ
3,3'-dimethylbenzidine	1800	UR
3-methylcholanthrene	360	UJ
3-nitroaniline	360	UR
4-aminobiphenyl	360	U
4-bromophenyl phenyl ether	360	U
4-chloro-3-methylphenol	360	U
4-chloroaniline	360	UR
4-chlorophenyl phenyl ether	360	U
4-nitroaniline	360	U
4-nitrophenol	720	U
4-nitroquinoline-1-oxide	360	UR
5-nitro-o-toluidine	360	U
7,12-dimethylbenz(a)anthracene	360	UJ
a,a-dimethylphenethylamine	360	U
Acenaphthene	360	U
Acenaphthylene	360	U
Acetophenone	360	U
Aniline	360	U
Anthracene	360	U
Aramite	360	UJ
Benzo(a)anthracene	360	U
Benzo(a)pyrene	360	U
Benzo(b)fluoranthene	360	U
Benzo(g,h,i)perylene	360	U
Benzo(k)fluoranthene	360	U
Benzyl alcohol	360	U
Bis(2-chloroethoxy)methane	360	U
Bis(2-chloroethyl)ether	360	U
Bis(2-ethylhexyl)phthalate	360	U
Butyl benzyl phthalate	360	U
Chrysene	360	U
Di-n-butyl phthalate	360	U
Di-n-octyl phthalate	360	U
Diallate	360	U
Dibenzo(a,h)anthracene	360	UJ
Dibenzofuran	360	U
Diethyl phthalate	360	U
Dimethyl phthalate	360	U
Diphenylamine	360	U
Ethyl methacrylate	360	UJ
Ethyl methanesulfonate	360	U
Fluoranthene	360	U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Fluorene	360	U
Hexachlorobenzene	360	U
Hexachlorobutadiene	360	U
Hexachlorocyclopentadiene	360	U
Hexachloroethane	360	U
Hexachloropropene	360	U
Indeno(1,2,3-cd)pyrene	360	U
Isophorone	360	U
Isosafrole	360	U
Methapyrilene	1800	U
Methyl methanesulfonate	360	UJ
N-nitroso-di-n-butylamine	360	U
N-nitroso-di-n-propylamine	360	U
N-nitrosodiethylamine	360	U
N-nitrosodimethylamine	360	UJ
N-nitrosodiphenylamine	360	U
N-nitrosomethylethylamine	360	UJ
N-nitrosomorpholine	360	U
N-nitrosopiperidine	360	UJ
N-nitrosopyrrolidine	360	U
Naphthalene	360	U
Nitrobenzene	360	U
o,o,o-triethylphosphorothioate	360	U
o-toluidine	360	UJ
p-dimethylaminoazobenzene	360	U
p-phenylenediamine	720	UJ
Pentachlorobenzene	360	U
Pentachloroethane	360	U
Pentachloronitrobenzene	360	U
Pentachlorophenol	360	U
Phenacetin	360	U
Phenanthrene	360	U
Phenol	360	U
Pronamide	360	U
Pyrene	360	U
Pyridine	360	U
Safrole	360	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	5	U

PARAMETER	RESULT	QUAL
2-chloro-1,3-butadiene	2	UR
2-hexanone	5	U
3-chloropropene	11	U
4-methyl-2-pentanone	5	U
Acetone	5	U
Acetonitrile	11	U
Acrolein	22	UR
Acrylonitrile	22	U
Benzene	2	U
Bis(2-chloroisopropyl)ether	22	U
Bromodichloromethane	2	U
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	5	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	UJ
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	22	UR
Ethylbenzene	2	U
Iodomethane	5	U
Isobutanol	22	U
Methacrylonitrile	11	U
Methyl methacrylate	11	U
Methylene chloride	5	U
Styrene	2	UJ
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	11	UR
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	5	U
Vinyl chloride	2	U
Xylenes, total	7	UJ

BG2SS-03 BG2SS-03 B&RE 2 ft

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	120	
Antimony	0.6	U
Arsenic	1.1	U
Barium	7.9	
Beryllium	0.07	U
Cadmium	0.12	U
Chromium	2	
Cobalt	0.18	U
Copper	2.2	J
Cyanide	0.25	U
Iron	118	
Lead	1.4	J
Manganese	6.1	J
Mercury	0.05	U
Nickel	0.44	U
Selenium	1.1	UJ
Silver	0.16	U
Thallium	1	UJ
Vanadium	1	
Zinc	2.5	J
Pesticides/PCBs (µg/kg)		
2,4,5-T	60.6	U
2,4,5-TP (silvex)	30.3	U
2,4-D	60.6	U
4,4'-DDD	40	UJ
4,4'-DDE	40	UJ
4,4'-DDT	40	UJ
Aldrin	20	UJ
alpha-BHC	20	UJ
Aroclor-1016	125	UJ
Aroclor-1221	125	UJ
Aroclor-1232	125	UJ
Aroclor-1242	125	UJ
Aroclor-1248	125	UJ
Aroclor-1254	125	UJ
Aroclor-1260	125	UJ
beta-BHC	20	UJ
Chlordane	250	UJ
Chlorobenzilate	2500	U
delta-BHC	20	UJ
Dieldrin	40	UJ
Dimethoate	2500	UJ
Dinoseb	500	U
Disulfoton	500	U
Endosulfan I	20	UJ
Endosulfan II	40	UJ
Endosulfan sulfate	40	UJ
Endrin	40	UJ
Endrin aldehyde	40	UJ
Famphur	500	UJ
gamma-BHC (lindane)	20	UJ
Heptachlor	20	UJ
Heptachlor epoxide	20	UJ
Isodrin	500	U
Kepone	500	UJ
Methoxychlor	200	UJ
Methyl parathion	50.1	UJ

PARAMETER	RESULT	QUAL
Parathion	50.1	UJ
Phorate	50.1	UJ
Sulfotep	500	U
Thionazin	500	U
Toxaphene	992	UJ
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	500	U
1,2,4-trichlorobenzene	500	U
1,2-dichlorobenzene	500	U
1,3,5-trinitrobenzene	2500	UJ
1,3-dichlorobenzene	500	U
1,3-dinitrobenzene	500	U
1,4-dichlorobenzene	500	U
1,4-dioxane	500	UJ
1,4-naphthoquinone	500	UJ
1-naphthylamine	500	U
2,3,4,6-tetrachlorophenol	500	U
2,4,5-trichlorophenol	500	U
2,4,6-trichlorophenol	500	U
2,4-dichlorophenol	500	U
2,4-dimethylphenol	500	U
2,4-dinitrophenol	1000	U
2,4-dinitrotoluene	500	U
2,6-dichlorophenol	500	U
2,6-dinitrotoluene	500	U
2-acetylaminofluorene	500	U
2-chloronaphthalene	500	U
2-chlorophenol	500	U
2-methyl-4,6-dinitrophenol	500	U
2-methylnaphthalene	500	U
2-methylphenol	500	U
2-naphthylamine	500	UR
2-nitroaniline	500	U
2-nitrophenol	500	U
2-picoline	500	U
3 & 4-methylphenol	500	U
3,3'-dichlorobenzidine	2500	UJ
3,3'-dimethylbenzidine	2500	UR
3-methylcholanthrene	500	UJ
3-nitroaniline	500	UR
4-aminobiphenyl	500	U
4-bromophenyl phenyl ether	500	U
4-chloro-3-methylphenol	500	U
4-chloroaniline	500	UR
4-chlorophenyl phenyl ether	500	U
4-nitroaniline	500	U
4-nitrophenol	1000	U
4-nitroquinoline-1-oxide	500	UR
5-nitro-o-toluidine		U
7,12-dimethylbenz(a)anthracene		UJ

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
a,a-dimethylphenethylamine	500	U
Acenaphthene	500	U
Acenaphthylene	500	U
Acetophenone	500	U
Aniline	500	U
Anthracene	500	U
Aramite	500	UJ
Benzo(a)anthracene	500	U
Benzo(a)pyrene	500	U
Benzo(b)fluoranthene	500	U
Benzo(g,h,i)perylene	500	U
Benzo(k)fluoranthene	500	U
Benzyl alcohol	500	U
Bis(2-chloroethoxy)methane	500	U
Bis(2-chloroethyl)ether	500	U
Bis(2-ethylhexyl)phthalate	500	U
Butyl benzyl phthalate	500	U
Chrysene	500	U
Di-n-butyl phthalate	500	U
Di-n-octyl phthalate	500	U
Diallate	500	U
Dibenzo(a,h)anthracene	500	UJ
Dibenzofuran	500	U
Diethyl phthalate	500	U
Dimethyl phthalate	500	U
Diphenylamine	500	U
Ethyl methacrylate	500	UJ
Ethyl methanesulfonate	500	U
Fluoranthene	500	U
Fluorene	500	U
Hexachlorobenzene	500	U
Hexachlorobutadiene	500	U
Hexachlorocyclopentadiene	500	U
Hexachloroethane	500	U
Hexachloropropene	500	U
Indeno(1,2,3-cd)pyrene	500	U
Isophorone	500	U
Isosafrole	500	U
Methapyrilene	2500	U
Methyl methanesulfonate	500	UJ
N-nitroso-di-n-butylamine	500	U
N-nitroso-di-n-propylamine	500	U
N-nitrosodiethylamine	500	U
N-nitrosodimethylamine	500	UJ
N-nitrosodiphenylamine	500	U
N-nitrosomethylethylamine	500	UJ
N-nitrosomorpholine	500	U
N-nitrosopiperidine	500	UJ
N-nitrosopyrrolidine	500	U
Naphthalene	500	U

PARAMETER	RESULT	QUAL
Nitrobenzene	500	U
o,o,o-triethylphosphorothioate	500	U
o-toluidine	500	UJ
p-dimethylaminoazobenzene	500	U
p-phenylenediamine	1000	UJ
Pentachlorobenzene	500	U
Pentachloroethane	500	U
Pentachloronitrobenzene	500	U
Pentachlorophenol	500	U
Phenacetin	500	U
Phenanthrene	500	U
Phenol	500	U
Pronamide	500	U
Pyrene	500	U
Pyridine	500	U
Safrole	500	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	3	U
1,1,1-trichloroethane	3	U
1,1,2,2-tetrachloroethane	3	U
1,1,2-trichloroethane	3	U
1,1-dichloroethane	3	U
1,1-dichloroethene	3	U
1,2,3-trichloropropane	3	U
1,2-dibromo-3-chloropropane	3	U
1,2-dibromoethane	3	U
1,2-dichloroethane	3	U
1,2-dichloropropane	3	U
2-butanone	8	U
2-chloro-1,3-butadiene	3	UR
2-hexanone	8	U
3-chloropropene	15	U
4-methyl-2-pentanone	8	U
Acetone	8	U
Acetonitrile	15	U
Acrolein	30	UR
Acrylonitrile	30	U
Benzene	3	U
Bis(2-chloroisopropyl)ether	30	U
Bromodichloromethane	3	U
Bromoform	3	U
Bromomethane	3	U
Carbon disulfide	8	U
Carbon tetrachloride	3	U
Chlorobenzene	3	U
Chloroethane	3	U
Chloroform	3	U
Chloromethane	3	U
Cis-1,3-dichloropropene	3	UJ
Dibromochloromethane	3	U

PARAMETER	RESULT	QUAL
Dibromomethane	3	U
Dichlorodifluoromethane	3	U
Ethyl cyanide	30	UR
Ethylbenzene	3	U
Iodomethane	8	U
Isobutanol	30	U
Methacrylonitrile	15	U
Methyl methacrylate	15	U
Methylene chloride	1	J
Styrene	3	U
Tetrachloroethene	3	UJ
Toluene	3	U
Trans-1,2-dichloroethene	3	U
Trans-1,3-dichloropropene	3	U
Trans-1,4-dichloro-2-butene	15	UR
Trichloroethene	3	U
Trichlorofluoromethane	3	U
Vinyl acetate	8	U
Vinyl chloride	3	U
Xylenes, total	9	UJ

BG 3

BG3SS-01	BG3SS-01	B&RE	0 ft

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	1640	
Antimony	0.67	U
Arsenic	2.6	U
Barium	11.2	
Beryllium	0.08	U
Cadmium	0.27	
Chromium	9.3	
Cobalt	0.33	
Copper	9.7	
Cyanide	0.55	U
Iron	2260	
Lead	48.3	
Manganese	25.9	
Mercury	0.08	
Nickel	2	
Selenium	1.8	
Silver	0.18	U
Thallium	1.2	UJ
Vanadium	3.6	
Zinc	89.1	
Pesticides/PCBs (µg/kg)		
2,4,5-T	64.5	U
2,4,5-TP (silvex)	32.2	U
2,4-D	64.5	U
Chlorobenzilate	26800	U
Dimethoate	26800	U
Dinoseb	5370	U

PARAMETER	RESULT	QUAL
Disulfoton	5370	U
Famphur	5370	U
Isodrin	5370	U
Kepone	5370	U
Sulfotep	5370	U
Thionazin	5370	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	5370	U
1,2,4-trichlorobenzene	5370	U
1,2-dichlorobenzene	5370	U
1,3,5-trinitrobenzene	26800	U
1,3-dichlorobenzene	5370	U
1,3-dinitrobenzene	5370	U
1,4-dichlorobenzene	5370	U
1,4-dioxane	5370	U
1,4-naphthoquinone	5370	U
1-naphthylamine	5370	U
2,3,4,6-tetrachlorophenol	5370	U
2,4,5-trichlorophenol	5370	U
2,4,6-trichlorophenol	5370	U
2,4-dichlorophenol	5370	U
2,4-dimethylphenol	5370	U
2,4-dinitrophenol	10700	U
2,4-dinitrotoluene	5370	U
2,6-dichlorophenol	5370	U
2,6-dinitrotoluene	5370	U
2-acetylaminofluorene	5370	U
2-chloronaphthalene	5370	U
2-chlorophenol	5370	U
2-methyl-4,6-dinitrophenol	5370	U
2-methylnaphthalene	5370	U
2-methylphenol	5370	U
2-naphthylamine	5370	UR
2-nitroaniline	5370	U
2-nitrophenol	5370	U
2-picoline	5370	U
3 & 4-methylphenol	5370	U
3,3'-dichlorobenzidine	26800	U
3,3'-dimethylbenzidine	26800	UR
3-methylcholanthrene	5370	U
3-nitroaniline	5370	U
4-aminobiphenyl	5370	U
4-bromophenyl phenyl ether	5370	U
4-chloro-3-methylphenol	5370	U
4-chloroaniline	5370	U
4-chlorophenyl phenyl ether	5370	U
4-nitroaniline	5370	U
4-nitrophenol	5370	U
4-nitroquinoline-1-oxide	5370	U
5-nitro-o-toluidine	5370	U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
7,12-dimethylbenz(a)anthracene	5370	U
a,a-dimethylphenethylamine	5370	U
Acenaphthene	5370	U
Acenaphthylene	5370	U
Acetophenone	5370	U
Aniline	5370	U
Anthracene	5370	U
Aramite	5370	U
Benzo(a)anthracene	5370	U
Benzo(a)pyrene	5370	U
Benzo(b)fluoranthene	5370	U
Benzo(g,h,i)perylene	5370	U
Benzo(k)fluoranthene	5370	U
Benzyl alcohol	5370	U
Bis(2-chloroethoxy)methane	5370	U
Bis(2-chloroethyl)ether	5370	U
Bis(2-ethylhexyl)phthalate	5370	U
Butyl benzyl phthalate	5370	U
Chrysene	5370	U
Di-n-butyl phthalate	5370	U
Di-n-octyl phthalate	5370	U
Diallate	5370	U
Dibenzo(a,h)anthracene	5370	U
Dibenzofuran	5370	U
Diethyl phthalate	5370	U
Dimethyl phthalate	5370	U
Diphenylamine	5370	U
Ethyl methacrylate	5370	U
Ethyl methanesulfonate	5370	U
Fluoranthene	5370	U
Fluorene	5370	U
Hexachlorobenzene	5370	U
Hexachlorobutadiene	5370	U
Hexachlorocyclopentadiene	5370	U
Hexachloroethane	5370	U
Hexachloropropene	5370	U
Indeno(1,2,3-cd)pyrene	5370	U
Isophorone	5370	U
Isosafrole	5370	U
Methapyrilene	26800	U
Methyl methanesulfonate	5370	U
N-nitroso-di-n-butylamine	5370	U
N-nitroso-di-n-propylamine	5370	U
N-nitrosodiethylamine	5370	U
N-nitrosodimethylamine	5370	U
N-nitrosodiphenylamine	5370	U
N-nitrosomethylethylamine	5370	U
N-nitrosomorpholine	5370	U
N-nitrosopiperidine	5370	U
N-nitrosopyrro'	5370	U

PARAMETER	RESULT	QUAL
Naphthalene	5370	U
Nitrobenzene	5370	U
o,o,o-triethylphosphorothioate	5370	U
o-toluidine	5370	U
p-dimethylaminoazobenzene	5370	U
p-phenylenediamine	10700	U
Pentachlorobenzene	5370	U
Pentachloroethane	5370	U
Pentachloronitrobenzene	5370	U
Pentachlorophenol	5370	U
Phenacetin	5370	U
Phenanthrene	5370	U
Phenol	5370	U
Pronamide	5370	U
Pyrene	5370	U
Pyridine	5370	U
Safrole	5370	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	3	U
1,1,1-trichloroethane	3	U
1,1,2,2-tetrachloroethane	4	
1,1,2-trichloroethane	3	U
1,1-dichloroethane	3	U
1,1-dichloroethene	3	U
1,2,3-trichloropropane	3	U
1,2-dibromo-3-chloropropane	3	U
1,2-dibromoethane	3	U
1,2-dichloroethane	3	U
1,2-dichloropropane	3	U
2-butanone	8	U
2-chloro-1,3-butadiene	3	UR
2-hexanone	2	J
3-chloropropene	16	U
4-methyl-2-pentanone	8	U
Acetone	3	U
Acetonitrile	16	U
Acrolein	32	UR
Acrylonitrile	32	U
Benzene	3	U
Bis(2-chloroisopropyl)ether	21	J
Bromodichloromethane	3	U
Bromoform	3	U
Bromomethane	3	U
Carbon disulfide	8	U
Carbon tetrachloride	3	U
Chlorobenzene	3	U
Chloroethane	3	U
Chloroform	1	J
Chloromethane	3	U
Cis-1,3-dichloropropene	3	U

PARAMETER	RESULT	QUAL
Dibromochloromethane	3	U
Dibromomethane	3	U
Dichlorodifluoromethane	3	U
Ethyl cyanide	32	UR
Ethylbenzene	3	U
Iodomethane	8	U
Isobutanol	32	U
Methacrylonitrile	16	U
Methyl methacrylate	16	U
Methylene chloride	1	J
Styrene	3	U
Tetrachloroethene	3	U
Toluene	3	U
Trans-1,2-dichloroethene	3	U
Trans-1,3-dichloropropene	3	U
Trans-1,4-dichloro-2-butene	16	UR
Trichloroethene	3	U
Trichlorofluoromethane	3	U
Vinyl acetate	8	U
Vinyl chloride	3	U
Xylenes, total	10	U
BG3SS-02 BG3SS-02 B&RE	**0 ft**	
Inorganics (mg/kg)		
Aluminum	216	
Antimony	0.48	U
Arsenic	0.91	U
Barium	6.5	
Beryllium	0.06	U
Cadmium	0.07	U
Chromium	2.1	
Cobalt	0.15	U
Copper	2.3	J
Cyanide	0.31	U
Iron	98.1	
Lead	0.82	J
Manganese	2.6	J
Mercury	0.06	U
Nickel	0.76	U
Selenium	0.89	UJ
Silver	0.13	U
Thallium	0.83	UJ
Vanadium	0.8	
Zinc	4.1	J
Pesticides/PCBs (µg/kg)		
2,4,5-T	48.2	U
2,4,5-TP (silvex)	24.1	U
2,4-D	48.2	U
4,4'-DDD	1.6	U
4,4'-DDE	1.6	U
4,4'-DDT	1.6	U

PARAMETER	RESULT	QUAL
Aldrin	0.79	U
alpha-BHC	0.79	U
Aroclor-1016	5	U
Aroclor-1221	5	U
Aroclor-1232	5	U
Aroclor-1242	5	U
Aroclor-1248	5	U
Aroclor-1254	5	U
Aroclor-1260	5	U
beta-BHC	0.79	U
Chlordane	9.9	U
Chlorobenzilate	2000	U
delta-BHC	0.79	U
Dieldrin	1.6	U
Dimethoate	2000	UJ
Dinoseb	400	U
Disulfoton	400	U
Endosulfan I	0.79	U
Endosulfan II	1.6	U
Endosulfan sulfate	1.6	U
Endrin	1.6	U
Endrin aldehyde	1.6	U
Famphur	400	UJ
gamma-BHC (lindane)	0.79	U
Heptachlor	0.79	U
Heptachlor epoxide	0.79	U
Isodrin	400	U
Kepone	400	UJ
Methoxychlor	7.9	U
Methyl parathion	2	U
Parathion	2	U
Phorate	2	U
Sulfotep	400	U
Thionazin	400	U
Toxaphene	39.3	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	400	U
1,2,4-trichlorobenzene	400	U
1,2-dichlorobenzene	400	U
1,3,5-trinitrobenzene	2000	UJ
1,3-dichlorobenzene	400	U
1,3-dinitrobenzene	400	U
1,4-dichlorobenzene	400	U
1,4-dioxane	400	UJ
1,4-naphthoquinone	400	UJ
1-naphthylamine	400	U
2,3,4,6-tetrachlorophenol	400	U
2,4,5-trichlorophenol	400	U
2,4,6-trichlorophenol		U
2,4-dichlorophenol		U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
2,4-dimethylphenol	400	U
2,4-dinitrophenol	800	U
2,4-dinitrotoluene	400	U
2,6-dichlorophenol	400	U
2,6-dinitrotoluene	400	U
2-acetylaminofluorene	400	U
2-chloronaphthalene	400	U
2-chlorophenol	400	U
2-methyl-4,6-dinitrophenol	400	U
2-methylnaphthalene	400	U
2-methylphenol	400	U
2-naphthylamine	400	UR
2-nitroaniline	400	U
2-nitrophenol	400	U
2-picoline	400	U
3 & 4-methylphenol	400	U
3,3'-dichlorobenzidine	2000	UJ
3,3'-dimethylbenzidine	2000	UR
3-methylcholanthrene	400	UJ
3-nitroaniline	400	UR
4-aminobiphenyl	400	U
4-bromophenyl phenyl ether	400	U
4-chloro-3-methylphenol	400	U
4-chloroaniline	400	UR
4-chlorophenyl phenyl ether	400	U
4-nitroaniline	400	U
4-nitrophenol	800	U
4-nitroquinoline-1-oxide	400	UR
5-nitro-o-toluidine	400	U
7,12-dimethylbenz(a)anthracene	400	UJ
a,a-dimethylphenethylamine	400	U
Acenaphthene	400	U
Acenaphthylene	400	U
Acetophenone	400	U
Aniline	400	U
Anthracene	400	U
Aramite	400	UJ
Benzo(a)anthracene	400	U
Benzo(a)pyrene	400	U
Benzo(b)fluoranthene	400	U
Benzo(g,h,i)perylene	400	U
Benzo(k)fluoranthene	400	U
Benzyl alcohol	400	U
Bis(2-chloroethoxy)methane	400	U
Bis(2-chloroethyl)ether	400	U
Bis(2-ethylhexyl)phthalate	400	U
Butyl benzyl phthalate	400	U
Chrysene	400	U
Di-n-butyl phthalate	400	U
Di-n-octyl phthalate	400	U

PARAMETER	RESULT	QUAL
Diallate	400	U
Dibenzo(a,h)anthracene	400	UJ
Dibenzofuran	400	U
Diethyl phthalate	400	U
Dimethyl phthalate	400	U
Diphenylamine	400	U
Ethyl methacrylate	400	UJ
Ethyl methanesulfonate	400	U
Fluoranthene	400	U
Fluorene	400	U
Hexachlorobenzene	400	U
Hexachlorobutadiene	400	U
Hexachlorocyclopentadiene	400	U
Hexachloroethane	400	U
Hexachloropropene	400	U
Indeno(1,2,3-cd)pyrene	400	U
Isophorone	400	U
Isosafrole	400	U
Methapyrilene	2000	U
Methyl methanesulfonate	400	UJ
N-nitroso-di-n-butylamine	400	U
N-nitroso-di-n-propylamine	400	U
N-nitrosodiethylamine	400	U
N-nitrosodimethylamine	400	UJ
N-nitrosodiphenylamine	400	U
N-nitrosomethylethylamine	400	UJ
N-nitrosomorpholine	400	U
N-nitrosopiperidine	400	UJ
N-nitrosopyrrolidine	400	U
Naphthalene	400	U
Nitrobenzene	400	U
o,o,o-triethylphosphorothioate	400	U
o-toluidine	400	UJ
p-dimethylaminoazobenzene	400	U
p-phenylenediamine	800	UJ
Pentachlorobenzene	400	U
Pentachloroethane	400	U
Pentachloronitrobenzene	400	U
Pentachlorophenol	400	U
Phenacetin	400	U
Phenanthrene	400	U
Phenol	400	U
Pronamide	400	U
Pyrene	400	U
Pyridine	400	U
Safrole	400	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U

PARAMETER	RESULT	QUAL
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	6	U
2-chloro-1,3-butadiene	2	U
2-hexanone	6	U
3-chloropropene	12	U
4-methyl-2-pentanone	6	U
Acetone	6	U
Acetonitrile	12	U
Acrolein	24	UR
Acrylonitrile	24	U
Benzene	3	U
Bis(2-chloroisopropyl)ether	24	U
Bromodichloromethane	2	U
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	6	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	U
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	24	UR
Ethylbenzene	2	U
Iodomethane	6	U
Isobutanol	24	U
Methacrylonitrile	12	U
Methyl methacrylate	12	U
Methylene chloride	6	U
Styrene	2	U
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	12	UR
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	6	U
Vinyl chloride	2	U
Xylenes, total	7	UJ

PARAMETER	RESULT	QUAL
BG 4		
B4SB B4SB B&RE	0 ft	
Inorganics (mg/kg)		
Aluminum	379	
Antimony	0.5	UJ
Arsenic	1.1	U
Barium	4.9	
Beryllium	0.02	U
Cadmium	0.06	U
Chromium	4.9	
Cobalt	0.25	U
Copper	7.4	
Cyanide	0.09	UJ
Iron	448	
Lead	14.2	
Manganese	9.7	
Mercury	0.03	
Nickel	1.1	
Selenium	0.5	UJ
Silver	0.25	U
Thallium	0.5	UJ
Vanadium	2.3	
Zinc	0.25	U
Pesticides/PCBs (µg/kg)		
2,4,5-T	2.6	U
2,4,5-TP (silvex)	2.6	U
2,4-D	2.6	U
4,4'-DDD	233	J
4,4'-DDE	741	
4,4'-DDT	557	
Aldrin	84.7	U
alpha-BHC	84.7	U
Aroclor-1016	530	U
Aroclor-1221	530	U
Aroclor-1232	530	U
Aroclor-1242	530	U
Aroclor-1248	530	U
Aroclor-1254	530	U
Aroclor-1260	530	U
beta-BHC	84.7	U
Chlordane	1060	U
delta-BHC	84.7	U
Dieldrin	169	U
Endosulfan I	84.7	U
Endosulfan II	169	U
Endosulfan sulfate	169	U
Endrin	169	U
Endrin aldehyde	169	U
gamma-BHC (lindane)	84.7	U
Heptachlor	84.7	U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Heptachlor epoxide	84.7	U
Methoxychlor	847	U
Methyl parathion	212	U
Parathion	212	U
Phorate	212	U
Toxaphene	4240	U
Semivolatile Organic Compounds (µg/kg)		
1,2-dichlorobenzene	2.6	U
1,3-dichlorobenzene	2.6	U
1,4-dichlorobenzene	2.6	U
Acenaphthene	416	U
Acenaphthylene	416	U
Anthracene	416	U
Benzo(a)anthracene	416	U
Benzo(a)pyrene	416	U
Benzo(b)fluoranthene	416	U
Benzo(g,h,i)perylene	416	U
Benzo(k)fluoranthene	416	U
Chrysene	416	U
Dibenzo(a,h)anthracene	416	U
Fluoranthene	416	U
Fluorene	416	U
Indeno(1,2,3-cd)pyrene	416	U
Naphthalene	416	U
Phenanthrene	416	U
Pyrene	416	U
Volatile Organic Compounds (µg/kg)		
Benzene	2.6	U
Chlorobenzene	2.6	U
Ethylbenzene	2.6	U
Toluene	3	U
Xylenes, total	7.7	U
BG 6		
B6SB B6SB B&RE 0 ft		
Inorganics (mg/kg)		
Aluminum	2220	
Antimony	0.53	UJ
Arsenic	3.1	U
Barium	13.8	
Beryllium	0.03	U
Cadmium	0.16	U
Chromium	7.2	
Cobalt	0.27	U
Copper	5.2	
Cyanide	0.09	UJ
Iron	1290	
Lead	8.8	
Manganese	17.5	
Mercury	0.03	
Nickel	1.6	

PARAMETER	RESULT	QUAL
Selenium	0.53	UJ
Silver	0.27	U
Thallium	0.53	UJ
Vanadium	4.5	
Zinc	0.27	U
Pesticides/PCBs (µg/kg)		
2,4,5-T	2.6	U
2,4,5-TP (silvex)	2.6	U
2,4-D	2.6	U
4,4'-DDD	2	
4,4'-DDE	1.8	U
4,4'-DDT	2.1	
Aldrin	0.88	U
alpha-BHC	0.88	U
Aroclor-1016	5.5	U
Aroclor-1221	5.5	U
Aroclor-1232	5.5	U
Aroclor-1242	5.5	U
Aroclor-1248	5.5	U
Aroclor-1254	5.5	U
Aroclor-1260	5.5	U
beta-BHC	0.88	U
Chlordane	11	U
delta-BHC	0.88	U
Dieldrin	1.8	U
Endosulfan I	3.5	J
Endosulfan II	1.8	U
Endosulfan sulfate	1.8	U
Endrin	1.2	J
Endrin aldehyde	1.8	U
gamma-BHC (lindane)	0.88	U
Heptachlor	0.88	U
Heptachlor epoxide	0.88	U
Methoxychlor	13.2	
Methyl parathion	2.2	U
Parathion	2.2	U
Phorate	2.2	U
Toxaphene	41	U
Semivolatile Organic Compounds (µg/kg)		
1,2-dichlorobenzene	2.7	U
1,3-dichlorobenzene	2.7	U
1,4-dichlorobenzene	2.7	U
Acenaphthene	441	U
Acenaphthylene	441	U
Anthracene	441	U
Benzo(a)anthracene	441	U
Benzo(a)pyrene	441	U
Benzo(b)fluoranthene	441	U
Benzo(g,h,i)perylene	441	U
Benzo(k)fluoranthene	441	U

PARAMETER	RESULT	QUAL
Chrysene	441	U
Dibenzo(a,h)anthracene	441	U
Fluoranthene	441	U
Fluorene	441	U
Indeno(1,2,3-cd)pyrene	441	U
Naphthalene	441	U
Phenanthrene	441	U
Pyrene	441	U
Volatile Organic Compounds (µg/kg)		
Benzene	2.7	U
Chlorobenzene	2.7	U
Ethylbenzene	2.7	U
Toluene	2.6	U
Xylenes, total	8	U
BG 8		
B8SB B8SB B&RE 0 ft		
Inorganics (mg/kg)		
Aluminum	429	
Antimony	0.48	UJ
Arsenic	0.78	U
Barium	7.1	
Beryllium	0.02	U
Cadmium	0.05	U
Chromium	3.6	
Cobalt	0.24	U
Copper	5.4	
Cyanide	0.08	UJ
Iron	390	
Lead	10.4	
Manganese	6	
Mercury	0.03	
Nickel	2.8	
Selenium	0.51	J
Silver	0.24	U
Thallium	0.48	UJ
Vanadium	8.2	
Zinc	0.24	U
Pesticides/PCBs (µg/kg)		
2,4,5-T	2.4	U
2,4,5-TP (silvex)	2.4	U
2,4-D	2.4	U
4,4'-DDD	1.6	U
4,4'-DDE	1.8	
4,4'-DDT	1.8	
Aldrin	0.81	U
alpha-BHC	0.81	U
Aroclor-1016	5	U
Aroclor-1221	5	U
Aroclor-1232	5	U
Aroclor-1242	5	U

PARAMETER	RESULT	QUAL
Aroclor-1248	5	U
Aroclor-1254	5	U
Aroclor-1260	5	U
beta-BHC	0.81	U
Chlordane	10.1	U
delta-BHC	0.81	U
Dieldrin	1.6	U
Endosulfan I	1	
Endosulfan II	1.6	U
Endosulfan sulfate	1.6	U
Endrin	1.6	U
Endrin aldehyde	1.6	U
gamma-BHC (lindane)	0.81	U
Heptachlor	0.81	U
Heptachlor epoxide	0.81	U
Methoxychlor	8.1	U
Methyl parathion	2	U
Parathion	2	U
Phorate	2	U
Toxaphene	40.4	U
Semivolatile Organic Compounds (µg/kg)		
1,2-dichlorobenzene	2.4	U
1,3-dichlorobenzene	2.4	U
1,4-dichlorobenzene	2.4	U
Acenaphthene	398	U
Acenaphthylene	398	U
Anthracene	398	U
Benzo(a)anthracene	398	U
Benzo(a)pyrene	398	U
Benzo(b)fluoranthene	398	U
Benzo(g,h,i)perylene	398	U
Benzo(k)fluoranthene	398	U
Chrysene	398	U
Dibenzo(a,h)anthracene	398	U
Fluoranthene	398	U
Fluorene	398	U
Indeno(1,2,3-cd)pyrene	398	U
Naphthalene	398	U
Phenanthrene	398	U
Pyrene	398	U
Volatile Organic Compounds (µg/kg)		
Benzene	2.4	U
Chlorobenzene	2.4	U
Ethylbenzene	2.4	U
Toluene	2	U
Xylenes, total	2.1	J
SWMU 1		
S1SS-4 S1SS-4 B&RE 0 ft		
Inorganics (mg/kg)		
Aluminum		

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Antimony	0.64	U
Arsenic	3.8	U
Barium	17	
Beryllium	0.07	U
Cadmium	0.23	U
Chromium	10.6	
Cobalt	0.37	
Copper	6.2	
Cyanide	0.28	UJ
Iron	2050	
Lead	17.2	
Manganese	25.8	
Mercury	0.05	U
Nickel	4.1	
Selenium	1.2	U
Silver	0.17	U
Thallium	1.1	U
Vanadium	8.8	
Zinc	20.7	
Pesticides/PCBs (µg/kg)		
2,4,5-T	51.9	U
2,4,5-TP (silvex)	26	U
2,4-D	51.9	U
Chlorobenzilate	2120	U
Dimethoate	2120	U
Dinoseb	424	U
Disulfoton	424	U
Famphur	424	U
Isodrin	424	U
Kepone	424	U
Sulfotep	424	U
Thionazin	424	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	424	U
1,2,4-trichlorobenzene	424	U
1,2-dichlorobenzene	424	U
1,3,5-trinitrobenzene	2120	U
1,3-dichlorobenzene	424	U
1,3-dinitrobenzene	424	U
1,4-dichlorobenzene	424	U
1,4-dioxane	424	U
1,4-naphthoquinone	424	U
1-naphthylamine	424	U
2,3,4,6-tetrachlorophenol	424	U
2,4,5-trichlorophenol	424	U
2,4,6-trichlorophenol	424	U
2,4-dichlorophenol	424	U
2,4-dimethylphenol	424	U
2,4-dinitrophenol	848	U
2,4-dinitrotoluene	424	U

PARAMETER	RESULT	QUAL
2,6-dichlorophenol	424	U
2,6-dinitrotoluene	424	U
2-acetylaminofluorene	424	U
2-chloronaphthalene	424	U
2-chlorophenol	424	U
2-methyl-4,6-dinitrophenol	424	U
2-methylnaphthalene	424	U
2-naphthylamine	424	U
2-nitroaniline	424	U
2-nitrophenol	424	U
2-picoline	424	U
3 & 4-methylphenol	424	U
3,3'-dichlorobenzidine	2120	U
3,3'-dimethylbenzidine	2120	UR
3-methylcholanthrene	424	U
3-nitroaniline	424	U
4-aminobiphenyl	424	U
4-bromophenyl phenyl ether	424	U
4-chloro-3-methylphenol	424	U
4-chloroaniline	424	U
4-chlorophenyl phenyl ether	424	U
4-nitroaniline	424	U
4-nitrophenol	424	U
4-nitroquinoline-1-oxide	424	U
5-nitro-o-toluidine	424	U
7,12-dimethylbenz(a)anthracene	424	U
a,a-dimethylphenethylamine	424	U
Acenaphthene	424	U
Acenaphthylene	424	U
Acetophenone	424	U
Aniline	424	U
Anthracene	424	U
Aramite	424	U
Benzo(a)anthracene	424	U
Benzo(a)pyrene	424	U
Benzo(b)fluoranthene	424	U
Benzo(g,h,i)perylene	424	U
Benzo(k)fluoranthene	424	U
Benzyl alcohol	424	U
Bis(2-chloroethoxy)methane	424	U
Bis(2-chloroethyl)ether	424	U
Bis(2-ethylhexyl)phthalate	424	U
Butyl benzyl phthalate	424	U
Chrysene	424	U
Di-n-butyl phthalate	424	U
Di-n-octyl phthalate	424	U
Diallate	424	U
Dibenzo(a,h)anthracene	424	U
Dibenzofuran	424	U
Diethyl phthalate	424	U

PARAMETER	RESULT	QUAL
Dimethyl phthalate	424	U
Diphenylamine	424	U
Ethyl methacrylate	424	U
Ethyl methanesulfonate	424	U
Fluoranthene	424	U
Fluorene	424	U
Hexachlorobenzene	424	U
Hexachlorobutadiene	424	U
Hexachlorocyclopentadiene	424	U
Hexachloroethane	424	U
Hexachloropropene	424	U
Indeno(1,2,3-cd)pyrene	424	U
Isophorone	424	U
Isosafrole	424	U
Methapyrilene	2120	U
Methyl methanesulfonate	424	U
N-nitroso-di-n-butylamine	424	U
N-nitroso-di-n-propylamine	424	U
N-nitrosodiethylamine	424	U
N-nitrosodimethylamine	424	U
N-nitrosodiphenylamine	424	U
N-nitrosomethylethylamine	424	U
N-nitrosomorpholine	424	U
N-nitrosopiperidine	424	U
N-nitrosopyrrolidine	424	U
Naphthalene	424	U
Nitrobenzene	424	U
o,o,o-triethylphosphorothioate	424	U
o-toluidine	424	U
p-dimethylaminoazobenzene	424	U
p-phenylenediamine	848	U
Pentachlorobenzene	424	U
Pentachloroethane	424	U
Pentachloronitrobenzene	424	U
Pentachlorophenol	424	U
Phenacetin	424	U
Phenanthrene	424	U
Phenol	424	U
Pronamide	424	U
Pyrene	424	U
Pyridine	424	U
Safrole	424	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	3	U
1,1,1-trichloroethane	3	U
1,1,2,2-tetrachloroethane	3	U
1,1,2-trichloroethane	3	U
1,1-dichloroethane	3	U
1,1-dichloroethene	3	U
1,2,3-trichloropropane	3	U

PARAMETER	RESULT	QUAL
1,2-dibromo-3-chloropropane	3	U
1,2-dibromoethane	3	U
1,2-dichloroethane	3	U
1,2-dichloropropane	3	U
2-butanone	7	U
2-chloro-1,3-butadiene	3	U
2-hexanone	7	U
3-chloropropene	13	U
4-methyl-2-pentanone	7	U
Acetone	1	J
Acetonitrile	13	U
Acrolein	26	UR
Acrylonitrile	26	U
Benzene	3	U
Bis(2-chloroisopropyl)ether	26	U
Bromodichloromethane	3	U
Bromoform	3	U
Bromomethane	3	U
Carbon disulfide	7	U
Carbon tetrachloride	3	U
Chlorobenzene	3	U
Chloroethane	3	U
Chloroform	3	U
Chloromethane	3	U
Cis-1,3-dichloropropene	3	U
Dibromochloromethane	3	U
Dibromomethane	3	U
Dichlorodifluoromethane	3	U
Ethyl cyanide	26	UR
Ethylbenzene	0.31	J
Iodomethane	7	U
Isobutanol	26	U
Methacrylonitrile	13	U
Methyl methacrylate	13	U
Methylene chloride	3	U
Styrene	3	U
Tetrachloroethene	3	U
Toluene	1	J
Trans-1,2-dichloroethene	3	U
Trans-1,3-dichloropropene	3	U
Trans-1,4-dichloro-2-butene	13	U
Trichloroethene	3	U
Trichlorofluoromethane	3	U
Vinyl acetate	7	U
Vinyl chloride	3	U
Xylenes, total	8	U

S1SB-7 KW02561 BEI(d) 0 ft

Inorganics (mg/kg)		
Aluminum	2800	
Antimony	0.48	

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Arsenic	1.1	
Barium	12.8	
Beryllium	0.15	
Cadmium	0.45	
Chromium	15.5	
Cobalt	0.51	
Copper	10.4	
Cyanide	0.75	U
Iron	1620	
Lead	38.7	
Manganese	25.3	
Mercury	0.048	
Nickel	2.5	
Selenium	0.79	
Silver	0.18	U
Thallium	0.41	U
Tin	2.1	
Vanadium	4.9	
Zinc	52.5	
Pesticides/PCBs (µg/kg)		
4,4'-DDD	4.4	U
4,4'-DDE	5.9	
4,4'-DDT	4.7	
Aldrin	2.2	U
alpha-BHC	2.2	U
Aroclor-1016	22	U
Aroclor-1221	22	U
Aroclor-1232	22	U
Aroclor-1242	22	U
Aroclor-1248	22	U
Aroclor-1254	22	U
Aroclor-1260	69	
beta-BHC	2.2	U
Chlordane	22	U
Chlorobenzilate	850	U
delta-BHC	2.2	U
Dieldrin	4.4	U
Endosulfan I	2.2	U
Endosulfan II	4.4	U
Endosulfan sulfate	4.4	U
Endrin	4.4	U
Endrin aldehyde	4.4	U
Endrin ketone	4.4	U
gamma-BHC (lindane)	2.2	U
Heptachlor	2.2	U
Heptachlor epoxide	2.2	U
Isodrin	850	U
Kepone	1700	U
Methoxychlor	22	U
Toxaphene	220	U

PARAMETER	RESULT	QUAL
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	850	U
1,2,4-trichlorobenzene	850	U
1,2-dichlorobenzene	850	U
1,3,5-trinitrobenzene	850	U
1,3-dichlorobenzene	850	U
1,3-dinitrobenzene	850	U
1,4-dichlorobenzene	850	U
1,4-naphthoquinone	850	U
1-naphthylamine	850	U
2,3,4,6-tetrachlorophenol	1700	U
2,4,5-trichlorophenol	4100	U
2,4,6-trichlorophenol	850	U
2,4-dichlorophenol	850	U
2,4-dimethylphenol	850	U
2,4-dinitrophenol	4100	U
2,4-dinitrotoluene	850	U
2,6-dichlorophenol	850	U
2,6-dinitrotoluene	850	U
2-acetylaminofluorene	1700	U
2-chloronaphthalene	850	U
2-chlorophenol	850	U
2-methyl-4,6-dinitrophenol	4100	U
2-methylnaphthalene	850	U
2-methylphenol	850	U
2-naphthylamine	850	U
2-nitroaniline	4100	U
2-nitrophenol	850	U
2-picoline	850	U
3 & 4-methylphenol	850	U
3,3'-dichlorobenzidine	1700	U
3-methylcholanthrene	850	U
3-nitroaniline	4100	U
4-aminobiphenyl	850	U
4-bromophenyl phenyl ether	850	U
4-chloro-3-methylphenol	1700	U
4-chloroaniline	1700	U
4-chlorophenyl phenyl ether	850	U
4-nitroaniline	4100	U
4-nitrophenol	4100	U
4-nitroquinoline-1-oxide	850	U
5-nitro-o-toluidine	850	U
7,12-dimethylbenz(a)anthracene	850	U
a,a-dimethylphenethylamine	1700	U
Acenaphthene	850	U
Acenaphthylene	850	U
Acetophenone	850	U
Aniline	850	U
Anthracene	850	U
Aramite	1700	U

PARAMETER	RESULT	QUAL
Benzo(a)anthracene	850	U
Benzo(a)pyrene	850	U
Benzo(b)fluoranthene	850	U
Benzo(g,h,i)perylene	850	U
Benzo(k)fluoranthene	850	U
Benzyl alcohol	1700	U
Bis(2-chloroethoxy)methane	850	U
Bis(2-chloroethyl)ether	850	U
Bis(2-ethylhexyl)phthalate	850	U
Butyl benzyl phthalate	850	U
Carbazole	850	U
Chrysene	850	U
Di-n-butyl phthalate	82	J
Di-n-octyl phthalate	850	U
Diallate	1700	U
Dibenzo(a,h)anthracene	850	U
Dibenzofuran	850	U
Diethyl phthalate	850	U
Dimethyl phthalate	850	U
Diphenylamine	850	U
Ethyl methacrylate	850	U
Ethyl methanesulfonate	850	U
Fluoranthene	850	U
Fluorene	850	U
Hexachlorobenzene	850	U
Hexachlorobutadiene	850	U
Hexachlorocyclopentadiene	850	U
Hexachloroethane	850	U
Hexachlorophene	51	
Hexachloropropene	850	U
Indeno(1,2,3-cd)pyrene	850	U
Isophorone	850	U
Isosafrole	850	U
Methapyrilene	850	U
Methyl methanesulfonate	850	U
N-nitroso-di-n-butylamine	850	U
N-nitroso-di-n-propylamine	850	U
N-nitrosodiethylamine	850	U
N-nitrosodimethylamine	850	U
N-nitrosomethylethylamine	850	U
N-nitrosomorpholine	850	U
N-nitrosopiperidine	850	U
N-nitrosopyrrolidine	850	U
Naphthalene	850	U
Nitrobenzene	850	U
o,o,o-triethylphosphorothioate	850	U
o-toluidine	850	U
p-dimethylaminoazobenzene	850	U
p-phenylenediamine	5400	U
Pentachlorobenzene	850	U

PARAMETER	RESULT	QUAL
Pentachloroethane	850	U
Pentachloronitrobenzene	1700	U
Pentachlorophenol	4100	U
Phenacetin	850	U
Phenanthrene	850	U
Phenol	850	U
Pronamide	1700	U
Pyrene	850	U
Pyridine	850	U
Safrole	850	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	6	U
1,1,1-trichloroethane	6	U
1,1,2,2-tetrachloroethane	6	U
1,1,2-trichloroethane	6	U
1,1-dichloroethane	6	U
1,1-dichloroethene	6	U
1,2,3-trichloropropane	6	U
1,2-dibromo-3-chloropropane	6	U
1,2-dibromoethane	6	U
1,2-dichloroethane	6	U
1,2-dichloroethene	6	U
1,2-dichloropropane	6	U
2-butanone	13	U
2-chloro-1,3-butadiene	25	U
2-hexanone	13	U
3-chloropropene	6	U
4-methyl-2-pentanone	13	U
Acetone	13	U
Acrolein	25	U
Acrylonitrile	13	U
Benzene	6	U
Bis(2-chloroisopropyl)ether	850	U
Bromodichloromethane	6	U
Bromoform	6	U
Bromomethane	13	U
Carbon disulfide	6	U
Carbon tetrachloride	6	U
Chlorobenzene	6	U
Chloroethane	13	U
Chloroform	6	U
Chloromethane	13	U
Cis-1,2-dichloroethene	6	U
Cis-1,3-dichloropropene	6	U
Dibromochloromethane	6	U
Dibromomethane	6	U
Dichlorodifluoromethane	6	U
Ethyl cyanide	6	U
Ethylbenzene		U
Iodomethane		U

BRAC Background Samples
Soil Data Set

PARAMETER	RESULT	QUAL
Methacrylonitrile	6	U
Methyl methacrylate	6	U
Methylene chloride	6	U
Styrene	6	U
Tetrachloroethene	6	U
Toluene	6	U
Trans-1,2-dichloroethene	6	U
Trans-1,3-dichloropropene	6	U
Trans-1,4-dichloro-2-butene	6	U
Trichloroethene	1	J
Trichlorofluoromethane	6	U
Vinyl acetate	13	U
Vinyl chloride	13	U
Xylenes, total	6	U

SWMU 2

S2SB-9	KW02592	BEI(d)	0 ft

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	1750	
Antimony	0.26	
Arsenic	2.7	
Barium	9.3	
Beryllium	0.13	
Cadmium	0.11	
Chromium	5.3	
Cobalt	0.22	
Copper	1.3	
Cyanide	0.49	U
Iron	1090	
Lead	0.65	
Manganese	15.9	
Mercury	0.044	U
Nickel	0.78	
Selenium	0.46	
Silver	0.16	U
Thallium	0.38	U
Tin	0.78	
Vanadium	2.8	
Zinc	2.6	
Pesticides/PCBs (µg/kg)		
4,4'-DDD	6.7	
4,4'-DDE	3.9	J
4,4'-DDT	9.1	
Aldrin	2	U
alpha-BHC	2	U
Aroclor-1016	20	U
Aroclor-1221	20	U
Aroclor-1232	20	U
Aroclor-1242	20	U
Aroclor-1248	20	U
Aroclor-1254	20	U
Aroclor-1260	20	U
beta-BHC	2	U
Chlordane	20	U
delta-BHC	2	U
Dieldrin	4	U
Endosulfan I	2	U
Endosulfan II	4	U
Endosulfan sulfate	4	U
Endrin	4	U
Endrin aldehyde	4	U
Endrin ketone	4	U
gamma-BHC (lindane)	2	U
Heptachlor	2	U
Heptachlor epoxide	2	U
Methoxychlor	20	U
Toxaphene	200	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	6	U
1,1,1-trichloroethane	6	U
1,1,2,2-tetrachloroethane	6	U
1,1,2-trichloroethane	6	U
1,1-dichloroethane	6	U
1,1-dichloroethene	6	U
1,2,3-trichloropropane	6	U
1,2-dibromo-3-chloropropane	6	U
1,2-dibromoethane	6	U
1,2-dichloroethane	6	U
1,2-dichloroethene	6	U
1,2-dichloropropane	6	U
2-butanone	12	U
2-chloro-1,3-butadiene	24	U
2-hexanone	12	U
3-chloropropene	6	U
4-methyl-2-pentanone	12	U
Acetone	12	U
Acrolein	24	U
Acrylonitrile	12	U
Benzene	6	U
Bromodichloromethane	6	U
Bromoform	6	U
Bromomethane	12	U
Carbon disulfide	6	U
Carbon tetrachloride	6	U
Chlorobenzene	6	U
Chloroethane	12	U
Chloroform	6	U
Chloromethane	12	U
Cis-1,2-dichloroethene	6	U
Cis-1,3-dichloropropene	6	U
Dibromochloromethane	6	U
Dibromomethane	6	U
Dichlorodifluoromethane	6	U
Ethyl cyanide	6	U
Ethylbenzene	6	U
Iodomethane	6	U
Methacrylonitrile	6	U
Methyl methacrylate	6	U
Methylene chloride	6	U
Styrene	6	U
Tetrachloroethene	6	U
Toluene	6	U
Trans-1,2-dichloroethene	6	U
Trans-1,3-dichloropropene	6	U
Trans-1,4-dichloro-2-butene	6	U
Trichloroethene	6	U
Trichlorofluoromethane	6	U
Vinyl acetate	12	U
Vinyl chloride	12	U
Xylenes, total	6	U

PARAMETER	RESULT	QUAL

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
BG 1		
BG1SD-01 BG1SD-01 B&RE	**0 in**	
Inorganics (mg/kg)		
Aluminum	3350	
Antimony	1.2	U
Arsenic	4.3	U
Barium	12.2	
Beryllium	0.14	U
Cadmium	0.9	
Chromium	11.7	
Cobalt	0.56	
Copper	34.6	
Cyanide	0.69	U
Iron	2600	
Lead	56.5	
Manganese	38.5	
Mercury	0.14	U
Nickel	5.5	
Selenium	2.2	U
Silver	0.32	U
Thallium	2.1	UJ
Vanadium	8.9	
Zinc	58.2	
Pesticides/PCBs (µg/kg)		
2,4,5-T	133	U
2,4,5-TP (silvex)	66.7	U
2,4-D	133	U
Chlorobenzilate	21900	U
Dimethoate	21900	U
Dinoseb	4380	U
Disulfoton	4380	U
Famphur	4380	U
Isodrin	4380	U
Kepone	4380	U
Sulfotep	4380	U
Thionazin	4380	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	4380	U
1,2,4-trichlorobenzene	4380	U
1,2-dichlorobenzene	4380	U
1,3,5-trinitrobenzene	21900	U
1,3-dichlorobenzene	4380	U
1,3-dinitrobenzene	4380	U
1,4-dichlorobenzene	4380	U
1,4-dioxane	4380	U
1,4-naphthoquinone	4380	U
1-naphthylamine	4380	U
2,3,4,6-tetrachlorophenol	4380	U
2,4,5-trichlorophenol	4380	U
2,4,6-trichlorophenol	4380	U

PARAMETER	RESULT	QUAL
2,4-dichlorophenol	4380	U
2,4-dimethylphenol	4380	U
2,4-dinitrophenol	8770	U
2,4-dinitrotoluene	4380	U
2,6-dichlorophenol	4380	U
2,6-dinitrotoluene	4380	U
2-acetylaminofluorene	4380	U
2-chloronaphthalene	4380	U
2-chlorophenol	4380	U
2-methyl-4,6-dinitrophenol	4380	U
2-methylnaphthalene	4380	U
2-methylphenol	4380	U
2-naphthylamine	4380	UR
2-nitroaniline	4380	U
2-nitrophenol	4380	U
2-picoline	4380	U
3 & 4-methylphenol	4380	U
3,3'-dichlorobenzidine	21900	U
3,3'-dimethylbenzidine	21900	UR
3-methylcholanthrene	4380	U
3-nitroaniline	4380	U
4-aminobiphenyl	4380	U
4-bromophenyl phenyl ether	4380	U
4-chloro-3-methylphenol	4380	U
4-chloroaniline	4380	UR
4-chlorophenyl phenyl ether	4380	U
4-nitroaniline	4380	U
4-nitrophenol	4380	U
4-nitroquinoline-1-oxide	4380	U
5-nitro-o-toluidine	4380	U
7,12-dimethylbenz(a)anthracene	4380	U
a,a-dimethylphenethylamine	4380	UR
Acenaphthene	4380	U
Acenaphthylene	4380	U
Acetophenone	4380	U
Aniline	4380	U
Anthracene	4380	U
Aramite	4380	U
Benzo(a)anthracene	4380	U
Benzo(a)pyrene	4380	U
Benzo(b)fluoranthene	4380	U
Benzo(g,h,i)perylene	4380	U
Benzo(k)fluoranthene	4380	U
Benzyl alcohol	4380	U
Bis(2-chloroethoxy)methane	4380	U
Bis(2-chloroethyl)ether	4380	U
Bis(2-ethylhexyl)phthalate	4380	U
Butyl benzyl phthalate	4380	U
Chrysene	4380	U
Di-n-butyl phthalate	4380	U

PARAMETER	RESULT	QUAL
Di-n-octyl phthalate	4380	U
Diallate	4380	U
Dibenzo(a,h)anthracene	4380	U
Dibenzofuran	4380	U
Diethyl phthalate	4380	U
Dimethyl phthalate	4380	U
Diphenylamine	4380	U
Ethyl methacrylate	4380	U
Ethyl methanesulfonate	4380	U
Fluoranthene	4380	U
Fluorene	4380	U
Hexachlorobenzene	4380	U
Hexachlorobutadiene	4380	U
Hexachlorocyclopentadiene	4380	U
Hexachloroethane	4380	U
Hexachloropropene	4380	U
Indeno(1,2,3-cd)pyrene	4380	U
Isophorone	4380	U
Isosafrole	4380	U
Methapyrilene	21900	U
Methyl methanesulfonate	4380	U
N-nitroso-di-n-butylamine	4380	U
N-nitroso-di-n-propylamine	4380	U
N-nitrosodiethylamine	4380	U
N-nitrosodimethylamine	4380	U
N-nitrosodiphenylamine	4380	U
N-nitrosomethylethylamine	4380	U
N-nitrosomorpholine	4380	U
N-nitrosopiperidine	4380	U
N-nitrosopyrrolidine	4380	U
Naphthalene	4380	U
Nitrobenzene	4380	U
o,o,o-triethylphosphorothioate	4380	U
o-toluidine	4380	U
p-dimethylaminoazobenzene	4380	U
p-phenylenediamine	8770	U
Pentachlorobenzene	4380	U
Pentachloroethane	4380	U
Pentachloronitrobenzene	4380	U
Pentachlorophenol	4380	U
Phenacetin	4380	U
Phenanthrene	4380	U
Phenol	4380	U
Pronamide	4380	U
Pyrene	4380	U
Pyridine	4380	U
Safrole	4380	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	7	U
1,1,1-trichloroethane	7	U

PARAMETER	RESULT	QUAL
1,1,2,2-tetrachloroethane	7	U
1,1,2-trichloroethane	7	U
1,1-dichloroethane	7	U
1,1-dichloroethene	7	U
1,2,3-trichloropropane	7	U
1,2-dibromo-3-chloropropane	7	U
1,2-dibromoethane	7	U
1,2-dichloroethane	7	U
1,2-dichloropropane	7	U
2-butanone	17	U
2-chloro-1,3-butadiene	7	U
2-hexanone	17	U
3-chloropropene	33	U
4-methyl-2-pentanone	17	U
Acetone	4	J
Acetonitrile	33	U
Acrolein	67	UR
Acrylonitrile	67	U
Benzene	7	U
Bis(2-chloroisopropyl)ether	67	U
Bromodichloromethane	7	U
Bromoform	7	U
Bromomethane	7	U
Carbon disulfide	17	U
Carbon tetrachloride	7	U
Chlorobenzene	7	U
Chloroethane	7	U
Chloroform	7	U
Chloromethane	7	U
Cis-1,3-dichloropropene	7	U
Dibromochloromethane	7	U
Dibromomethane	7	U
Dichlorodifluoromethane	7	U
Ethyl cyanide	67	UR
Ethylbenzene	7	U
Iodomethane	17	U
Isobutanol	67	U
Methacrylonitrile	33	U
Methyl methacrylate	33	U
Methylene chloride	5	J
Styrene	7	U
Tetrachloroethene	7	U
Toluene	7	U
Trans-1,2-dichloroethene	7	U
Trans-1,3-dichloropropene	7	U
Trans-1,4-dichloro-2-butene	33	U
Trichloroethene	7	U
Trichlorofluoromethane	7	U
Vinyl acetate	17	U
Vinyl chloride	7	U

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Xylenes, total	19	U
BG 2		
BG2SD-01 BG2SD-01 B&RE	**0 in**	
Inorganics (mg/kg)		
Aluminum	2350	
Antimony	3	U
Barium	15.2	
Beryllium	0.35	U
Cadmium	0.47	U
Chromium	5.8	
Cobalt	0.93	U
Copper	1.8	
Cyanide	1.5	U
Iron	1360	
Lead	5.5	
Manganese	14.9	
Mercury	0.35	U
Nickel	2.3	
Selenium	5.6	U
Silver	0.82	U
Thallium	5.2	UJ
Vanadium	5.4	
Zinc	19.9	
Pesticides/PCBs (µg/kg)		
2,4,5-T	308	U
2,4,5-TP (silvex)	154	U
2,4-D	308	U
Chlorobenzilate	12600	U
Dimethoate	12600	U
Dinoseb	2530	U
Disulfoton	2530	U
Famphur	2530	U
Isodrin	2530	U
Kepone	2530	U
Sulfotep	2530	U
Thionazin	2530	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	2530	U
1,2,4-trichlorobenzene	2530	U
1,2-dichlorobenzene	2530	U
1,3,5-trinitrobenzene	12600	U
1,3-dichlorobenzene	2530	U
1,3-dinitrobenzene	2530	U
1,4-dichlorobenzene	2530	U
1,4-dioxane	2530	U
1,4-naphthoquinone	2530	U
1-naphthylamine	2530	U
2,3,4,6-tetrachlorophenol	2530	U
2,4,5-trichlorophenol	2530	U
2,4,6-trichloro	2530	U

PARAMETER	RESULT	QUAL
2,4-dichlorophenol	2530	U
2,4-dimethylphenol	2530	U
2,4-dinitrophenol	5050	U
2,4-dinitrotoluene	2530	U
2,6-dichlorophenol	2530	U
2,6-dinitrotoluene	2530	U
2-acetylaminofluorene	2530	U
2-chloronaphthalene	2530	U
2-chlorophenol	2530	U
2-methyl-4,6-dinitrophenol	2530	U
2-methylnaphthalene	2530	U
2-methylphenol	2530	U
2-naphthylamine	2530	UR
2-nitroaniline	2530	U
2-nitrophenol	2530	U
2-picoline	2530	U
3 & 4-methylphenol	2530	U
3,3'-dichlorobenzidine	12600	U
3,3'-dimethylbenzidine	12600	UR
3-methylcholanthrene	2530	U
3-nitroaniline	2530	U
4-aminobiphenyl	2530	U
4-bromophenyl phenyl ether	2530	U
4-chloro-3-methylphenol	2530	U
4-chloroaniline	2530	UR
4-chlorophenyl phenyl ether	2530	U
4-nitroaniline	2530	U
4-nitrophenol	2530	U
4-nitroquinoline-1-oxide	2530	U
5-nitro-o-toluidine	2530	U
7,12-dimethylbenz(a)anthracene	2530	U
a,a-dimethylphenethylamine	2530	UR
Acenaphthene	2530	U
Acenaphthylene	2530	U
Acetophenone	2530	U
Aniline	2530	U
Anthracene	2530	U
Aramite	2530	U
Benzo(a)anthracene	2530	U
Benzo(a)pyrene	2530	U
Benzo(b)fluoranthene	2530	U
Benzo(g,h,i)perylene	2530	U
Benzo(k)fluoranthene	2530	U
Benzyl alcohol	2530	U
Bis(2-chloroethoxy)methane	2530	U
Bis(2-chloroethyl)ether	2530	U
Bis(2-ethylhexyl)phthalate	2530	U
Butyl benzyl phthalate	2530	U
Chrysene	2530	U
Di-n-butyl phthalate	2530	U

PARAMETER	RESULT	QUAL
Di-n-octyl phthalate	2530	U
Diallate	2530	U
Dibenzo(a,h)anthracene	2530	U
Dibenzofuran	2530	U
Diethyl phthalate	2530	U
Dimethyl phthalate	2530	U
Diphenylamine	2530	U
Ethyl methacrylate	2530	U
Ethyl methanesulfonate	2530	U
Fluoranthene	2530	U
Fluorene	2530	U
Hexachlorobenzene	2530	U
Hexachlorobutadiene	2530	U
Hexachlorocyclopentadiene	2530	U
Hexachloroethane	2530	U
Hexachloropropene	2530	U
Indeno(1,2,3-cd)pyrene	2530	U
Isophorone	2530	U
Isosafrole	2530	U
Methapyrilene	12600	U
Methyl methanesulfonate	2530	U
N-nitroso-di-n-butylamine	2530	U
N-nitroso-di-n-propylamine	2530	U
N-nitrosodiethylamine	2530	U
N-nitrosodimethylamine	2530	U
N-nitrosodiphenylamine	2530	U
N-nitrosomethylethylamine	2530	U
N-nitrosomorpholine	2530	U
N-nitrosopiperidine	2530	U
N-nitrosopyrrolidine	2530	U
Naphthalene	2530	U
Nitrobenzene	2530	U
o,o,o-triethylphosphorothioate	2530	U
o-toluidine	2530	U
p-dimethylaminoazobenzene	2530	U
p-phenylenediamine	5050	U
Pentachlorobenzene	2530	U
Pentachloroethane	2530	U
Pentachloronitrobenzene	2530	U
Pentachlorophenol	2530	U
Phenacetin	2530	U
Phenanthrene	2530	U
Phenol	2530	U
Pronamide	2530	U
Pyrene	2530	U
Pyridine	2530	U
Safrole	2530	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	15	U
1,1,1-trichloroethane	15	U

PARAMETER	RESULT	QUAL
1,1,2,2-tetrachloroethane	15	U
1,1,2-trichloroethane	15	U
1,1-dichloroethane	15	U
1,1-dichloroethene	15	U
1,2,3-trichloropropane	15	U
1,2-dibromo-3-chloropropane	15	U
1,2-dibromoethane	15	U
1,2-dichloroethane	15	U
1,2-dichloropropane	15	U
2-butanone	39	U
2-chloro-1,3-butadiene	15	U
2-hexanone	39	U
3-chloropropene	77	U
4-methyl-2-pentanone	39	U
Acetone	38	
Acetonitrile	77	U
Acrolein	154	UR
Acrylonitrile	154	U
Benzene	15	U
Bis(2-chloroisopropyl)ether	154	U
Bromodichloromethane	15	U
Bromoform	15	U
Bromomethane	15	U
Carbon disulfide	39	U
Carbon tetrachloride	15	U
Chlorobenzene	15	U
Chloroethane	15	U
Chloroform	15	U
Chloromethane	15	U
Cis-1,3-dichloropropene	15	U
Dibromochloromethane	15	U
Dibromomethane	15	U
Dichlorodifluoromethane	15	U
Ethyl cyanide	154	UR
Ethylbenzene	15	U
Iodomethane	39	U
Isobutanol	154	U
Methacrylonitrile	77	U
Methyl methacrylate	77	U
Methylene chloride	15	U
Styrene	15	U
Tetrachloroethene	15	U
Toluene	15	U
Trans-1,2-dichloroethene	15	U
Trans-1,3-dichloropropene	15	U
Trans-1,4-dichloro-2-butene	77	U
Trichloroethene	15	U
Trichlorofluoromethane	15	U
Vinyl acetate		U
Vinyl chloride		U

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Xylenes, total	46	U
BG 3		
BG3SD-01 BG3SD-01 B&RE	**0 In**	
Inorganics (mg/kg)		
Aluminum	497	
Antimony	0.79	U
Arsenic	3.2	U
Barium	5	
Beryllium	0.09	U
Cadmium	0.12	U
Chromium	2.1	
Cobalt	0.24	U
Copper	3.2	
Cyanide	1.1	U
Iron	363	
Lead	32.6	
Manganese	17.3	
Mercury	0.09	U
Nickel	0.7	
Selenium	1.5	U
Silver	0.21	U
Thallium	1.4	UJ
Vanadium	2.8	
Zinc	15.7	
Pesticides/PCBs (µg/kg)		
2,4,5-T	75.5	U
2,4,5-TP (silvex)	37.7	U
2,4-D	75.5	U
Chlorobenzilate	30700	U
Dimethoate	30700	U
Dinoseb	6150	U
Disulfoton	6150	U
Famphur	6150	U
Isodrin	6150	U
Kepone	6150	U
Sulfotep	6150	U
Thionazin	6150	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	6150	U
1,2,4-trichlorobenzene	6150	U
1,2-dichlorobenzene	6150	U
1,3,5-trinitrobenzene	30700	U
1,3-dichlorobenzene	6150	U
1,3-dinitrobenzene	6150	U
1,4-dichlorobenzene	6150	U
1,4-dioxane	6150	U
1,4-naphthoquinone	6150	U
1-naphthylamine	6150	U
2,3,4,6-tetrachlorophenol	6150	U
2,4,5-trichlorophenol	6150	U

PARAMETER	RESULT	QUAL
2,4,6-trichlorophenol	6150	U
2,4-dichlorophenol	6150	U
2,4-dimethylphenol	6150	U
2,4-dinitrophenol	12300	U
2,4-dinitrotoluene	6150	U
2,6-dichlorophenol	6150	U
2,6-dinitrotoluene	6150	U
2-acetylaminofluorene	6150	U
2-chloronaphthalene	6150	U
2-chlorophenol	6150	U
2-methyl-4,6-dinitrophenol	6150	U
2-methylnaphthalene	6150	U
2-methylphenol	6150	U
2-naphthylamine	6150	UR
2-nitroaniline	6150	U
2-nitrophenol	6150	U
2-picoline	6150	U
3 & 4-methylphenol	6150	U
3,3'-dichlorobenzidine	30700	U
3,3'-dimethylbenzidine	30700	UR
3-methylcholanthrene	6150	U
3-nitroaniline	6150	U
4-aminobiphenyl	6150	U
4-bromophenyl phenyl ether	6150	U
4-chloro-3-methylphenol	6150	U
4-chloroaniline	6150	U
4-chlorophenyl phenyl ether	6150	U
4-nitroaniline	6150	U
4-nitrophenol	6150	U
4-nitroquinoline-1-oxide	6150	U
5-nitro-o-toluidine	6150	U
7,12-dimethylbenz(a)anthracene	6150	U
a,a-dimethylphenethylamine	6150	U
Acenaphthene	6150	U
Acenaphthylene	6150	U
Acetophenone	6150	U
Aniline	6150	U
Anthracene	6150	U
Aramite	6150	U
Benzo(a)anthracene	6150	U
Benzo(a)pyrene	6150	U
Benzo(b)fluoranthene	6150	U
Benzo(g,h,i)perylene	6150	U
Benzo(k)fluoranthene	6150	U
Benzyl alcohol	6150	U
Bis(2-chloroethoxy)methane	6150	U
Bis(2-chloroethyl)ether	6150	U
Bis(2-ethylhexyl)phthalate	6150	U
Butyl benzyl phthalate	6150	U
Chrysene	6150	U

PARAMETER	RESULT	QUAL
Di-n-butyl phthalate	6150	U
Di-n-octyl phthalate	6150	U
Diallate	6150	U
Dibenzo(a,h)anthracene	6150	U
Dibenzofuran	6150	U
Diethyl phthalate	6150	U
Dimethyl phthalate	6150	U
Diphenylamine	6150	U
Ethyl methacrylate	6150	U
Ethyl methanesulfonate	6150	U
Fluoranthene	6150	U
Fluorene	6150	U
Hexachlorobenzene	6150	U
Hexachlorobutadiene	6150	U
Hexachlorocyclopentadiene	6150	U
Hexachloroethane	6150	U
Hexachloropropene	6150	U
Indeno(1,2,3-cd)pyrene	6150	U
Isophorone	6150	U
Isosafrole	6150	U
Methapyrilene	30700	U
Methyl methanesulfonate	6150	U
N-nitroso-di-n-butylamine	6150	U
N-nitroso-di-n-propylamine	6150	U
N-nitrosodiethylamine	6150	U
N-nitrosodimethylamine	6150	U
N-nitrosodiphenylamine	6150	U
N-nitrosomethylethylamine	6150	U
N-nitrosomorpholine	6150	U
N-nitrosopiperidine	6150	U
N-nitrosopyrrolidine	6150	U
Naphthalene	6150	U
Nitrobenzene	6150	U
o,o,o-triethylphosphorothioate	6150	U
o-toluidine	6150	U
p-dimethylaminoazobenzene	6150	U
p-phenylenediamine	12300	U
Pentachlorobenzene	6150	U
Pentachloroethane	6150	U
Pentachloronitrobenzene	6150	U
Pentachlorophenol	6150	U
Phenacetin	6150	U
Phenanthrene	6150	U
Phenol	6150	U
Pronamide	6150	U
Pyrene	6150	U
Pyridine	6150	U
Safrole	6150	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	4	U

PARAMETER	RESULT	QUAL
1,1,1-trichloroethane	4	U
1,1,2,2-tetrachloroethane	4	U
1,1,2-trichloroethane	4	U
1,1-dichloroethane	4	U
1,1-dichloroethene	4	U
1,2,3-trichloropropane	4	U
1,2-dibromo-3-chloropropane	4	U
1,2-dibromoethane	4	U
1,2-dichloroethane	4	U
1,2-dichloropropane	4	U
2-butanone	9	U
2-chloro-1,3-butadiene	4	U
2-hexanone	9	U
3-chloropropene	19	U
4-methyl-2-pentanone	9	U
Acetone	4	U
Acetonitrile	19	U
Acrolein	38	UR
Acrylonitrile	38	U
Benzene	4	U
Bis(2-chloroisopropyl)ether	38	U
Bromodichloromethane	4	U
Bromoform	4	U
Bromomethane	4	U
Carbon disulfide	9	U
Carbon tetrachloride	4	U
Chlorobenzene	4	U
Chloroethane	4	U
Chloroform	4	U
Chloromethane	4	U
Cis-1,3-dichloropropene	4	U
Dibromochloromethane	4	U
Dibromomethane	4	U
Dichlorodifluoromethane	4	U
Ethyl cyanide	38	UR
Ethylbenzene	4	U
Iodomethane	9	U
Isobutanol	38	U
Methacrylonitrile	19	U
Methyl methacrylate	19	U
Methylene chloride	4	U
Styrene	4	U
Tetrachloroethene	4	U
Toluene	4	U
Trans-1,2-dichloroethene	4	U
Trans-1,3-dichloropropene	4	U
Trans-1,4-dichloro-2-butene	19	U
Trichloroethene	4	U
Trichlorofluoromethane	4	U
Vinyl acetate	9	U

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Vinyl chloride	4	U
Xylenes, total	11	U

BG 4

B4SS-1 B4SS-1 B&RE 0 in

Inorganics (mg/kg)

PARAMETER	RESULT	QUAL
Aluminum	97.7	
Antimony	0.57	UJ
Arsenic	3.4	
Barium	8.3	J
Beryllium	0.03	U
Cadmium	0.07	U
Chromium	1.2	U
Cobalt	0.28	U
Copper	4.6	
Cyanide	0.22	U
Iron	109	
Lead	7	
Manganese	4	
Mercury	0.02	U
Nickel	0.57	U
Selenium	0.57	UJ
Silver	0.28	U
Thallium	0.57	UJ
Vanadium	1.6	
Zinc	0.57	UJ

Pesticides/PCBs (µg/kg)

PARAMETER	RESULT	QUAL
2,4,5-T	2.9	U
2,4,5-TP (silvex)	2.9	U
2,4-D	2.9	U
4,4'-DDD	1.9	U
4,4'-DDE	1.9	U
4,4'-DDT	1.9	U
Aldrin	0.96	U
alpha-BHC	1.1	
Aroclor-1016	6	U
Aroclor-1221	6	U
Aroclor-1232	6	U
Aroclor-1242	6	U
Aroclor-1248	6	U
Aroclor-1254	6	U
Aroclor-1260	6	U
beta-BHC	0.96	U
Chlordane	12.1	U
delta-BHC	0.96	U
Dieldrin	1.9	U
Endosulfan I	0.96	U
Endosulfan II	1.9	U
Endosulfan sulfate	1.9	U
Endrin	1.9	U
Endrin aldehy	1.9	U
gamma-BHC (lindane)	0.96	U
Heptachlor	1.1	
Heptachlor epoxide	0.96	U
Methoxychlor	9.6	U
Methyl parathion	2.4	U
Parathion	2.4	U
Phorate	2.4	U
Toxaphene	48.3	U

Semivolatile Organic Compounds (µg/kg)

PARAMETER	RESULT	QUAL
1,2-dichlorobenzene	2.9	U
1,3-dichlorobenzene	2.9	U
1,4-dichlorobenzene	2.9	U
Acenaphthene	487	UJ
Acenaphthylene	487	UJ
Anthracene	487	UJ
Benzo(a)anthracene	487	UJ
Benzo(a)pyrene	487	UJ
Benzo(b)fluoranthene	487	UJ
Benzo(g,h,i)perylene	487	UJ
Benzo(k)fluoranthene	487	UJ
Chrysene	487	UJ
Dibenzo(a,h)anthracene	487	UJ
Fluoranthene	487	UJ
Fluorene	487	UJ
Indeno(1,2,3-cd)pyrene	487	UJ
Naphthalene	487	UJ
Phenanthrene	487	UJ
Pyrene	487	UJ

Volatile Organic Compounds (µg/kg)

PARAMETER	RESULT	QUAL
Benzene	2.9	U
Chlorobenzene	2.9	U
Ethylbenzene	2.9	U
Toluene	2.9	U
Xylenes, total	8.8	U

B4SS-2 B4SS-2 B&RE 0 in

Inorganics (mg/kg)

PARAMETER	RESULT	QUAL
Aluminum	186	
Antimony	0.66	UJ
Arsenic	1.8	
Barium	7.6	J
Beryllium	0.03	U
Cadmium	0.08	U
Chromium	1.7	U
Cobalt	0.33	U
Copper	5.7	
Cyanide	0.12	UJ
Iron	272	
Lead	8.4	
Manganese	6.6	
Mercury	0.07	
Nickel	0.66	U
Selenium	0.66	UJ
Silver	0.33	U
Thallium	0.66	UJ
Vanadium	2.4	J
Zinc	0.66	UJ

Pesticides/PCBs (µg/kg)

PARAMETER	RESULT	QUAL
2,4,5-T	3.4	U
2,4,5-TP (silvex)	3.4	U
2,4-D	24.7	J
4,4'-DDD	2.3	U
4,4'-DDE	2.3	U
4,4'-DDT	2.3	U
Aldrin	1.1	U
alpha-BHC	1.2	
Aroclor-1016	7.2	U
Aroclor-1221	7.2	U
Aroclor-1232	7.2	U
Aroclor-1242	7.2	U
Aroclor-1248	7.2	U
Aroclor-1254	7.2	U
Aroclor-1260	7.2	U
beta-BHC	1.1	U
Chlordane	14.4	U
delta-BHC	1.1	U
Dieldrin	2.3	U
Endosulfan I	1.2	
Endosulfan II	2.3	U
Endosulfan sulfate	2.3	U
Endrin	2.3	U
Endrin aldehyde	2.3	U
gamma-BHC (lindane)	1.3	J
Heptachlor	1.3	J
Heptachlor epoxide	1.1	U
Methoxychlor	11.5	U
Methyl parathion	2.9	U
Parathion	2.9	U
Phorate	2.9	U
Toxaphene	57.5	U

Semivolatile Organic Compounds (µg/kg)

PARAMETER	RESULT	QUAL
1,2-dichlorobenzene	3.5	U
1,3-dichlorobenzene	5.9	
1,4-dichlorobenzene	3.5	U
Acenaphthene	577	UJ
Acenaphthylene	577	UJ
Anthracene	577	UJ
Benzo(a)anthracene	577	UJ
Benzo(a)pyrene	577	UJ
Benzo(b)fluoranthene	577	UJ
Benzo(g,h,i)perylene	577	UJ
Benzo(k)fluoranthene	577	UJ
Chrysene	577	UJ
Dibenzo(a,h)anthracene	577	UJ
Fluoranthene	577	UJ
Fluorene	577	UJ
Indeno(1,2,3-cd)pyrene	577	UJ
Naphthalene	577	UJ
Phenanthrene	577	UJ
Pyrene	577	UJ

Volatile Organic Compounds (µg/kg)

PARAMETER	RESULT	QUAL
Benzene	3.5	U
Chlorobenzene	3.5	U
Ethylbenzene	3.5	U
Toluene	18.9	
Xylenes, total	10.5	U

BG 5

B5SS-1 B5SS-1 B&RE 0 in

Inorganics (mg/kg)

PARAMETER	RESULT	QUAL
Aluminum	636	
Antimony	0.81	UJ
Arsenic	2.3	
Barium	13.2	J
Beryllium	0.04	U
Cadmium	0.15	U
Chromium	4.9	U
Cobalt	0.4	U
Copper	8.2	
Cyanide	0.29	U
Iron	528	
Lead	6.8	
Manganese	12.5	
Mercury	0.04	
Nickel	1.3	
Selenium	0.81	UJ
Silver	0.4	U
Thallium	0.81	UJ
Vanadium	3.4	J
Zinc	0.81	UJ

Pesticides/PCBs (µg/kg)

PARAMETER	RESULT	QUAL
2,4,5-T	4	UR
2,4,5-TP (silvex)	4	UR
2,4-D	4	UR
4,4'-DDD	2.7	U
4,4'-DDE	2.7	U
4,4'-DDT	2.7	U
Aldrin	1.3	U
alpha-BHC	1.5	
Aroclor-1016	8.4	U
Aroclor-1221		U
Aroclor-1232		U

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Aroclor-1242	8.4	U
Aroclor-1248	8.4	U
Aroclor-1254	8.4	U
Aroclor-1260	8.4	U
beta-BHC	1.3	U
Chlordane	16.7	U
delta-BHC	1.3	U
Dieldrin	2.7	U
Endosulfan I	1.3	U
Endosulfan II	2.7	U
Endosulfan sulfate	2.7	U
Endrin	2.7	U
Endrin aldehyde	2.7	U
gamma-BHC (lindane)	2.1	
Heptachlor	1.3	U
Heptachlor epoxide	1.3	U
Methoxychlor	13.4	U
Methyl parathion	3.3	U
Parathion	3.3	U
Phorate	3.3	U
Toxaphene	66.8	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4-trichlorobenzene	669	UJ
1,2-dichlorobenzene	4.1	U
1,3-dichlorobenzene	4.1	U
1,4-dichlorobenzene	4.1	U
2,4-dinitrotoluene	669	UJ
Acenaphthene	669	UJ
Acenaphthylene	669	UJ
Anthracene	669	UJ
Benzo(a)anthracene	669	UJ
Benzo(a)pyrene	669	UJ
Benzo(b)fluoranthene	669	UJ
Benzo(g,h,i)perylene	669	UJ
Benzo(k)fluoranthene	669	UJ
Chrysene	669	UJ
Dibenzo(a,h)anthracene	669	UJ
Fluoranthene	669	UJ
Fluorene	669	UJ
Indeno(1,2,3-cd)pyrene	669	UJ
N-nitroso-di-n-propylamine	669	UJ
Naphthalene	669	UJ
Phenanthrene	669	UJ
Pyrene	669	UJ
Volatile Organic Compounds (µg/kg)		
Benzene	4.1	U
Chlorobenzene	4.1	U
Ethylbenzene	4.1	U
Toluene	3.5	J
Xylenes, total	12	U
BG 6		
B6SS B6SS B&RE	**0 in**	
Inorganics (mg/kg)		
Aluminum	945	
Antimony	0.98	UJ
Arsenic	8.1	U
Barium	7.2	
Beryllium	0.05	U
Cadmium	0.72	U
Chromium	6.2	
Cobalt	0.49	U
Copper	14	
Cyanide	0.17	UJ
Iron	3640	
Lead	23.7	
Manganese	14.3	
Mercury	0.05	
Nickel	3.6	
Selenium	0.98	UJ
Silver	0.49	U
Thallium	0.98	UJ
Vanadium	11.7	
Zinc	140	
Pesticides/PCBs (µg/kg)		
2,4,5-T	5.1	U
2,4,5-TP (silvex)	5.1	U
2,4-D	5.1	U
4,4'-DDD	3.9	
4,4'-DDE	3.9	
4,4'-DDT	3.7	
Aldrin	1.7	U
alpha-BHC	1.7	U
Aroclor-1016	10.6	U
Aroclor-1221	10.6	U
Aroclor-1232	10.6	U
Aroclor-1242	10.6	U
Aroclor-1248	10.6	U
Aroclor-1254	10.6	U
Aroclor-1260	10.6	U
beta-BHC	1.7	U
Chlordane	21.2	U
delta-BHC	2.8	J
Dieldrin	3.4	U
Endosulfan I	2.7	J
Endosulfan II	3.4	U
Endosulfan sulfate	3.4	U
Endrin	3.4	U
Endrin aldehyde	3.4	U
gamma-BHC (lindane)	2	J
Heptachlor	1.7	U
Heptachlor epoxide	1.7	U
Methoxychlor	16.9	U
Methyl parathion	4.2	U
Parathion	4.2	U
Phorate	4.2	U
Toxaphene	84.7	U
Semivolatile Organic Compounds (µg/kg)		
1,2-dichlorobenzene	5.1	U
1,3-dichlorobenzene	5.1	U
1,4-dichlorobenzene	5.1	U
Acenaphthene	844	U
Acenaphthylene	844	U
Anthracene	844	U
Benzo(a)anthracene	844	U
Benzo(a)pyrene	844	U
Benzo(b)fluoranthene	844	U
Benzo(g,h,i)perylene	844	U
Benzo(k)fluoranthene	844	U
Chrysene	844	U
Dibenzo(a,h)anthracene	844	U
Fluoranthene	844	U
Fluorene	844	U
Indeno(1,2,3-cd)pyrene	844	U
Naphthalene	844	U
Phenanthrene	844	U
Pyrene	844	U
Volatile Organic Compounds (µg/kg)		
Benzene	5.1	U
Chlorobenzene	5.1	U
Ethylbenzene	5.1	U
Toluene	5	U
Xylenes, total	15.4	U
BG 7		
B7SS-1 B7SS-1 B&RE	**0 in**	
Inorganics (mg/kg)		
Aluminum	741	
Antimony	0.88	U
Arsenic	2.7	
Barium	6.5	
Beryllium	0.04	U
Cadmium	0.19	U
Chromium	5.6	U
Cobalt	0.44	U
Copper	12.3	
Cyanide	0.14	U
Iron	736	
Lead	12	
Manganese	4.4	
Mercury	0.03	U
Nickel	2.4	
Selenium	0.88	U
Silver	0.5	
Thallium	0.88	U
Vanadium	6.2	
Zinc	11.6	
Pesticides/PCBs (µg/kg)		
2,4,5-T	4.5	UJ
2,4,5-TP (silvex)	4.5	UJ
2,4-D	4.5	UJ
4,4'-DDD	3	U
4,4'-DDE	2.2	J
4,4'-DDT	3	U
Aldrin	1.5	U
Aroclor-1016	9.3	U
Aroclor-1221	9.3	U
Aroclor-1232	9.3	U
Aroclor-1242	9.3	U
Aroclor-1248	9.3	U
Aroclor-1254	9.3	U
Aroclor-1260	9.3	U
beta-BHC	1.5	U
Chlordane	18.6	U
delta-BHC	1.5	U
Dieldrin	3	U
Endosulfan I	1.5	U
Endosulfan II	3	U
Endosulfan sulfate	3	U
Endrin	3	U
Endrin aldehyde	3	U
gamma-BHC (lindane)	1.2	J
Heptachlor	1.5	U
Heptachlor epoxide	1.5	U
Methoxychlor	14.9	U
Methyl parathion	3.7	U
Parathion	3.7	U
Phorate	3.7	U
Toxaphene	74.4	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4-trichlorobenzene	739	U
1,2-dichlorobenzene	4.5	U
1,3-dichlorobenzene	4.5	U
1,4-dichlorobenzene	4.5	U
2,4-dinitrotoluene	739	U
Acenaphthene	739	U
Acenaphthylene	739	U
Anthracene	739	U
Benzo(a)anthracene	739	U
Benzo(a)pyrene	739	U
Benzo(b)fluoranthene	739	U
Benzo(g,h,i)perylene	739	U

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Benzo(k)fluoranthene	739	U
Chrysene	739	U
Dibenzo(a,h)anthracene	739	U
Fluoranthene	739	U
Fluorene	739	U
Indeno(1,2,3-cd)pyrene	739	U
N-nitroso-di-n-propylamine	739	U
Naphthalene	739	U
Phenanthrene	739	U
Pyrene	739	U
Volatile Organic Compounds (µg/kg)		
Benzene	4.5	U
Chlorobenzene	4.5	U
Ethylbenzene	4.5	U
Toluene	5	U
Xylenes, total	13.6	U

B7SS-2 B7SS-2 B&RE 0 in

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	2280	
Antimony	1.2	U
Arsenic	7	
Barium	13.2	
Beryllium	0.06	U
Cadmium	0.12	U
Chromium	9.2	U
Cobalt	0.59	U
Copper	13.8	
Cyanide	0.2	U
Iron	1370	
Lead	19.8	
Manganese	12.1	
Mercury	0.05	U
Nickel	4.1	
Selenium	1.2	U
Silver	0.59	U
Thallium	1.2	U
Vanadium	7.7	
Zinc	29.6	
Pesticides/PCBs (µg/kg)		
2,4,5-T	6.1	UJ
2,4,5-TP (silvex)	6.1	UJ
2,4-D	6.1	UJ
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
4,4'-DDT	4.1	U
Aldrin	2.1	U
alpha-BHC	2.1	U
Aroclor-1016	12.9	U
Aroclor-1221	12.9	U
Aroclor-1232	12.9	U
Aroclor-1242	12.9	U
Aroclor-1248	12.9	U
Aroclor-1254	12.9	U
Aroclor-1260	12.9	U
beta-BHC	2.1	U
Chlordane	25.8	U
delta-BHC	2.1	U
Dieldrin	4.1	U
Endosulfan I	2.1	U
Endosulfan II	4.1	U
Endosulfan sulfate	4.1	U
Endrin	4.1	U
Endrin aldehyde	4.1	U
gamma-BHC (lindane)	2.1	U
Heptachlor	2.1	U
Heptachlor epoxide	2.1	U
Methoxychlor	43.8	
Methyl parathion	5.2	U
Parathion	5.2	U
Phorate	5.2	U
Toxaphene	103	U
Semivolatile Organic Compounds (µg/kg)		
1,2-dichlorobenzene	6.2	U
1,3-dichlorobenzene	6.2	U
1,4-dichlorobenzene	6.2	U
Acenaphthene	1040	U
Acenaphthylene	1040	U
Anthracene	1040	U
Benzo(a)anthracene	1040	U
Benzo(a)pyrene	1040	U
Benzo(b)fluoranthene	1040	U
Benzo(g,h,i)perylene	1040	U
Benzo(k)fluoranthene	1040	U
Chrysene	1040	U
Dibenzo(a,h)anthracene	1040	U
Fluoranthene	1040	U
Fluorene	1040	U
Indeno(1,2,3-cd)pyrene	1040	U
Naphthalene	1040	U
Phenanthrene	1040	U
Pyrene	1040	U
Volatile Organic Compounds (µg/kg)		
Benzene	6.2	U
Chlorobenzene	6.2	U
Ethylbenzene	6.2	U
Toluene	6	U
Xylenes, total	18.8	U

BG 8

B8SS B8SS B&RE 0 in

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	120	
Antimony	0.57	UJ
Arsenic	1.1	U
Barium	5.3	
Beryllium	0.03	U
Cadmium	0.06	
Chromium	3	
Cobalt	0.28	U
Copper	5.3	
Cyanide	0.1	UJ
Iron	452	
Lead	8.4	
Manganese	4.4	
Mercury	0.02	U
Nickel	0.93	
Selenium	0.59	J
Silver	0.28	U
Thallium	0.57	UJ
Vanadium	2.6	
Zinc	0.28	U
Pesticides/PCBs (µg/kg)		
2,4,5-T	28.4	U
2,4,5-TP (silvex)	28.4	U
2,4-D	28.4	U
4,4'-DDD	1.9	U
4,4'-DDE	1.9	U
4,4'-DDT	1.9	U
Aldrin	0.93	U
alpha-BHC	0.93	U
Aroclor-1016	5.8	U
Aroclor-1221	5.8	U
Aroclor-1232	5.8	U
Aroclor-1242	5.8	U
Aroclor-1248	5.8	U
Aroclor-1254	5.8	U
Aroclor-1260	5.8	U
beta-BHC	0.93	U
Chlordane	11.6	U
delta-BHC	0.93	U
Dieldrin	1.9	U
Endosulfan I	1.6	J
Endosulfan II	1.9	U
Endosulfan sulfate	1.9	U
Endrin	1.4	J
Endrin aldehyde	1.9	U
gamma-BHC (lindane)	0.93	U
Heptachlor	0.93	U
Heptachlor epoxide	0.93	U
Methoxychlor	9.3	U
Methyl parathion	2.3	U
Parathion	2.3	U
Phorate	2.3	U
Toxaphene	46.6	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4-trichlorobenzene	467	UJ
1,2-dichlorobenzene	2.8	U
1,3-dichlorobenzene	2.8	U
1,4-dichlorobenzene	2.8	U
2,4-dinitrotoluene	467	UJ
Acenaphthene	467	UJ
Acenaphthylene	467	UJ
Anthracene	467	UJ
Benzo(a)anthracene	467	UJ
Benzo(a)pyrene	467	UJ
Benzo(b)fluoranthene	489	J
Benzo(g,h,i)perylene	467	UJ
Benzo(k)fluoranthene	467	UJ
Chrysene	417	J
Dibenzo(a,h)anthracene	467	UJ
Fluoranthene	690	J
Fluorene	467	UJ
Indeno(1,2,3-cd)pyrene	467	UJ
N-nitroso-di-n-propylamine	467	UJ
Naphthalene	467	UJ
Phenanthrene	467	UJ
Pyrene	509	J
Volatile Organic Compounds (µg/kg)		
Benzene	2.8	U
Chlorobenzene	2.8	U
Ethylbenzene	2.8	U
Toluene	3	U
Xylenes, total	8.6	U

SWMU 1

S1SS-7SD KW02569 BEI(d) 0 in

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	1970	
Antimony	0.19	U
Arsenic	1.5	
Barium	10.9	
Beryllium	0.12	
Cadmium	0.12	
Chromium	5.3	
Cobalt	0.12	
Copper	0.76	
Cyanide	0.59	U
Iron	898	
Lead	0.14	U
Manganese	17 1	
Mercury		U
Nickel		

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Selenium	0.24	
Silver	0.12	U
Thallium	0.28	U
Tin	0.99	
Vanadium	3.7	
Zinc	3.5	
Pesticides/PCBs (µg/kg)		
4,4'-DDD	4.8	U
4,4'-DDE	4.8	U
4,4'-DDT	4.8	U
Aldrin	2.4	U
alpha-BHC	2.4	U
Aroclor-1016	24	U
Aroclor-1221	24	U
Aroclor-1232	24	U
Aroclor-1242	24	U
Aroclor-1248	24	U
Aroclor-1254	24	U
Aroclor-1260	24	U
beta-BHC	2.4	U
Chlordane	24	U
Chlorobenzilate	930	U
delta-BHC	2.4	U
Dieldrin	4.8	U
Endosulfan I	2.4	U
Endosulfan II	4.8	U
Endosulfan sulfate	4.8	U
Endrin	4.8	U
Endrin aldehyde	4.8	U
Endrin ketone	4.8	U
gamma-BHC (lindane)	2.4	U
Heptachlor	2.4	U
Heptachlor epoxide	2.4	U
Isodrin	930	U
Kepone	1800	U
Methoxychlor	24	U
Toxaphene	240	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	930	U
1,2,4-trichlorobenzene	930	U
1,2-dichlorobenzene	930	U
1,3,5-trinitrobenzene	930	U
1,3-dichlorobenzene	930	U
1,3-dinitrobenzene	930	U
1,4-dichlorobenzene	930	U
1,4-naphthoquinone	930	U
1-naphthylamine	930	U
2,3,4,6-tetrachlorophenol	1800	U
2,4,5-trichlorophenol	4500	U
2,4,6-trichlorophenol	930	U

PARAMETER	RESULT	QUAL
2,4-dichlorophenol	930	U
2,4-dimethylphenol	930	U
2,4-dinitrophenol	4500	U
2,4-dinitrotoluene	930	U
2,6-dichlorophenol	930	U
2,6-dinitrotoluene	930	U
2-acetylaminofluorene	1800	U
2-chloronaphthalene	930	U
2-chlorophenol	930	U
2-methyl-4,6-dinitrophenol	4500	U
2-methylnaphthalene	930	U
2-methylphenol	930	U
2-naphthylamine	930	U
2-nitroaniline	4500	U
2-nitrophenol	930	U
2-picoline	930	U
3 & 4-methylphenol	930	U
3,3'-dichlorobenzidine	1800	U
3-methylcholanthrene	930	U
3-nitroaniline	4500	U
4-aminobiphenyl	930	U
4-bromophenyl phenyl ether	930	U
4-chloro-3-methylphenol	1800	U
4-chloroaniline	1800	U
4-chlorophenyl phenyl ether	930	U
4-nitroaniline	4500	U
4-nitrophenol	4500	U
4-nitroquinoline-1-oxide	930	U
5-nitro-o-toluidine	930	U
7,12-dimethylbenz(a)anthracene	930	U
a,a-dimethylphenethylamine	1800	U
Acenaphthene	930	U
Acenaphthylene	930	U
Acetophenone	930	U
Aniline	930	U
Anthracene	930	U
Aramite	1800	U
Benzo(a)anthracene	930	U
Benzo(a)pyrene	930	U
Benzo(b)fluoranthene	930	U
Benzo(g,h,i)perylene	930	U
Benzo(k)fluoranthene	930	U
Benzyl alcohol	1800	U
Bis(2-chloroethoxy)methane	930	U
Bis(2-chloroethyl)ether	930	U
Bis(2-ethylhexyl)phthalate	930	U
Butyl benzyl phthalate	930	U
Carbazole	930	U
Chrysene	930	U
Di-n-butyl phthalate	930	U

PARAMETER	RESULT	QUAL
Di-n-octyl phthalate	930	U
Diallate	1800	U
Dibenzo(a,h)anthracene	930	U
Dibenzofuran	930	U
Diethyl phthalate	930	U
Dimethyl phthalate	930	U
Diphenylamine	930	U
Ethyl methacrylate	930	U
Ethyl methanesulfonate	930	U
Fluoranthene	930	U
Fluorene	930	U
Hexachlorobenzene	930	U
Hexachlorobutadiene	930	U
Hexachlorocyclopentadiene	930	U
Hexachloroethane	930	U
Hexachlorophene	820	
Hexachloropropene	930	U
Indeno(1,2,3-cd)pyrene	930	U
Isophorone	930	U
Isosafrole	930	U
Methapyrilene	930	U
Methyl methanesulfonate	930	U
N-nitroso-di-n-butylamine	930	U
N-nitroso-di-n-propylamine	930	U
N-nitrosodiethylamine	930	U
N-nitrosodimethylamine	930	U
N-nitrosomethylethylamine	930	U
N-nitrosomorpholine	930	U
N-nitrosopiperidine	930	U
N-nitrosopyrrolidine	930	U
Naphthalene	930	U
Nitrobenzene	930	U
o,o,o-triethylphosphorothioate	930	U
o-toluidine	930	U
p-dimethylaminoazobenzene	930	U
p-phenylenediamine	5900	U
Pentachlorobenzene	930	U
Pentachloroethane	930	U
Pentachloronitrobenzene	1800	U
Pentachlorophenol	4500	U
Phenacetin	930	U
Phenanthrene	930	U
Phenol	930	U
Pronamide	1800	U
Pyrene	930	U
Pyridine	930	U
Safrole	930	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	7	U
1,1,1-trichloroethane	7	U

PARAMETER	RESULT	QUAL
1,1,2,2-tetrachloroethane	7	U
1,1,2-trichloroethane	7	U
1,1-dichloroethane	7	U
1,1-dichloroethene	7	U
1,2,3-trichloropropane	7	U
1,2-dibromo-3-chloropropane	7	U
1,2-dibromoethane	7	U
1,2-dichloroethane	7	U
1,2-dichloroethene	7	U
1,2-dichloropropane	7	U
2-butanone	15	U
2-chloro-1,3-butadiene	29	U
2-hexanone	15	U
3-chloropropene	7	U
4-methyl-2-pentanone	15	U
Acetone	15	U
Acrolein	29	U
Acrylonitrile	15	U
Benzene	7	U
Bis(2-chloroisopropyl)ether	930	U
Bromodichloromethane	7	U
Bromoform	7	U
Bromomethane	15	U
Carbon disulfide	7	U
Carbon tetrachloride	7	U
Chlorobenzene	7	U
Chloroethane	15	U
Chloroform	7	U
Chloromethane	15	U
Cis-1,2-dichloroethene	7	U
Cis-1,3-dichloropropene	7	U
Dibromochloromethane	7	U
Dibromomethane	7	U
Dichlorodifluoromethane	7	U
Ethyl cyanide	7	U
Ethylbenzene	7	U
Iodomethane	7	U
Methacrylonitrile	7	U
Methyl methacrylate	7	U
Methylene chloride	7	U
Styrene	7	U
Tetrachloroethene	7	U
Toluene	7	U
Trans-1,2-dichloroethene	7	U
Trans-1,3-dichloropropene	7	U
Trans-1,4-dichloro-2-butene	7	U
Trichloroethene	7	U
Trichlorofluoromethane	7	U
Vinyl acetate	15	U
Vinyl chloride	15	U

BRAC Background Samples
Sediment Data Set

PARAMETER	RESULT	QUAL
Xylenes, total	7	U

SWMU 4

S4SS-4	S4SS-4	B&RE	0 in

PARAMETER	RESULT	QUAL
Inorganics (mg/kg)		
Aluminum	2810	
Antimony	1	U
Arsenic	2.9	
Barium	9.8	
Beryllium	0.05	U
Cadmium	0.1	U
Chromium	9.9	
Cobalt	0.52	U
Copper	8.5	
Cyanide	0.19	UJ
Iron	2060	
Lead	24.3	
Manganese	38.6	
Mercury	0.04	
Nickel	2.6	
Selenium	1	U
Silver	0.52	U
Thallium	1	U
Vanadium	6.2	
Zinc	0.52	U
Pesticides/PCBs (µg/kg)		
Chlorobenzilate	4580	U
Dimethoate	4580	U
Dinoseb	916	U
Disulfoton	916	U
Famphur	916	U
Isodrin	916	U
Kepone	916	U
Sulfotep	916	U
Thionazin	916	U
Semivolatile Organic Compounds (µg/kg)		
1,2,4,5-tetrachlorobenzene	916	U
1,2,4-trichlorobenzene	916	U
1,2-dichlorobenzene	916	U
1,3,5-trinitrobenzene	4580	U
1,3-dichlorobenzene	916	U
1,3-dinitrobenzene	916	U
1,4-dichlorobenzene	916	U
1,4-dioxane	916	U
1,4-naphthoquinone	916	U
1-naphthylamine	916	U
2,3,4,6-tetrachlorophenol	916	U
2,4,5-trichlorophenol	916	U
2,4,6-trichlorophenol	916	U
2,4-dichlorophe·	916	U
2,4-dimethylp:	916	U

PARAMETER	RESULT	QUAL
2,4-dinitrophenol	1830	U
2,4-dinitrotoluene	916	U
2,6-dichlorophenol	916	U
2,6-dinitrotoluene	916	U
2-acetylaminofluorene	916	U
2-chloronaphthalene	916	U
2-chlorophenol	916	U
2-methyl-4,6-dinitrophenol	916	U
2-methylnaphthalene	916	U
2-methylphenol	916	U
2-naphthylamine	916	U
2-nitroaniline	916	U
2-nitrophenol	916	U
2-picoline	916	U
3,3'-dichlorobenzidine	1830	U
3,3'-dimethylbenzidine	4580	U
3-methylcholanthrene	916	U
3-nitroaniline	916	U
4-aminobiphenyl	916	U
4-bromophenyl phenyl ether	916	U
4-chloro-3-methylphenol	916	U
4-chloroaniline	916	U
4-chlorophenyl phenyl ether	916	U
4-methylphenol	916	U
4-nitroaniline	916	U
4-nitrophenol	916	U
4-nitroquinoline-1-oxide	916	U
5-nitro-o-toluidine	916	U
7,12-dimethylbenz(a)anthracene	916	U
a,a-dimethylphenethylamine	916	U
Acenaphthene	916	U
Acenaphthylene	916	U
Acetophenone	916	U
Aniline	916	U
Anthracene	916	U
Aramite	916	U
Benzo(a)anthracene	916	U
Benzo(a)pyrene	916	U
Benzo(b)fluoranthene	916	U
Benzo(g,h,i)perylene	916	U
Benzo(k)fluoranthene	916	U
Benzyl alcohol	916	U
Bis(2-chloroethoxy)methane	916	U
Bis(2-chloroethyl)ether	916	U
Bis(2-ethylhexyl)phthalate	916	U
Butyl benzyl phthalate	916	U
Chrysene	916	U
Di-n-butyl phthalate	916	U
Di-n-octyl phthalate	916	U
Diallate	916	U

PARAMETER	RESULT	QUAL
Dibenzo(a,h)anthracene	916	U
Dibenzofuran	916	U
Diethyl phthalate	916	U
Dimethyl phthalate	916	U
Diphenylamine	916	U
Ethyl methacrylate	916	U
Ethyl methanesulfonate	916	U
Fluoranthene	916	U
Fluorene	916	U
Hexachlorobenzene	916	U
Hexachlorobutadiene	916	U
Hexachlorocyclopentadiene	916	U
Hexachloroethane	916	U
Hexachloropropene	916	U
Indeno(1,2,3-cd)pyrene	916	U
Isophorone	916	U
Isosafrole	916	U
Methapyrilene	4580	U
Methyl methanesulfonate	916	U
N-nitroso-di-n-butylamine	916	U
N-nitroso-di-n-propylamine	916	U
N-nitrosodiethylamine	916	U
N-nitrosodimethylamine	916	U
N-nitrosodiphenylamine	916	U
N-nitrosomethylethylamine	916	U
N-nitrosomorpholine	916	U
N-nitrosopiperidine	916	U
N-nitrosopyrrolidine	916	U
Naphthalene	916	U
Nitrobenzene	916	U
o,o,o-triethylphosphorothioate	916	U
o-toluidine	916	U
p-dimethylaminoazobenzene	916	U
p-phenylenediamine	1830	U
Pentachlorobenzene	916	U
Pentachloroethane	916	U
Pentachloronitrobenzene	916	U
Pentachlorophenol	916	U
Phenacetin	916	U
Phenanthrene	916	U
Phenol	916	U
Pronamide	916	U
Pyrene	916	U
Pyridine	916	U
Safrole	916	U
Volatile Organic Compounds (µg/kg)		
1,1,1,2-tetrachloroethane	5.6	U
1,1,1-trichloroethane	5.6	U
1,1,2,2-tetrachloroethane	5.6	U
1,1,2-trichloroethane	5.6	U

PARAMETER	RESULT	QUAL
1,1-dichloroethane	5.6	U
1,1-dichloroethene	5.6	U
1,2,3-trichloropropane	2.8	U
1,2-dibromo-3-chloropropane	2.8	U
1,2-dibromoethane	2.8	U
1,2-dichloroethane	5.6	U
1,2-dichloropropane	5.6	U
2-butanone	13.9	U
2-chloro-1,3-butadiene	2.8	UR
2-hexanone	13.9	U
3-chloropropene	13.9	U
4-methyl-2-pentanone	13.9	U
Acetone	27.8	U
Acetonitrile	13.9	U
Acrolein	27.8	UR
Acrylonitrile	27.8	U
Benzene	5.6	U
Bis(2-chloroisopropyl)ether	27.8	U
Bromodichloromethane	5.6	U
Bromoform	5.6	U
Bromomethane	5.6	U
Carbon disulfide	13.9	U
Carbon tetrachloride	5.6	U
Chlorobenzene	5.6	U
Chloroethane	5.6	U
Chloroform	5.6	U
Chloromethane	5.6	U
Cis-1,3-dichloropropene	5.6	U
Dibromochloromethane	5.6	U
Dibromomethane	5.6	U
Dichlorodifluoromethane	5.6	U
Ethyl cyanide	27.8	UR
Ethylbenzene	5.6	U
Iodomethane	6.9	U
Isobutanol	27.8	UR
Methacrylonitrile	13.9	UR
Methyl methacrylate	13.9	U
Methylene chloride	14	U
Styrene	5.6	U
Tetrachloroethene	2	J
Toluene	6	U
Trans-1,2-dichloroethene	5.6	U
Trans-1,3-dichloropropene	5.6	U
Trans-1,4-dichloro-2-butene	13.9	U
Trichloroethene	5.6	U
Trichlorofluoromethane	5.6	U
Vinyl acetate	13.9	U
Vinyl chloride	5.6	U
Xylenes, total		U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
BG 1		
BG1SW-01 BG1SW-01	**B&RE**	
Inorganics		
Aluminum	11.1	U
Antimony	2.6	U
Arsenic	4.9	U
Barium	7.9	
Beryllium	0.3	U
Cadmium	0.4	U
Chromium	0.9	U
Cobalt	0.8	U
Copper	1.2	U
Cyanide	2.5	U
Iron	3	U
Lead	1.8	U
Manganese	0.6	U
Mercury	0.48	
Nickel	1.3	U
Selenium	4.8	U
Silver	0.7	U
Thallium	4.5	U
Vanadium	0.7	U
Zinc	1.4	U
Pesticides/PCBs		
2,4,5-T	0.19	U
2,4,5-TP (silvex)	0.096	U
2,4-D	0.19	U
4,4'-DDD	0.039	U
4,4'-DDE	0.039	U
4,4'-DDT	0.039	U
Aldrin	0.019	U
alpha-BHC	0.019	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.019	U
Chlordane	0.24	U
Chlorobenzilate	50	U
delta-BHC	0.019	U
Dieldrin	0.039	U
Dimethoate	50	U
Dinoseb	10	U
Disulfoton	10	U
Endosulfan I	0.019	U
Endosulfan II	0.039	U
Endosulfan sulfate	0.039	U

PARAMETER	RESULT	QUAL
Endrin	0.039	U
Endrin aldehyde	0.039	U
Famphur	10	U
gamma-BHC (lindane)	0.019	U
Heptachlor	0.019	U
Heptachlor epoxide	0.019	U
Isodrin	10	U
Kepone	10	U
Methoxychlor	0.19	U
Methyl parathion	0.048	U
Parathion	0.048	U
Phorate	0.048	U
Sulfotep	10	U
Thionazin	10	U
Toxaphene	0.97	U
Semivolatile Organic Compounds		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	50	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U
2-methylnaphthalene	10	U
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	U
2-picoline	10	U
3 & 4-methylphenol	10	U
3,3'-dichlorobenzidine	50	U
3,3'-dimethylbenzidine	50	UR
3-methylcholanthrene	10	U
3-nitroaniline	10	U

PARAMETER	RESULT	QUAL
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-nitroaniline	10	U
4-nitrophenol	10	U
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	50	U
Methyl methanesulfonate	10	U

PARAMETER	RESULT	QUAL
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol	10	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	5	U
2-chloro-1,3-butadiene	2	U
2-hexanone	5	U
3-chloropropene	10	U
4-methyl-2-pentanone	5	U
Acetone	2	U
Acetonitrile	10	U
Acrolein	20	UR
Acrylonitrile	20	U
Benzene	2	U
Bis(2-chloroisopropyl)ether	20	U
Bromodichloromethane	2	U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	5	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	U
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	20	UR
Ethylbenzene	2	U
Iodomethane	5	U
Isobutanol	20	U
Methacrylonitrile	10	U
Methyl methacrylate	10	U
Methylene chloride	2	U
Styrene	2	U
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	10	U
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	5	U
Vinyl chloride	2	U
Xylenes, total	6	U
BG 2		
BG2SW-01	**BG2SW-01**	**B&RE**
Inorganics		
Aluminum	11.1	U
Antimony	3.5	
Arsenic	5.5	U
Barium	7	
Beryllium	0.3	U
Cadmium	0.4	U
Chromium	0.9	U
Cobalt	0.8	U
Copper	1.2	U
Cyanide	3.1	U
Iron	3	U
Lead	1.8	U
Manganese	1.2	U
Mercury	0.1	U
Nickel	1.3	U
Selenium	4.8	U
Silver	0.7	U

PARAMETER	RESULT	QUAL
Thallium	12	
Vanadium	0.7	U
Zinc	2.8	U
Pesticides/PCBs		
2,4,5-T	0.2	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.2	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U
Chlordane	0.25	U
Chlorobenzilate	50	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Dimethoate	50	U
Dinoseb	10	U
Disulfoton	10	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
Famphur	10	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Isodrin	10	U
Kepone	10	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Sulfotep	10	U
Thionazin	10	U
Toxaphene	1	U
Semivolatile Organic Compounds		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	50	U

PARAMETER	RESULT	QUAL
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U
2-methylnaphthalene	10	U
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	U
2-picoline	10	U
3 & 4-methylphenol	10	U
3,3'-dichlorobenzidine	50	U
3,3'-dimethylbenzidine	50	UR
3-methylcholanthrene	10	U
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-nitroaniline	10	U
4-nitrophenol	10	U
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U

PARAMETER	RESULT	QUAL
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	50	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol		U
Phenacetin		U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	5	U
2-chloro-1,3-butadiene	2	U
2-hexanone	5	U
3-chloropropene	10	U
4-methyl-2-pentanone	5	U
Acetone	2	U
Acetonitrile	10	U
Acrolein	20	UR
Acrylonitrile	20	U
Benzene	2	U
Bis(2-chloroisopropyl)ether	20	U
Bromodichloromethane	2	U
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	5	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	U
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	20	UR
Ethylbenzene	2	U
Iodomethane	5	U
Isobutanol	20	U
Methacrylonitrile	10	U
Methyl methacrylate	10	U
Methylene chloride	2	U
Styrene	2	U

PARAMETER	RESULT	QUAL
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	10	U
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	5	U
Vinyl chloride	2	U
Xylenes, total	6	U

BG 3

BG3SW-01 BG3SW-01 B&RE

PARAMETER	RESULT	QUAL
Inorganics		
Aluminum	11.1	U
Antimony	7.3	
Arsenic	4.9	U
Barium	5.8	
Beryllium	0.3	U
Cadmium	0.4	U
Chromium	0.9	U
Cobalt	0.8	U
Copper	1.2	U
Cyanide	0.97	U
Iron	3	U
Lead	3.9	U
Manganese	1.2	U
Mercury	0.1	U
Nickel	1.3	U
Selenium	4.8	U
Silver	0.7	U
Thallium	7.4	
Vanadium	0.7	U
Zinc	2.8	U
Pesticides/PCBs		
2,4,5-T	0.2	U
2,4,5-TP (silvex)	0.098	U
2,4-D	0.2	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U

PARAMETER	RESULT	QUAL
Chlordane	0.25	U
Chlorobenzilate	50	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Dimethoate	50	U
Dinoseb	10	U
Disulfoton	10	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
Famphur	10	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Isodrin	10	U
Kepone	10	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Sulfotep	10	U
Thionazin	10	U
Toxaphene	1	U
Semivolatile Organic Compounds		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	50	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U
2-methylnaphthalene	10	U

PARAMETER	RESULT	QUAL
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	U
2-picoline	10	U
3 & 4-methylphenol	10	U
3,3'-dichlorobenzidine	50	U
3,3'-dimethylbenzidine	50	UR
3-methylcholanthrene	10	U
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-nitroaniline	10	U
4-nitrophenol	10	U
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	50	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol	10	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	5	U
2-chloro-1,3-[illegible]ne	2	U

PARAMETER	RESULT	QUAL
2-hexanone	5	U
3-chloropropene	10	U
4-methyl-2-pentanone	5	U
Acetone	2	U
Acetonitrile	10	U
Acrolein	20	UR
Acrylonitrile	20	U
Benzene	2	U
Bis(2-chloroisopropyl)ether	20	U
Bromodichloromethane	2	U
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	5	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	U
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	20	UR
Ethylbenzene	2	U
Iodomethane	5	U
Isobutanol	20	U
Methacrylonitrile	10	U
Methyl methacrylate	10	U
Methylene chloride	2	U
Styrene	2	U
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	10	U
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	5	U
Vinyl chloride	2	U
Xylenes, total	6	U

BG 4

B4SW	B4SW	B&RE
Inorganics		
Aluminum	28	U
Antimony	4	UJ
Arsenic	6.1	U
Barium	6.6	J
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U

PARAMETER	RESULT	QUAL
Cobalt	2	U
Copper	4	UJ
Cyanide	1.5	UR
Iron	4	U
Lead	3.2	U
Manganese	2	UJ
Mercury	0.36	
Nickel	4	U
Selenium	4	U
Silver	2	U
Thallium	4	UJ
Vanadium	2	U
Zinc	2	UJ
Pesticides/PCBs		
2,4,5-T	0.097	U
2,4,5-TP (silvex)	0.097	U
2,4-D	0.097	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U
Chlordane	0.25	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Toxaphene	1	U
Semivolatile Organic Compounds		
1,2-dichlorobenzene	2	U
1,3-dichlorobenzene	2	U
1,4-dichlorobenzene	2	U

PARAMETER	RESULT	QUAL
1-methylnaphthalene	10	U
2-methylnaphthalene	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Anthracene	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Chrysene	10	U
Dibenzo(a,h)anthracene	10	U
Fluoranthene	10	U
Fluorene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Naphthalene	10	U
Phenanthrene	10	U
Pyrene	10	U
Volatile Organic Compounds		
Benzene	2	U
Chlorobenzene	2	U
Ethylbenzene	2	U
Toluene	2	U
Xylenes, total	6	U

BG 5

B5SW	B5SW	B&RE
Inorganics		
Aluminum	28	U
Antimony	4	UJ
Arsenic	4	U
Barium	6.5	J
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U
Cobalt	2	U
Copper	4	UJ
Cyanide	1.4	UR
Iron	4	U
Lead	5.1	U
Manganese	2	UJ
Mercury	0.41	
Nickel	4	U
Selenium	4	U
Silver	2	U
Thallium	4	UJ
Vanadium	2	U
Zinc	2	UJ
Pesticides/PCBs		
2,4,5-T	[illegible]	U
2,4,5-TP (silvex)	[illegible]	U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
2,4-D	0.096	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U
Chlordane	0.25	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Toxaphene	1	U
Semivolatile Organic Compounds		
1,2-dichlorobenzene	2	U
1,3-dichlorobenzene	2	U
1,4-dichlorobenzene	2	U
1-methylnaphthalene	10	U
2-methylnaphthalene	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Anthracene	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Chrysene	10	U
Dibenzo(a,h)anthracene	10	U
Fluoranthene	10	U
Fluorene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Naphthalene	10	U

PARAMETER	RESULT	QUAL
Phenanthrene	10	U
Pyrene	10	U
Volatile Organic Compounds		
Benzene	2	U
Chlorobenzene	2	U
Ethylbenzene	2	U
Toluene	2	U
Xylenes, total	6	U

BG 6

B6SW	B6SW	B&RE
Inorganics		
Aluminum	28	U
Antimony	4	U
Arsenic	4	U
Barium	8.1	
Beryllium	0.2	U
Cadmium	0.4	U
Chromium	2	U
Cobalt	2	U
Copper	4	U
Cyanide	1.4	U
Iron	4	U
Lead	3	U
Manganese	2	U
Mercury	0.1	U
Nickel	4	U
Selenium	4	U
Silver	2	U
Thallium	4	U
Vanadium	2	U
Zinc	2	U
Pesticides/PCBs		
2,4,5-T	0.097	U
2,4,5-TP (silvex)	0.097	U
2,4-D	0.097	U
4,4'-DDD	0.047	U
4,4'-DDE	0.047	U
4,4'-DDT	0.047	U
Aldrin	0.024	U
alpha-BHC	0.024	U
Aroclor-1016	0.15	U
Aroclor-1221	0.15	U
Aroclor-1232	0.15	U
Aroclor-1242	0.15	U
Aroclor-1254	0.15	U
Aroclor-1260	0.15	U
beta-BHC	0.024	U
Chlordane	0.29	U
delta-BHC	0.024	U
Dieldrin	0.047	U

PARAMETER	RESULT	QUAL
Endosulfan I	0.024	U
Endosulfan II	0.047	U
Endosulfan sulfate	0.047	U
Endrin	0.047	U
Endrin aldehyde	0.047	U
gamma-BHC (lindane)	0.024	U
Heptachlor	0.024	U
Heptachlor epoxide	0.024	U
Methoxychlor	0.24	U
Methyl parathion	0.059	U
Parathion	0.059	U
Phorate	0.059	U
Toxaphene	1.2	U
Semivolatile Organic Compounds		
1,2-dichlorobenzene	2	U
1,3-dichlorobenzene	2	U
1,4-dichlorobenzene	2	U
Acenaphthene	10	U
Acenaphthylene	10	U
Anthracene	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Chrysene	10	U
Dibenzo(a,h)anthracene	10	U
Fluoranthene	10	U
Fluorene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Naphthalene	10	U
Phenanthrene	10	U
Pyrene	10	U
Volatile Organic Compounds		
Benzene	2	U
Chlorobenzene	2	U
Ethylbenzene	2	U
Toluene	2	U
Xylenes, total	6	U

BG 7

B7SW-1	B7SW-1	B&RE
Inorganics		
Aluminum	28	U
Antimony	4	UJ
Arsenic	4	U
Barium	6.8	U
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U
Cobalt	2	U

PARAMETER	RESULT	QUAL
Copper	4	U
Cyanide	1.4	U
Iron	14.7	U
Lead	3	UJ
Manganese	2	UJ
Mercury	4.2	
Nickel	4	U
Selenium	4	UJ
Silver	2	U
Thallium	6.6	U
Vanadium	2	U
Zinc	2	UJ
Pesticides/PCBs		
2,4,5-T	0.097	U
2,4,5-TP (silvex)	0.097	U
2,4-D	0.097	U
4,4'-DDD	0.08	U
4,4'-DDE	0.08	U
4,4'-DDT	0.08	U
Aldrin	0.04	U
alpha-BHC	0.04	U
Aroclor-1016	0.25	U
Aroclor-1221	0.25	U
Aroclor-1232	0.25	U
Aroclor-1242	0.25	U
Aroclor-1248	0.25	U
Aroclor-1254	0.25	U
Aroclor-1260	0.25	U
beta-BHC	0.04	U
Chlordane	0.5	U
delta-BHC	0.04	U
Dieldrin	0.08	U
Endosulfan I	0.04	U
Endosulfan II	0.08	U
Endosulfan sulfate	0.08	U
Endrin	0.08	U
Endrin aldehyde	0.08	U
gamma-BHC (lindane)	0.04	U
Heptachlor	0.04	U
Heptachlor epoxide	0.04	U
Methoxychlor	0.4	U
Methyl parathion	0.1	U
Parathion	0.1	U
Phorate	0.1	U
Toxaphene	2	U
Semivolatile Organic Compounds		
1,2-dichlorobenzene	2	U
1,3-dichlorobenzene	2	U
1,4-dichlorobenzene	2	U
Acenaphthene	10	U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
Acenaphthylene	10	U
Anthracene	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Chrysene	10	U
Dibenzo(a,h)anthracene	10	U
Fluoranthene	10	U
Fluorene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Naphthalene	10	U
Phenanthrene	10	U
Pyrene	10	U
Volatile Organic Compounds		
Benzene	2	U
Chlorobenzene	2	U
Ethylbenzene	2	U
Toluene	2	U
Xylenes, total	6	U

SWMU 1

S1SS-7SW	KW02568	BEI(d)
Inorganics		
Aluminum	148	
Antimony	2.4	U
Arsenic	2.6	
Barium	7.4	
Beryllium	0.17	
Cadmium	0.2	U
Chromium	1.3	U
Cobalt	0.8	U
Copper	2	
Cyanide	10	U
Iron	170	
Lead	1.7	U
Manganese	12.3	
Mercury	0.08	U
Nickel	1.6	U
Selenium	3	U
Silver	1.5	U
Thallium	3.5	U
Tin	5	U
Vanadium	2.8	
Zinc	12.8	
Pesticides/PCBs		
4,4'-DDD	0.1	U
4,4'-DDE	0.1	U
4,4'-DDT	0.1	U
Aldrin	0.051	U

PARAMETER	RESULT	QUAL
alpha-BHC	0.051	U
Aroclor-1016	0.51	U
Aroclor-1221	0.51	U
Aroclor-1232	0.51	U
Aroclor-1242	0.51	U
Aroclor-1248	0.51	U
Aroclor-1254	0.51	U
Aroclor-1260	0.51	U
beta-BHC	0.051	U
Chlordane	0.51	U
Chlorobenzilate	10	U
delta-BHC	0.051	U
Dieldrin	0.1	U
Endosulfan I	0.051	U
Endosulfan II	0.1	U
Endosulfan sulfate	0.1	U
Endrin	0.1	U
Endrin aldehyde	0.1	U
Endrin ketone	0.1	U
gamma-BHC (lindane)	0.051	U
Heptachlor	0.051	U
Heptachlor epoxide	0.051	U
Isodrin	10	U
Kepone	20	U
Methoxychlor	0.51	U
Toxaphene	5.1	U
Semivolatile Organic Compounds		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	10	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	20	U
2,4,5-trichlorophenol	50	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	50	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	20	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	50	U
2-methylnaphthalene	10	U

PARAMETER	RESULT	QUAL
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	50	U
2-nitrophenol	10	U
2-picoline	10	U
3 & 4-methylphenol	10	U
3,3'-dichlorobenzidine	20	U
3-methylcholanthrene	10	U
3-nitroaniline	50	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	20	U
4-chloroaniline	20	U
4-chlorophenyl phenyl ether	10	U
4-nitroaniline	50	U
4-nitrophenol	50	U
4-nitroquinoline-1-oxide	10	U
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	20	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	20	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	20	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Carbazole	10	U
Chrysene	10	U
Di-n-butyl phthalate	2	J
Di-n-octyl phthalate	10	U
Diallate	20	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U

PARAMETER	RESULT	QUAL
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	10	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	65	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	20	U
Pentachlorophenol	50	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	20	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds		
1,1,1,2-tetrachloroethane	5	U
1,1,1-trichloroethane	5	U
1,1,2,2-tetrachloroethane	5	U
1,1,2-trichloroethane	5	U
1,1-dichloroethane	5	U
1,1-dichloroethene	5	U
1,2,3-trichloropropane	5	U
1,2-dibromo-3-chloropropane	5	U
1,2-dibromoethane	5	U
1,2-dichloroethane	5	U
1,2-dichloroethene	5	U
1,2-dichloropropane	5	U
2-butanone	[illegible]	U
2-chloro-1,3-butadiene	[illegible]	U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
2-hexanone	10	U
3-chloropropene	5	U
4-methyl-2-pentanone	10	U
Acetone	12	
Acrolein	20	U
Acrylonitrile	10	U
Benzene	5	U
Bis(2-chloroisopropyl)ether	10	U
Bromodichloromethane	5	U
Bromoform	5	U
Bromomethane	10	U
Carbon disulfide	5	U
Carbon tetrachloride	5	U
Chlorobenzene	5	U
Chloroethane	10	U
Chloroform	5	U
Chloromethane	10	U
Cis-1,2-dichloroethene	5	U
Cis-1,3-dichloropropene	5	U
Dibromochloromethane	5	U
Dibromomethane	5	U
Dichlorodifluoromethane	5	U
Ethyl cyanide	5	U
Ethylbenzene	5	U
Iodomethane	5	U
Methacrylonitrile	5	U
Methyl methacrylate	5	U
Methylene chloride	5	U
Styrene	5	U
Tetrachloroethene	5	U
Toluene	5	U
Trans-1,2-dichloroethene	5	U
Trans-1,3-dichloropropene	5	U
Trans-1,4-dichloro-2-butene	5	U
Trichloroethene	5	U
Trichlorofluoromethane	5	U
Vinyl acetate	5	U
Vinyl chloride	10	U
Xylenes, total	5	U

SWMU 2

S2SS-4SW	KW02590	BEI(d)
Inorganics		
Aluminum	25	
Antimony	2.4	U
Arsenic	4.1	
Barium	9.9	
Beryllium	0.26	
Cadmium	0.2	U
Chromium	1.3	U
Cobalt	0.8	U

PARAMETER	RESULT	QUAL
Copper	1.1	U
Cyanide	5	U
Iron	61.6	
Lead	1.7	U
Manganese	3.2	
Mercury	0.08	U
Nickel	1.6	U
Selenium	3	U
Silver	1.5	U
Thallium	3.5	U
Tin	5	U
Vanadium	2	
Zinc	1.4	
Pesticides/PCBs		
4,4'-DDD	0.11	U
4,4'-DDE	0.11	U
4,4'-DDT	0.11	U
Aldrin	0.056	U
alpha-BHC	0.056	U
Aroclor-1016	0.56	U
Aroclor-1221	0.56	U
Aroclor-1232	0.56	U
Aroclor-1242	0.56	U
Aroclor-1248	0.56	U
Aroclor-1254	0.56	U
Aroclor-1260	0.56	U
beta-BHC	0.056	U
Chlordane	0.56	U
delta-BHC	0.056	U
Dieldrin	0.11	U
Endosulfan I	0.056	U
Endosulfan II	0.11	U
Endosulfan sulfate	0.11	U
Endrin	0.11	U
Endrin aldehyde	0.11	U
Endrin ketone	0.11	U
gamma-BHC (lindane)	0.056	U
Heptachlor	0.056	U
Heptachlor epoxide	0.056	U
Methoxychlor	0.56	U
Toxaphene	5.6	U
Volatile Organic Compounds		
1,1,1,2-tetrachloroethane	5	U
1,1,1-trichloroethane	5	U
1,1,2,2-tetrachloroethane	5	U
1,1,2-trichloroethane	5	U
1,1-dichloroethane	5	U
1,1-dichloroethene	5	U
1,2,3-trichloropropane	5	U
1,2-dibromo-3-chloropropane	5	U

PARAMETER	RESULT	QUAL
1,2-dibromoethane	5	U
1,2-dichloroethane	5	U
1,2-dichloroethene	5	U
1,2-dichloropropane	5	U
2-butanone	10	U
2-chloro-1,3-butadiene	5	U
2-hexanone	10	U
3-chloropropene	5	U
4-methyl-2-pentanone	10	U
Acetone	10	U
Acrolein	20	U
Acrylonitrile	10	U
Benzene	5	U
Bromodichloromethane	5	U
Bromoform	5	U
Bromomethane	10	U
Carbon disulfide	5	U
Carbon tetrachloride	5	U
Chlorobenzene	5	U
Chloroethane	10	U
Chloroform	5	U
Chloromethane	10	U
Cis-1,2-dichloroethene	5	U
Cis-1,3-dichloropropene	5	U
Dibromochloromethane	5	U
Dibromomethane	5	U
Dichlorodifluoromethane	5	U
Ethyl cyanide	5	U
Ethylbenzene	5	U
Iodomethane	5	U
Methacrylonitrile	5	U
Methyl methacrylate	5	U
Methylene chloride	5	U
Styrene	5	U
Tetrachloroethene	5	U
Toluene	5	U
Trans-1,2-dichloroethene	5	U
Trans-1,3-dichloropropene	5	U
Trans-1,4-dichloro-2-butene	5	U
Trichloroethene	5	U
Trichlorofluoromethane	5	U
Vinyl acetate	5	U
Vinyl chloride	10	U
Xylenes, total	5	U

SWMU 4

S4SW-1	S4SW-1	B&RE
Inorganics		
Aluminum	28	U
Antimony	4	UJ
Arsenic	4	U

PARAMETER	RESULT	QUAL
Barium	3.4	U
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U
Cobalt	2	U
Copper	4	UJ
Cyanide	1.4	UR
Iron	8.5	
Lead	3.5	U
Manganese	2	UJ
Mercury	0.6	
Nickel	4	U
Selenium	4	U
Silver	2	U
Thallium	4	UJ
Vanadium	2	U
Zinc	2	UJ
Pesticides/PCBs		
Chlorobenzilate	50	U
Dimethoate	50	U
Disulfoton	10	U
Famphur	10	U
Isodrin	10	U
Kepone	10	U
Sulfotep	10	U
Thionazin	10	U
Semivolatile Organic Compounds		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	50	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U

BRAC Background Samples
Surface-Water Data Set

PARAMETER	RESULT	QUAL
2-methylnaphthalene	10	U
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	U
2-picoline	10	U
3,3'-dichlorobenzidine	50	U
3,3'-dimethylbenzidine	50	U
3-methylcholanthrene	10	U
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-methylphenol	10	U
4-nitroaniline	10	U
4-nitrophenol	20	U
4-nitroquinoline-1-oxide	10	U
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U

PARAMETER	RESULT	QUAL
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	50	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol	10	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	5	U

PARAMETER	RESULT	QUAL
2-chloro-1,3-butadiene	2	U
2-hexanone	5	U
3-chloropropene	10	U
4-methyl-2-pentanone	5	U
Acetone	10	UJ
Acetonitrile	10	U
Acrolein	20	UR
Acrylonitrile	20	U
Benzene	2	U
Bis(2-chloroisopropyl)ether	10	U
Bromodichloromethane	2	U
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	5	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	U
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	UJ
Ethyl cyanide	20	U
Ethylbenzene	2	U
Iodomethane	5	U
Isobutanol	20	UR
Methacrylonitrile	10	UJ
Methyl methacrylate	10	U
Methylene chloride	5	U
Styrene	2	U
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	2	U
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	10	U
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	5	UJ
Vinyl chloride	2	U
Xylenes, total	4	U

PARAMETER	RESULT	QUAL

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
IR 1		
I1MW-6 **I1MW-6**	**B&RE**	
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	U
Arsenic	4	U
Barium	9.9	U
Beryllium	0.2	U
Cadmium	0.4	U
Chromium	2	U
Cobalt	2	U
Copper	4	U
Cyanide	1.4	U
Iron	4	U
Lead	3	U
Manganese	3.2	
Mercury	0.1	U
Nickel	4	U
Selenium	4	U
Silver	2	U
Thallium	4	U
Vanadium	3.4	
Zinc	2	U
Pesticides/PCBs (µg/L)		
2,4,5-T	0.1	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.1	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U
Chlordane	0.25	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U

PARAMETER	RESULT	QUAL
Heptachlor epoxide	0.02	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Toxaphene	0.99	U
I1MW-7 **I1DPGW-2**	**B&RE**	
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	UJ
Arsenic	4	U
Barium	8.4	J
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U
Cobalt	2	U
Copper	4.3	J
Cyanide	1.4	UR
Iron	4	U
Lead	3	U
Manganese	4.5	J
Mercury	0.1	U
Nickel	4	U
Selenium	4.1	J
Silver	2	U
Thallium	4	UJ
Vanadium	3.7	J
Zinc	2	UJ
Pesticides/PCBs (µg/L)		
2,4,5-T	0.1	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.1	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U
Chlordane	0.25	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U

PARAMETER	RESULT	QUAL
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Toxaphene	1	U
I1MW-7 **I1MW-7**	**B&RE**	
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	UJ
Arsenic	4	U
Barium	7	J
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U
Cobalt	2	U
Copper	4	UJ
Cyanide	1.4	UR
Iron	4	U
Lead	3.7	U
Manganese	4.1	J
Mercury	0.1	U
Nickel	4	U
Selenium	4	U
Silver	2	U
Thallium	4	UJ
Vanadium	4.1	J
Zinc	2	UJ
Pesticides/PCBs (µg/L)		
2,4,5-T	0.097	U
2,4,5-TP (silvex)	0.097	U
2,4-D	0.097	U
4,4'-DDD	0.04	U
4,4'-DDE	0.04	U
4,4'-DDT	0.04	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U

PARAMETER	RESULT	QUAL
Chlordane	0.25	U
delta-BHC	0.02	U
Dieldrin	0.04	U
Endosulfan I	0.02	U
Endosulfan II	0.04	U
Endosulfan sulfate	0.04	U
Endrin	0.04	U
Endrin aldehyde	0.04	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Methoxychlor	0.2	U
Methyl parathion	0.05	U
Parathion	0.05	U
Phorate	0.05	U
Toxaphene	1	U
IR 3		
I3MW-6 **I3MW-6**	**B&RE**	
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	UJ
Arsenic	4	U
Barium	11.1	U
Beryllium	0.2	U
Cadmium	0.4	U
Chromium	2	U
Cobalt	2	U
Copper	4	U
Iron	141	U
Lead	3	U
Manganese	2	U
Mercury	0.1	U
Nickel	4	U
Selenium	4	UJ
Silver	2	U
Thallium	4	U
Vanadium	3.8	
Zinc	2	U
Pesticides/PCBs (µg/L)		
2,4,5-T	0.1	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.1	U
4,4'-DDD	0.08	U
4,4'-DDE	0.08	U
4,4'-DDT	0.08	U
Aldrin	0.04	U
alpha-BHC	0.04	U
Aroclor-1016	0.25	U
Aroclor-1221	0.25	U
Aroclor-1232	0.25	U

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
Aroclor-1242	0.25	U
Aroclor-1248	0.25	U
Aroclor-1254	0.25	U
Aroclor-1260	0.25	U
beta-BHC	0.04	U
Chlordane	0.5	U
delta-BHC	0.04	U
Dieldrin	0.08	U
Endosulfan I	0.04	U
Endosulfan II	0.08	U
Endosulfan sulfate	0.08	U
Endrin	0.08	U
Endrin aldehyde	0.08	U
gamma-BHC (lindane)	0.04	U
Heptachlor	0.04	U
Heptachlor epoxide	0.04	U
Methoxychlor	0.4	U
Methyl parathion	0.1	U
Parathion	0.1	U
Phorate	0.1	U
Toxaphene	2	U

SWMU 1

S1MW-3 S1DPGW-01 B&RE

PARAMETER	RESULT	QUAL
Inorganics (µg/L)		
Aluminum	8.3	U
Antimony	2.6	U
Arsenic	11.7	
Barium	19.3	J
Beryllium	0.2	U
Cadmium	0.3	UJ
Chromium	0.6	U
Cobalt	0.6	U
Copper	0.9	U
Cyanide	4.7	U
Iron	77.6	J
Lead	1.3	UJ
Manganese	0.4	UJ
Mercury	0	U
Nickel	0.9	UJ
Selenium	4.8	UR
Silver	0.5	U
Thallium	5.7	UJ
Vanadium	0.5	U
Zinc	1	U
Pesticides/PCBs (µg/L)		
2,4,5-T	0.1	U
2,4,5-TP (silvex)	0	U
2,4-D	0.1	U
4,4'-DDD	0.1	U
4,4'-DDE	0.1	U
4,4'-DDT	0.1	U
Aldrin	0	U
alpha-BHC	0	U
Aroclor-1016	0.4	U
Aroclor-1221	0.4	U
Aroclor-1232	0.4	U
Aroclor-1242	0.4	U
Aroclor-1248	0.4	U
Aroclor-1254	0.4	U
Aroclor-1260	0.4	U
beta-BHC	0	U
Chlordane	0.8	U
Chlorobenzilate	37.7	U
delta-BHC	0	U
Dieldrin	0.1	U
Dimethoate	37.7	U
Dinoseb	7.5	U
Disulfoton	7.5	UJ
Endosulfan I	0	U
Endosulfan II	0.1	U
Endosulfan sulfate	0.1	U
Endrin	0.1	U
Endrin aldehyde	0.1	U
Famphur	7.5	U
gamma-BHC (lindane)	0	U
Heptachlor	0	U
Heptachlor epoxide	0	U
Isodrin	7.5	U
Kepone	7.5	U
Methoxychlor	0.6	U
Methyl parathion	0.1	U
Parathion	0.1	U
Phorate	0.1	U
Sulfotep	10	U
Thionazin	7.5	U
Toxaphene	3.2	U
Semivolatile Organic Compounds (µg/L)		
1,2,4,5-tetrachlorobenzene	7.5	U
1,2,4-trichlorobenzene	7.5	U
1,2-dichlorobenzene	7.5	U
1,3,5-trinitrobenzene	37.7	UJ
1,3-dichlorobenzene	7.5	U
1,3-dinitrobenzene	7.5	U
1,4-dichlorobenzene	7.5	U
1,4-dioxane	7.5	U
1,4-naphthoquinone	7.5	UJ
1-naphthylamine	7.5	U
2,3,4,6-tetrachlorophenol	7.5	U
2,4,5-trichlorophenol	7.5	U
2,4,6-trichlorophenol	7.5	U
2,4-dichlorophenol	7.5	U
2,4-dimethylphenol	7.5	U
2,4-dinitrophenol	15	U
2,4-dinitrotoluene	7.5	U
2,6-dichlorophenol	7.5	U
2,6-dinitrotoluene	7.5	U
2-acetylaminofluorene	7.5	U
2-chloronaphthalene	7.5	U
2-chlorophenol	7.5	U
2-methyl-4,6-dinitrophenol	7.5	U
2-methylnaphthalene	7.5	U
2-methylphenol	7.5	U
2-naphthylamine	7.5	U
2-nitroaniline	7.5	U
2-nitrophenol	7.5	U
2-picoline	7.5	U
3 & 4-methylphenol	7.5	U
3,3'-dichlorobenzidine	37.7	UJ
3,3'-dimethylbenzidine	37.7	U
3-methylcholanthrene	7.5	UJ
3-nitroaniline	7.5	U
4-aminobiphenyl	7.5	U
4-bromophenyl phenyl ether	7.5	U
4-chloro-3-methylphenol	7.5	U
4-chloroaniline	7.5	U
4-chlorophenyl phenyl ether	7.5	U
4-nitroaniline	7.5	U
4-nitrophenol	15	U
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	7.5	U
7,12-dimethylbenz(a)anthracene	7.5	UJ
a,a-dimethylphenethylamine	7.5	UJ
Acenaphthene	7.5	U
Acenaphthylene	7.5	U
Acetophenone	7.5	U
Aniline	7.5	U
Anthracene	7.5	U
Aramite	7.5	U
Benzo(a)anthracene	7.5	U
Benzo(a)pyrene	7.5	UJ
Benzo(b)fluoranthene	7.5	UJ
Benzo(g,h,i)perylene	7.5	UJ
Benzo(k)fluoranthene	7.5	UJ
Benzyl alcohol	7.5	U
Bis(2-chloroethoxy)methane	7.5	U
Bis(2-chloroethyl)ether	7.5	U
Bis(2-ethylhexyl)phthalate	7.5	U
Butyl benzyl phthalate	7.5	U
Chrysene	7.5	U
Di-n-butyl phthalate	7.5	UJ
Di-n-octyl phthalate	7.5	UJ
Diallate	7.5	U
Dibenzo(a,h)anthracene	7.5	UJ
Dibenzofuran	7.5	U
Diethyl phthalate	7.5	U
Dimethyl phthalate	7.5	U
Diphenylamine	7.5	U
Ethyl methacrylate	7.5	U
Ethyl methanesulfonate	7.5	U
Fluoranthene	7.5	U
Fluorene	7.5	U
Hexachlorobenzene	7.5	U
Hexachlorobutadiene	7.5	U
Hexachlorocyclopentadiene	7.5	U
Hexachloroethane	7.5	U
Hexachloropropene	7.5	U
Indeno(1,2,3-cd)pyrene	7.5	UJ
Isophorone	7.5	U
Isosafrole	7.5	U
Methapyrilene	37.7	U
Methyl methanesulfonate	7.5	U
N-nitroso-di-n-butylamine	7.5	U
N-nitroso-di-n-propylamine	7.5	U
N-nitrosodiethylamine	7.5	U
N-nitrosodimethylamine	7.5	U
N-nitrosodiphenylamine	7.5	U
N-nitrosomethylethylamine	7.5	U
N-nitrosomorpholine	7.5	UJ
N-nitrosopiperidine	7.5	UJ
N-nitrosopyrrolidine	7.5	U
Naphthalene	7.5	U
Nitrobenzene	7.5	U
o,o,o-triethylphosphorothioate	7.5	U
o-toluidine	7.5	U
p-dimethylaminoazobenzene	7.5	U
p-phenylenediamine	15	UJ
Pentachlorobenzene	7.5	UJ
Pentachloroethane	7.5	U
Pentachloronitrobenzene	7.5	UJ
Pentachlorophenol	7.5	U
Phenacetin	7.5	U
Phenanthrene	7.5	U
Phenol	7.5	U
Pronamide	7.5	U
Pyrene	7.5	U
Pyridine	7.5	U
Safrole	7.5	U

S1MW-3 S1MW-3 B&RE

PARAMETER	RESULT	QUAL
Inorganics (µg/L)		
Aluminum		U

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
Antimony	3.7	U
Arsenic	12.1	
Barium	19.6	J
Beryllium	0.3	U
Cadmium	0.4	UJ
Chromium	0.9	U
Cobalt	0.8	U
Copper	1.2	U
Cyanide	8.7	
Iron	76.2	J
Lead	1.8	UJ
Manganese	0.6	UJ
Mercury	0.1	U
Nickel	1.3	U
Selenium	4.8	UR
Silver	0.7	U
Thallium	7	J
Vanadium	0.7	U
Zinc	1.4	U
Pesticides/PCBs (µg/L)		
2,4,5-T	0.21	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.21	U
4,4'-DDD	0.43	U
4,4'-DDE	0.43	U
4,4'-DDT	0.43	U
Aldrin	0.22	U
alpha-BHC	0.22	U
Aroclor-1016	1.4	U
Aroclor-1221	1.4	U
Aroclor-1232	1.4	U
Aroclor-1242	1.4	U
Aroclor-1248	1.4	U
Aroclor-1254	1.4	U
Aroclor-1260	1.4	U
beta-BHC	0.22	U
Chlordane	2.7	U
Chlorobenzilate	51	U
delta-BHC	0.22	U
Dieldrin	0.43	U
Dimethoate	51	U
Dinoseb	10	UJ
Disulfoton	10	UJ
Endosulfan I	0.22	U
Endosulfan II	0.43	U
Endosulfan sulfate	0.43	U
Endrin	0.43	U
Endrin aldehyde	0.43	U
Famphur	10	U
gamma-BHC (lindane)	0.22	U

PARAMETER	RESULT	QUAL
Heptachlor	0.22	U
Heptachlor epoxide	0.22	U
Isodrin	10	U
Kepone	10	U
Methoxychlor	2.2	U
Methyl parathion	0.54	U
Parathion	0.54	U
Phorate	0.54	U
Sulfotep	10	U
Thionazin	10	U
Toxaphene	10.9	U
Semivolatile Organic Compounds (µg/L)		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	51	UJ
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	UJ
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	UJ
2,4,5-trichlorophenol	10	UJ
2,4,6-trichlorophenol	10	UJ
2,4-dichlorophenol	10	UJ
2,4-dimethylphenol	10	UJ
2,4-dinitrophenol	20	UJ
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	UJ
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	UJ
2-methyl-4,6-dinitrophenol	10	UJ
2-methylnaphthalene	10	U
2-methylphenol	10	UJ
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	UJ
2-picoline	10	U
3 & 4-methylphenol	10	UJ
3,3'-dichlorobenzidine	51	UJ
3,3'-dimethylbenzidine	51	U
3-methylcholanthrene	10	UJ
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	UJ
4-chloroaniline	10	U

PARAMETER	RESULT	QUAL
4-chlorophenyl phenyl ether	10	U
4-nitroaniline	10	U
4-nitrophenol	20	UJ
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	UJ
a,a-dimethylphenethylamine	10	UJ
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	UJ
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	UJ
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	UJ
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	51	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U

PARAMETER	RESULT	QUAL
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	UJ
N-nitrosopiperidine	10	UJ
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	UJ
Pentachlorobenzene	10	UJ
Pentachloroethane	10	U
Pentachloronitrobenzene	10	UJ
Pentachlorophenol	10	UJ
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	UJ
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U

SWMU 2

S2MW-1 S2DPGW-01 B&RE

PARAMETER	RESULT	QUAL
Inorganics (µg/L)		
Aluminum	56.2	U
Antimony	1.9	U
Arsenic	3.6	U
Barium	10.5	J
Beryllium	0.2	U
Cadmium	0.3	UJ
Chromium	0.9	U
Cobalt	0.6	U
Copper	0.9	U
Cyanide	0.6	U
Iron	16.4	U
Lead	1.3	UJ
Manganese	3.7	J
Mercury	0	U
Nickel	1.6	U
Selenium	4.8	UR
Silver	0.5	U
Thallium	3.3	UJ
Vanadium	0.6	U
Zinc	3.3	U
Pesticides/PCBs (µg/L)		
2,4,5-T	2.1	U
2,4,5-TP (silvex)	1	U
2,4-D	2.1	U
4,4'-DDD	0	U

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
4,4'-DDE	0	U
4,4'-DDT	0	U
Aldrin	0	U
alpha-BHC	0	U
Aroclor-1016	0	U
Aroclor-1221	0	U
Aroclor-1232	0	U
Aroclor-1242	0	U
Aroclor-1248	0	U
Aroclor-1254	0	U
Aroclor-1260	0	U
beta-BHC	0	U
Chlordane	0.1	U
delta-BHC	0	U
Dieldrin	0	U
Endosulfan I	0	U
Endosulfan II	0	U
Endosulfan sulfate	0	U
Endrin	0	U
Endrin aldehyde	0	U
gamma-BHC (lindane)	0	U
Heptachlor	0	U
Heptachlor epoxide	0	U
Methoxychlor	0.1	U
Methyl parathion	0	U
Parathion	0	U
Phorate	0	U
Toxaphene	0.7	U
S2MW-1	**S2MW-1**	**B&RE**
Inorganics (µg/L)		
Aluminum	93.9	U
Antimony	2.6	U
Arsenic	4.9	U
Barium	10.6	J
Beryllium	0.3	U
Cadmium	0.4	UJ
Chromium	0.97	
Cobalt	0.8	U
Copper	1.2	U
Cyanide	0.8	U
Iron	37	U
Lead	1.8	UJ
Manganese	4.1	J
Mercury	0.1	U
Nickel	2.7	U
Selenium	4.8	UR
Silver	0.7	U
Thallium	4.5	UJ
Vanadium	0.88	U
Zinc	5.2	

PARAMETER	RESULT	QUAL
Pesticides/PCBs (µg/L)		
2,4,5-T	0.21	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.21	U
4,4'-DDD	0.039	U
4,4'-DDE	0.039	U
4,4'-DDT	0.039	U
Aldrin	0.02	U
alpha-BHC	0.02	U
Aroclor-1016	0.12	U
Aroclor-1221	0.12	U
Aroclor-1232	0.12	U
Aroclor-1242	0.12	U
Aroclor-1248	0.12	U
Aroclor-1254	0.12	U
Aroclor-1260	0.12	U
beta-BHC	0.02	U
Chlordane	0.25	U
delta-BHC	0.02	U
Dieldrin	0.039	U
Endosulfan I	0.02	U
Endosulfan II	0.039	U
Endosulfan sulfate	0.039	U
Endrin	0.039	U
Endrin aldehyde	0.039	U
gamma-BHC (lindane)	0.02	U
Heptachlor	0.02	U
Heptachlor epoxide	0.02	U
Methoxychlor	0.2	U
Methyl parathion	0.049	U
Parathion	0.049	U
Phorate	0.049	U
Toxaphene	0.98	U
S2MW-4	**S2MW-4**	**B&RE**
Inorganics (µg/L)		
Aluminum	11.1	U
Antimony	2.6	U
Arsenic	4.9	U
Barium	16.5	J
Beryllium	0.3	U
Cadmium	0.4	UJ
Chromium	0.9	U
Cobalt	0.8	U
Copper	1.2	U
Cyanide	2.4	
Iron	97.4	J
Lead	1.8	UJ
Manganese	10.3	J
Mercury	0.13	
Nickel	1.7	U

PARAMETER	RESULT	QUAL
Selenium	4.8	UR
Silver	0.7	U
Thallium	4.5	UJ
Vanadium	0.7	U
Zinc	1.4	U
Pesticides/PCBs (µg/L)		
2,4,5-T	0.21	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.21	U
4,4'-DDD	0.042	U
4,4'-DDE	0.042	U
4,4'-DDT	0.042	U
Aldrin	0.021	U
alpha-BHC	0.021	U
Aroclor-1016	0.13	U
Aroclor-1221	0.13	U
Aroclor-1232	0.13	U
Aroclor-1242	0.13	U
Aroclor-1248	0.13	U
Aroclor-1254	0.13	U
Aroclor-1260	0.13	U
beta-BHC	0.021	U
Chlordane	0.26	U
delta-BHC	0.021	U
Dieldrin	0.042	U
Endosulfan I	0.021	U
Endosulfan II	0.042	U
Endosulfan sulfate	0.042	U
Endrin	0.042	U
Endrin aldehyde	0.042	U
gamma-BHC (lindane)	0.021	U
Heptachlor	0.021	U
Heptachlor epoxide	0.021	U
Methoxychlor	0.21	U
Methyl parathion	0.053	U
Parathion	0.053	U
Phorate	0.053	U
Toxaphene	1	U
SWMU 4		
S4MW-4	**S4MW-4**	**B&RE**
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	UJ
Arsenic	13.7	U
Barium	11	U
Beryllium	0.2	U
Cadmium	0.4	UJ
Chromium	2	U
Cobalt	2	U
Copper	4	U

PARAMETER	RESULT	QUAL
Cyanide	1.4	U
Iron	229	U
Lead	3	UJ
Manganese	11.9	U
Mercury	0.1	U
Nickel	4	U
Selenium	4	UJ
Silver	2	U
Thallium	4	U
Vanadium	2	U
Zinc	2	UJ
Pesticides/PCBs (µg/L)		
Chlorobenzilate	10	U
Dimethoate	10	U
Dinoseb	10	U
Disulfoton	10	U
Famphur	10	U
Isodrin	10	U
Kepone	10	U
Sulfotep	10	U
Thionazin	10	U
Semivolatile Organic Compounds (µg/L)		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	20	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U
2-methylnaphthalene	10	U
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline		U
2-nitrophenol		U

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
2-picoline	10	U
3,3'-dichlorobenzidine	50	U
3,3'-dimethylbenzidine	20	U
3-methylcholanthrene	10	U
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-methylphenol	10	U
4-nitroaniline	10	U
4-nitrophenol	10	U
4-nitroquinoline-1-oxide	10	U
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U

PARAMETER	RESULT	QUAL
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	10	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol	10	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds (µg/L)		
1,1,1,2-tetrachloroethane	2	U
1,1,1-trichloroethane	2	U
1,1,2,2-tetrachloroethane	2	U
1,1,2-trichloroethane	2	U
1,1-dichloroethane	2	U
1,1-dichloroethene	2	U
1,2,3-trichloropropane	2	U
1,2-dibromo-3-chloropropane	2	U
1,2-dibromoethane	2	U
1,2-dichloroethane	2	U
1,2-dichloropropane	2	U
2-butanone	5	U
2-chloro-1,3-butadiene	2	U
2-hexanone	5	U
3-chloropropene	10	U
4-methyl-2-pentanone	5	U
Acetone	10	U

PARAMETER	RESULT	QUAL
Acetonitrile	10	U
Acrolein	20	U
Acrylonitrile	20	U
Benzene	2	U
Bis(2-chloroisopropyl)ether	10	U
Bromodichloromethane	2	U
Bromoform	2	U
Bromomethane	2	U
Carbon disulfide	5	U
Carbon tetrachloride	2	U
Chlorobenzene	2	U
Chloroethane	2	U
Chloroform	2	U
Chloromethane	2	U
Cis-1,3-dichloropropene	2	U
Dibromochloromethane	2	U
Dibromomethane	2	U
Dichlorodifluoromethane	2	U
Ethyl cyanide	20	U
Ethylbenzene	2	U
Iodomethane	5	U
Isobutanol	20	U
Methacrylonitrile	10	U
Methyl methacrylate	10	U
Methylene chloride	5	U
Styrene	3.4	
Tetrachloroethene	2	U
Toluene	2	U
Trans-1,2-dichloroethene	1.2	J
Trans-1,3-dichloropropene	2	U
Trans-1,4-dichloro-2-butene	10	U
Trichloroethene	2	U
Trichlorofluoromethane	2	U
Vinyl acetate	5	U
Vinyl chloride	2.4	
Xylenes, total	4	U

SWMU 5

S5MW-4	S5MW-4	B&RE
Inorganics (µg/L)		
Aluminum	28	U
Antimony	12.6	U
Arsenic	6.4	U
Barium	8	
Beryllium	1.2	U
Cadmium	1.2	U
Chromium	2.1	
Cobalt	2	U
Copper	4	U
Cyanide	1.4	U
Iron	31.1	U

PARAMETER	RESULT	QUAL
Lead	3	U
Manganese	2.2	
Mercury	0.24	
Nickel	4	U
Selenium	4	U
Silver	3.3	
Thallium	4	U
Vanadium	3.9	
Zinc	2	U
Pesticides/PCBs (µg/L)		
Chlorobenzilate	50	U
Dimethoate	50	U
Dinoseb	10	U
Disulfoton	10	U
Famphur	10	U
Isodrin	10	U
Kepone	10	U
Sulfotep	10	U
Thionazin	10	U
Semivolatile Organic Compounds (µg/L)		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	50	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U
2-methylnaphthalene	10	U
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	U
2-picoline	10	U
3,3'-dichlorobenzidine	50	U

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
3,3'-dimethylbenzidine	50	U
3-methylcholanthrene	10	U
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-methylphenol	10	U
4-nitroaniline	10	U
4-nitrophenol	20	U
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-[illegible]ne	10	U

PARAMETER	RESULT	QUAL
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	50	U
Methyl methanesulfonate	10	U
N-nitroso-di-n-butylamine	10	U
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol	10	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds (µg/L)		
Methyl methacrylate	10	U
S5MW-5	**S5MW-5**	**B&RE**
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	U
Arsenic	27.3	U
Barium	11.2	
Beryllium	0.2	U
Cadmium	0.48	U
Chromium	2	U
Cobalt	2	U
Copper	4	U
Cyanide	1.4	U
Iron	20.2	U
Lead	3	U
Manganese	4.4	
Mercury	0.19	
Nickel	4	U
Selenium	4	U

PARAMETER	RESULT	QUAL
Silver	2	U
Thallium	4	U
Vanadium	2	U
Zinc	2	U
Pesticides/PCBs (µg/L)		
Chlorobenzilate	50	U
Dimethoate	50	U
Dinoseb	10	U
Disulfoton	10	U
Famphur	10	U
Isodrin	10	U
Kepone	10	U
Sulfotep	10	U
Thionazin	10	U
Semivolatile Organic Compounds (µg/L)		
1,2,4,5-tetrachlorobenzene	10	U
1,2,4-trichlorobenzene	10	U
1,2-dichlorobenzene	10	U
1,3,5-trinitrobenzene	50	U
1,3-dichlorobenzene	10	U
1,3-dinitrobenzene	10	U
1,4-dichlorobenzene	10	U
1,4-dioxane	10	U
1,4-naphthoquinone	10	U
1-naphthylamine	10	U
2,3,4,6-tetrachlorophenol	10	U
2,4,5-trichlorophenol	10	U
2,4,6-trichlorophenol	10	U
2,4-dichlorophenol	10	U
2,4-dimethylphenol	10	U
2,4-dinitrophenol	20	U
2,4-dinitrotoluene	10	U
2,6-dichlorophenol	10	U
2,6-dinitrotoluene	10	U
2-acetylaminofluorene	10	U
2-chloronaphthalene	10	U
2-chlorophenol	10	U
2-methyl-4,6-dinitrophenol	10	U
2-methylnaphthalene	10	U
2-methylphenol	10	U
2-naphthylamine	10	U
2-nitroaniline	10	U
2-nitrophenol	10	U
2-picoline	10	U
3,3'-dichlorobenzidine	50	U
3,3'-dimethylbenzidine	50	U
3-methylcholanthrene	10	U
3-nitroaniline	10	U
4-aminobiphenyl	10	U
4-bromophenyl phenyl ether	10	U

PARAMETER	RESULT	QUAL
4-chloro-3-methylphenol	10	U
4-chloroaniline	10	U
4-chlorophenyl phenyl ether	10	U
4-methylphenol	10	U
4-nitroaniline	10	U
4-nitrophenol	20	U
4-nitroquinoline-1-oxide	10	UR
5-nitro-o-toluidine	10	U
7,12-dimethylbenz(a)anthracene	10	U
a,a-dimethylphenethylamine	10	U
Acenaphthene	10	U
Acenaphthylene	10	U
Acetophenone	10	U
Aniline	10	U
Anthracene	10	U
Aramite	10	U
Benzo(a)anthracene	10	U
Benzo(a)pyrene	10	U
Benzo(b)fluoranthene	10	U
Benzo(g,h,i)perylene	10	U
Benzo(k)fluoranthene	10	U
Benzyl alcohol	10	U
Bis(2-chloroethoxy)methane	10	U
Bis(2-chloroethyl)ether	10	U
Bis(2-ethylhexyl)phthalate	10	U
Butyl benzyl phthalate	10	U
Chrysene	10	U
Di-n-butyl phthalate	10	U
Di-n-octyl phthalate	10	U
Diallate	10	U
Dibenzo(a,h)anthracene	10	U
Dibenzofuran	10	U
Diethyl phthalate	10	U
Dimethyl phthalate	10	U
Diphenylamine	10	U
Ethyl methacrylate	10	U
Ethyl methanesulfonate	10	U
Fluoranthene	10	U
Fluorene	10	U
Hexachlorobenzene	10	U
Hexachlorobutadiene	10	U
Hexachlorocyclopentadiene	10	U
Hexachloroethane	10	U
Hexachloropropene	10	U
Indeno(1,2,3-cd)pyrene	10	U
Isophorone	10	U
Isosafrole	10	U
Methapyrilene	50	U
Methyl methanesulfonate	[illegible]	U
N-nitroso-di-n-butylamine	[illegible]	U

BRAC Background Samples
Groundwater Data Set

PARAMETER	RESULT	QUAL
N-nitroso-di-n-propylamine	10	U
N-nitrosodiethylamine	10	U
N-nitrosodimethylamine	10	U
N-nitrosodiphenylamine	10	U
N-nitrosomethylethylamine	10	U
N-nitrosomorpholine	10	U
N-nitrosopiperidine	10	U
N-nitrosopyrrolidine	10	U
Naphthalene	10	U
Nitrobenzene	10	U
o,o,o-triethylphosphorothioate	10	U
o-toluidine	10	U
p-dimethylaminoazobenzene	10	U
p-phenylenediamine	20	U
Pentachlorobenzene	10	U
Pentachloroethane	10	U
Pentachloronitrobenzene	10	U
Pentachlorophenol	10	U
Phenacetin	10	U
Phenanthrene	10	U
Phenol	10	U
Pronamide	10	U
Pyrene	10	U
Pyridine	10	U
Safrole	10	U
Volatile Organic Compounds (µg/L)		
Methyl methacrylate	10	U

SWMU 7

S7MW-2	S7MW-2	B&RE
Herbicides (µg/L)		
2,4,5-T	0.1	U
2,4,5-TP (silvex)	0.1	U
2,4-D	0.1	U
Inorganics (µg/L)		
Aluminum	28	U
Antimony	4	U
Arsenic	6.7	U
Barium	6.4	
Beryllium	0.2	U
Cadmium	0.4	U
Chromium	2	U
Cobalt	2	U
Copper	4	U
Cyanide	1.4	U
Iron	29.8	U
Lead	3	U
Manganese	2.3	
Mercury	0.23	
Nickel	4	U
Selenium	4	U

PARAMETER	RESULT	QUAL
Silver	2	U
Thallium	4	U
Vanadium	2	U
Zinc	2	U
Pesticides/PCBs (µg/L)		
4,4'-DDD	0.08	U
4,4'-DDE	0.08	U
4,4'-DDT	0.08	U
Aldrin	0.04	U
alpha-BHC	0.04	U
Aroclor-1016	0.25	U
Aroclor-1221	0.25	U
Aroclor-1232	0.25	U
Aroclor-1242	0.25	U
Aroclor-1248	0.25	U
Aroclor-1254	0.25	U
Aroclor-1260	0.25	U
beta-BHC	0.04	U
Chlordane	0.5	U
delta-BHC	0.04	U
Dieldrin	0.08	U
Endosulfan I	0.04	U
Endosulfan II	0.08	U
Endosulfan sulfate	0.08	U
Endrin	0.08	U
Endrin aldehyde	0.08	U
gamma-BHC (lindane)	0.04	U
Heptachlor	0.04	U
Heptachlor epoxide	0.04	U
Methoxychlor	0.4	U
Methyl parathion	0.1	U
Parathion	0.1	U
Phorate	0.1	U
Toxaphene	2	U

PARAMETER	RESULT	QUAL

PARAMETER	RESULT	QUAL

Appendix B

Part 4 - Data Quality Objectives Sample Number Calculation

Most Conservative Optimal Sample Size Estimates by Medium from Gilbert Equation(1)

Media	Chemical Group	Parameter	Mean	Standard Deviation	2 x Avg. Background	95% UCL	Strictest Action Level	Basis for Action Level	NUMBER OF SAMPLES NEEDED Lenient Δ = 1 x AL 1-β=0.90	Tough Δ = 0.5 x AL 1-β=0.95	Stringent Δ = 0.25 x AL 1-β=0.95	Extreme Δ = 0.1 x AL 1-β=0.99
SOIL	INORGANIC	Beryllium	0.044	0.042	0.088	0.067	0.200	FDEP Residential	1	1	1	12
	(mg/kg)											
	SVOC	Benzo(b)fluoranthene	431.808	681.166	863.616	843.432	1,400.000	FDEP Residential	1	1	1	10
	(ug/kg)											
	VOC	Chloromethane	2.455	2.055	4.910	3.836	200.000	FDEP Residential	1	1	2	16
	(ug/kg)											
	PEST	Methoxychlor	59.855	131.070	119.710	153.617	380,000.000	FDEP Residential	1	1	1	14
	(ug/kg)											
	PCB	Aroclor-1260	43.480	81.898	86.960	98.500	9,000.000	FDEP Residential	1	2	7	47
	(ug/kg)											
GW	INORGANIC	Iron	41.720	43.240	83.440	72.652	11,000.000	Tap Water RBCs	1	1	3	21
	(mg/kg)											
	VOC	Styrene	3.400	0.450	6.800	3.400	100.000	MCL / FL MCL	1	1	1	1
	(ug/l)											
SED	INORGANIC	Lead	17.089	15.683	34.178	27.497	34.178	2 x Avg. Background	1	6	15	135
	(mg/kg)											
	SVOC	1,3-dichlorobenzene	622.642	1,028.053	1,245.284	1,304.881	1,700.000	USEPA SQB	1	6	14	122
	(ug/kg)											
	VOC	Acetone	13.080	14.646	26.160	33.412	64.000	Ontario Guidelines	1	2	7	50
	(ug/kg)											
	PEST	Methoxychlor	11.700	13.185	23.400	23.484	19.000	USEPA SQB	1	2	8	63
	(ug/kg)		11.700	13.185	23.400	23.484						
SW	INORGANIC	Copper	2.035	1.490	4.070	3.101	2.900	FDEP Criteria	1	7	18	167
	(mg/kg)											
	SVOC	Di-n-butyl phthalate	4.400	1.342	8.800	6.066	3.000	EPA REG III Fresh water BTAGs	1	6	14	127
	(ug/l)											
	VOC	Acetone	5.000	4.940	10.000	10.184	###########	MCL / FL MCL	1	1	1	1
	(ug/l)											

(1) $n = \dfrac{\sigma^2 (t_{1-\beta})^2 / \Delta^2}{1 + (\sigma^2 (t_{1-b})^2 / \Delta^2)/N}$

Appendix C

Brown & Root Environmental Forms

Equipment Calibration Log

Instrument (Name/Model Number/ Serial Number):________________________________

Manufacturer: ________________________ **Date Purchased:**____________________

Name and Number of Rental Agency (if applicable):________________________________

Calibration Date/Time	Initial Settings	Standard/ Gas	Procedure	Adjustments Made	Final Settings	Signature	Comments

BROWN and ROOT
ENVIRONMENTAL

FIELD LOG OF BORING

WELL NO.__________

SHEET _____ OF _____

PROJECT:	JOB NO.:	BORING NO.:
	LOGGED BY:	TOTAL DEPTH:

DRILLING CONTRACTOR:	SURFACE ELEV.:	DATUM:
DRILLER'S NAME:	START, TIME:	DATE:
DRILL RIG TYPE:	FINISH, TIME:	DATE:
BORING METHOD:	WATER DEPTH:	
HOLE DIAMETER:	DATE:	
SAMPLING METHOD:	TIME:	
HAMMER WGT.: DROP HGT:	BACKFILLED, TIME:	DATE:
CONDITIONS:	LOCATION OF BORING:	

SAMPLE DEPTH	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED				OVA READING (ppm)	LAB SAMPLE	DEPTH IN FEET		LITHOLOGY	

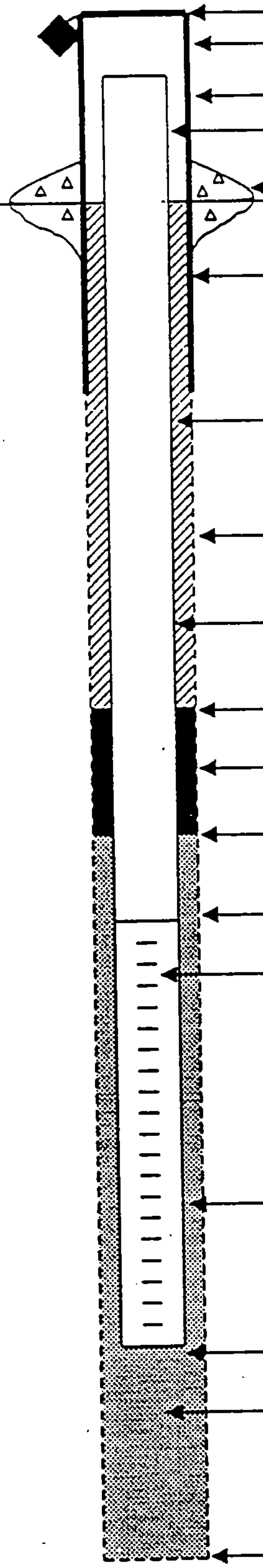
NOTES:____________________ EDITED BY/DATE:__________

OVERBURDEN
MONITORING WELL SHEET

PROJECT ____________ LOCATION ____________
PROJECT NO. ____________ BORING ____________
ELEVATION ____________ DATE ____________
FIELD GEOLOGIST ____________

DRILLER ____________
DRILLING METHOD ____________
DEVELOPMENT METHOD ____________

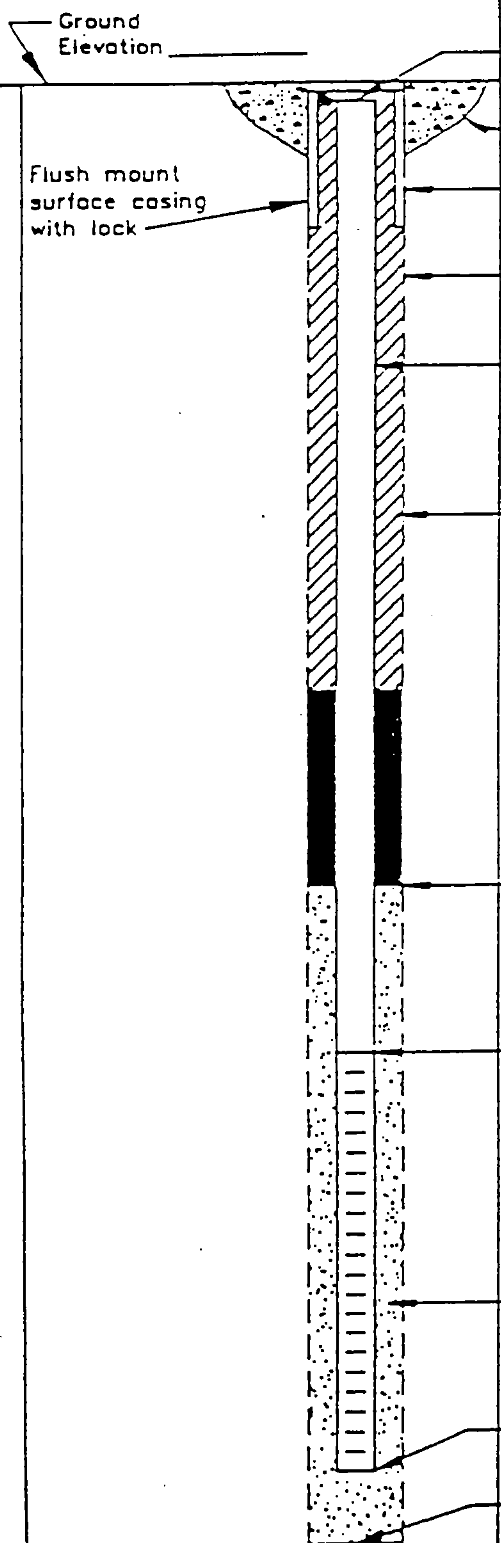
GROUND ELEVATION



ELEVATION OF TOP OF SURFACE CASING : ____________
ELEVATION OF TOP OF RISER PIPE: ____________
STICK - UP TOP OF SURFACE CASING: ____________
STICK - UP RISER PIPE : ____________
TYPE OF SURFACE SEAL: ____________
I.D. OF SURFACE CASING: ____________
TYPE OF SURFACE CASING: ____________
RISER PIPE I.D. ____________
TYPE OF RISER PIPE: ____________
BOREHOLE DIAMETER: ____________
TYPE OF BACKFILL: ____________
ELEVATION / DEPTH TOP OF SEAL: ______ / ______
TYPE OF SEAL: ____________
DEPTH TOP OF SAND PACK: ____________
ELEVATION / DEPTH TOP OF SCREEN: ______ / ______
TYPE OF SCREEN: ____________
SLOT SIZE x LENGTH: ____________
I.D. OF SCREEN: ____________
TYPE OF SAND PACK: ____________
ELEVATION / DEPTH BOTTOM OF SCREEN: ______ / ______
ELEVATION / DEPTH BOTTOM OF SAND PACK: ______ / ______
TYPE OF BACKFILL BELOW OBSERVATION WELL: ____________
ELEVATION / DEPTH OF HOLE: ______ / ______

MONITORING WELL SHEET

PROJECT ______	LOCATION ______	DRILLER ______
PROJECT NO. ______	BORING ______	DRILLING METHOD ______
ELEVATION ______	DATE ______	DEVELOPMENT METHOD ______
FIELD GEOLOGIST ______		



ELEVATION TOP OF RISER: ______

TYPE OF SURFACE SEAL: ______

TYPE OF PROTECTIVE CASING: ______

I.D. OF PROTECTIVE CASING: ______

DIAMETER OF HOLE: ______

TYPE OF RISER PIPE: ______

RISER PIPE I.D.: ______

TYPE OF BACKFILL/SEAL: ______

______

DEPTH/ELEVATION TOP OF SAND: ______/______

DEPTH/ELEVATION TOP OF SCREEN: ______/______

TYPE OF SCREEN: ______

SLOT SIZE x LENGTH: ______

TYPE OF SAND PACK: ______

DIAMETER OF HOLE IN BEDROCK: ______

DEPTH/ELEVATION BOTTOM OF SCREEN: ______/______

DEPTH/ELEVATION BOTTOM OF SAND: ______/______

DEPTH/ELEVATION BOTTOM OF HOLE: ______/______

BACKFILL MATERIAL BELOW SAND: ______

ACFILE: L870\GEOL\OBUR01.DWG

Brown & Root Environmental

WELL DEVELOPMENT FORM

Well Number ____________________

Site Name ____________________

Date and Time Well Installed ____________________

Well Stickup ____________________ ft above/below grade

Total Depth Of Well ____________________ ft below top of casing

Static Level Before Purging ____________________ ft below top of casing

Inside Diameter of Well ____________________ inches

One Casing Volume ____________________ gallons

V=0.1632h (2 inch diameter casing)

h=height of water column

WELL DEVELOPMENT NOTES

Date__________ Time Begun ____________________

Developed By ________________________________

Method(s) Used ____

____

Time	Temp (C°)	pH	Conductivity (mS/cm)	Color	Turbidity (NTU)	Total Volume Removed (gals)

Casing Volumes Removed ______________

Time Completed ____________________

SAMPLE LOG SHEET

Brown & Root Environmental

☐ Monitoring Well Data
☐ Domestic Well Data
☐ Other________________

Page _____ of _____

By____________

Project Site Name ______________________________ Project Site Number ______________________________

B&RE Sample ID ______________________________ Source Location ______________________________

	Purge Data					
	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.
Total Well Depth:						
Well Stickup:						
Well Casing Size:						
Static Water Level:						
One Casing Volume:						
Start Purge (hrs.):						
End Purge (hrs.):						
Total Purge Time (min.):						
Total Amount Purged (gal.):						
Monitoring Reading:						
Purge Method:						
Sample Method:						
Depth Sampled:						

	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	D.O.
Sample Data & Time:					
Sampled By:					

Signature(s):

Observations/Notes:

Type of Sample

☐ Low Concentration
☐ High Concentration
☐ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative:

Dup #

MSMSD ☐

Air Bill #

Date Shipped

Time Shipped

Lab

Other

Brown & Root Environmental

SAMPLE LOG SHEET

Page _____ of ___

☐ Surface Water
☐ Water QA/QC Blank Sample
- ☐ Trip Blank
- ☐ Rinsate Blank
- ☐ Field Blank
- ☐ Ambient Condition Blank

Project Site Name ____________________ Project Site Number ____________________

B&RE Sample Name ____________________ Sample Source or Location ____________________

____

Surface Water Data

pH	Temp. (°C)	Dissolv. O_2	Color	Elect. Conduct.(mS/cm)

Sample Date and Time:	Observations/Notes:
Sampled By (Print):	
Sampled By (Signatures):	

Analysis	Preserv.	Bottle Lot #s	Laboratory	Ship Date/Time	Airbill #

COC #

Brown & Root Environmental

SAMPLE LOG SHEET

☐ Surface Soil
☐ Subsurface Soil
☐ Sediment
☐ Other

Project Site Name ____________________ Project Site Number ____________________

B&RE Sample Name ____________________ Sample Source or Location ____________________

____

Sample Method:	Sample Date and Time:
Sample Depth:	Color:
Sampled By (Print):	Sample Description:
Sampled By (Signatures):	FID Reading of Sample (if appropriate):
Concentration of Sample: ☐ Low ☐ Medium ☐ High	Type of Sample: ☐ Composite ☐ Grab

Observations/Notes:

Analyses

Analysis	Bottle Lot #

Shipment

Laboratory	Ship Date/Time	Airbill #

Appendix D

Quality Assurance Elements

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TABLE OF CONTENTS (Continued)

TABLES

FIGURES

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This quality assurance document has been prepared by Brown & Root Environmental (B&R Environmental) on behalf of the United States Navy Southern Division Naval Facilities Engineering Command and the Naval Air Station (NAS) Key West, Key West, Florida, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298, Contract Task Order (CTO) 032. This QA document and other associated documents, including the Workplan and Health and Safety Plan (HASP), constitute the project planning documents for the Site Investigation (SI) to be performed at the NAS Key West.

This quality assurance document presents the organization, objectives, planned activities, and specific Quality Assurance/Quality Control (QA/QC) procedures associated with the Workplan for the SI. Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described. All QA/QC procedures are structured in accordance with applicable technical standards, the Naval Facilities Engineering Service Center (NFESC) guidance document "Navy Installation Restoration Laboratory Quality Assurance Guide (February 1996), and United States Environmental Protection Agency (U.S. EPA) Region IV and the Florida Department of Environmental Protection (FDEP) requirements, regulations, guidance, and technical standards.

1.2 FACILITY DESCRIPTION

A description of the NAS Key West, including its location, size and borders, site condition, and natural and manmade features, is provided in Section 2.1 of the Workplan.

1.3 PROJECT OBJECTIVES

This section discusses the overall project objectives and the anticipated target parameters and intended data uses for both field and laboratory analytical data.

1.3.1 Overall Project Objectives

The objective of the work will be to investigate and characterize several properties identified for closure under the Base Realignment and Closure (BRAC) Act of 1992. The investigation will include collecting surface soil, sediment, surface water, and groundwater screening samples and installing and sampling permanent groundwater monitoring wells. The characterization of the BRAC sites is necessary in order to facilitate the closure and transfer of the property.

1.3.2 Project Target Parameters and Intended Data Uses

This section discusses the field and laboratory analytical information to be generated during the course of the investigation. Field parameters and intended data uses are discussed in Section 1.4.2.1. Laboratory parameters and intended data uses are discussed in Section 1.4.2.2.

1.3.2.1 Field Parameters

Field parameters will include those associated with the completion of soil borings, installation and development of monitoring wells, and collection of soil, sediment, surface water, and groundwater samples. Field measurements will include only those measurements completed with simple field instrumentation.

Field measurements of total volatile organics will be completed using a Flame Ionization Detector (FID). These measurements will be used to screen samples and verify that organic concentrations are not of a magnitude that would cause health and safety concerns.

Field parameters including pH, specific conductance, turbidity, and temperature will be completed for all aqueous phase samples. These measurements will be used to support monitoring well development and purging of stagnant water from well casings. Specific conductance and pH will also be used as general indicators of water quality.

1.3.2.2 Laboratory Parameters

The analytical methods to be used for analysis of the NAS Key West samples have been selected based on existing information regarding the use of the facility. The suite of analyses for environmental samples collected during the NAS Key West BRAC SI includes Target Compound List (TCL) volatiles (VOCs) TCL semivolatiles (SVOCs), TCL organochlorine pesticides, TCL PCBs, and Target Analyte List (TAL) metals. Additionally, any drums of solid investigation derived waste (IDW) will be sampled as discussed in Section 6.0 of the Workplan. These samples will be analyzed for the full regulatory list of Toxicity Characteristic Leaching Procedure (TCLP) parameters. Tables 1-1 through 1-3 provide a summary of all target laboratory analytes and associated estimated quantitation limits (EQLs). Analytical methods are

TABLE 1-1

ESTIMATED QUANTITATION LIMITS (EQLs) - TARGET COMPOUND LIST ORGANICS
NAS KEY WEST, FLORIDA
PAGE 1 OF 4

Parameter	EQL[1] Aqueous Samples[2] (µg/L)	EQL[1] Solid Samples[3] (µg/kg)
VOLATILE ORGANIC COMPOUNDS SW-846 METHOD 8260a/8260b		
1,1-Dichloroethane	1	1
1,1-Dichloroethene	1	1
1,1,1-Trichloroethane	1	1
1,1,2,2-Tetrachloroethane	1	1
1,1,2-Trichloroethane	1	1
1,2-Dichlorobenzene	1	1
1,2-Dichloroethane	1	1
1,2-Dichloropropane	1	1
1,3-Dichlorobenzene	1	1
1,4-Dichlorobenzene	1	1
2-Butanone	5	5
2-Hexanone	5	5
4-Methyl-2-pentanone	5	5
Acetone	5	5
Benzene	1	1
Bromodichloromethane	1	1
Bromoform	1	1
Bromomethane	1	1
Carbon disulfide	5	5
Carbon tetrachloride	1	1
Chlorobenzene	1	1
Chloroethane	1	1
Chloroform	1	1
Chloromethane	1	1
cis-1,2-Dichloroethene	1	1
cis-1,3-Dichloropropene	1	1
Dibromochloromethane	1	1
Ethylbenzene	1	1
Methylene chloride	1	1
Styrene	1	1
Tetrachloroethene	1	1
Toluene	1	1
trans-1,2-Dichloroethene	1	1
trans-1,3-Dichloropropene	1	1
Trichloroethene	1	1
Vinyl chloride	1	1

TABLE 1-1

ESTIMATED QUANTITATION LIMITS (EQLs) - TARGET COMPOUND LIST ORGANICS
NAS KEY WEST, FLORIDA
PAGE 2 OF 4

Parameter	EQL[1] Aqueous Samples[2] (µg/L)	EQL[1] Solid Samples[3] (µg/kg)
SEMIVOLATILE ORGANIC COMPOUNDS SW-846 METHOD 8270b/8270c		
1,2,4-Trichlorobenzene	10	333
2,4,5-Trichlorophenol	10	333
2,4,6-Trichlorophenol	10	333
2,4-Dichlorophenol	10	333
2,4-Dimethylphenol	10	333
2,4-Dinitrophenol	20	667
2,4-Dinitrotoluene	10	333
2,6-Dinitrotoluene	10	333
2-Chloronaphthalene	10	333
2-Chlorophenol	10	333
2-Methylnaphthalene	10	333
2-Methylphenol	10	333
2-Nitroaniline	10	333
2-Nitrophenol	10	333
3,3'-Dichlorobenzidine	50	1,670
3&4-Methylphenol	10	333
3-Nitroaniline	10	333
4,6-Dinitro-2-methylphenol	10	333
4-Bromophenyl-phenylether	10	333
4-Chloro-3-methylphenol	10	333
4-Chloroaniline	20	667
4-Chlorophenyl-phenylether	10	333
4-Nitroaniline	10	333
4-Nitrophenol	20	667
Acenaphthene	10	333
Acenaphthylene	10	333
Anthracene	10	333
Benzo(a)anthracene	10	333
Benzo(a)pyrene	10	333
Benzo(b)fluoranthene	10	333
Benzo(g,h,i)perylene	10	333
Benzo(k)fluoranthene	20	333
Bis(2-chloroethoxy)methane	10	333
Bis(2-chloroethyl)ether	10	333
Bis(2-chloroisopropyl)ether	10	333
Bis(2-ethylhexyl)phthalate	10	333

TABLE 1-1

ESTIMATED QUANTITATION LIMITS (EQLs) - TARGET COMPOUND LIST ORGANICS NAS KEY WEST, FLORIDA PAGE 3 OF 4

Parameter	EQL[1] Aqueous Samples[2] (µg/L)	EQL[1] Solid Samples[3] (µg/kg)
SEMIVOLATILE ORGANIC COMPOUNDS SW-846 METHOD 8270b/8270c		
Butylbenzylphthalate	10	333
Carbazole	10	333
Chrysene	10	333
Dibenz(a,h)anthracene	10	333
Dibenzofuran	10	333
Diethylphthalate	10	333
Di-n-butylphthalate	10	333
Di-n-octylphthalate	10	333
Dimethylphthalate	10	333
Fluoranthene	10	333
Fluorene	10	333
Hexachlorobenzene	10	333
Hexachlorobutadiene	10	333
Hexachlorocyclopentadiene	10	333
Hexachloroethane	10	333
Indeno(1,2,3-cd)pyrene	10	333
Isophorone	10	333
Naphthalene	10	333
Nitrobenzene	10	333
N-nitrosodiphenylamine	10	333
Pentachlorophenol	10	333
Phenanthrene	10	333
Phenol	10	333
Pyrene	10	333

TABLE 1-1

ESTIMATED QUANTITATION LIMITS (EQLs) - TARGET COMPOUND LIST ORGANICS
NAS KEY WEST, FLORIDA
PAGE 4 OF 4

Parameter	EQL[1] Aqueous Samples[2] (µg/L)	EQL[1] Solid Samples[3] (µg/kg)
PESTICIDES SW-846 METHOD 8081/8081a		
4,4'-DDD	0.040	1.33
4,4'-DDE	0.040	1.33
4,4'-DDT	0.040	1.33
Aldrin	0.020	0.67
alpha-BHC	0.020	0.67
alpha-Chlordane	0.020	0.67
beta-BHC	0.020	0.67
delta-BHC	0.020	0.67
Dieldrin	0.040	1.33
Endosulfan I	0.020	0.67
Endosulfan II	0.040	1.33
Endosulfan sulfate	0.040	0.67
Endrin	0.040	1.33
Endrin aldehyde	0.040	1.33
Endrin ketone	0.040	1.33
gamma-BHC (Lindane)	0.020	0.67
gamma-Chlordane	0.020	0.67
Heptachlor	0.020	0.67
Heptachlor epoxide	0.020	0.67
Methoxychlor	0.020	6.7
Toxaphene	1	33.3
PCBS SW-846 METHOD 8081/8082		
Aroclor-1016	0.125	4.17
Aroclor-1221	0.125	4.17
Aroclor-1232	0.125	4.17
Aroclor-1242	0.125	4.17
Aroclor-1248	0.125	4.17
Aroclor-1254	0.125	4.17
Aroclor-1260	0.125	4.17

1 Estimated Quantitation Limit; as specified by General Engineering Laboratories in their 21 October 1997 RFP response.
2 Aqueous (groundwater, surface water) samples.
3 Solid (surface soil, sediment) samples.

TABLE 1-2

ESTIMATED QUANTITATION LIMITS - TARGET ANALYTE LIST (TAL) INORGANICS NAS KEY WEST, FLORIDA

Parameter	Estimated Quantitation Limit[1]	
	Aqueous Samples[2] (µg/L)	Solid Samples[3] (mg/kg)
Aluminum	50	2.5
Antimony	10	0.500
Arsenic	5	0.250
Barium	5	0.250
Beryllium	5	0.250
Cadmium	50	0.250
Calcium	100	5.0
Chromium	5	0.250
Cobalt	5	0.250
Copper	5	0.250
Iron	50	2.5
Lead	5	0.250
Magnesium	10	0.500
Manganese	10	0.500
Mercury	0.2	0.033
Nickel	5	0.250
Potassium	100	5.0
Selenium	5	0.250
Silver	5	0.250
Sodium	100	5.0
Thallium	10	0.500
Tin	10	0.250
Vanadium	5	0.250
Zinc	5	0.250

1 As specified by General Engineering Laboratories in their 21 October 1997 RFP response.
2 Aqueous (groundwater, surface water) samples.
3 Solid (soil, sediment) samples.

TABLE 1-3

ESTIMATED QUANTITATION LIMITS (EQLs) - TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) ORGANICS NAS KEY WEST, FLORIDA

Parameter	EQL[1] Solid Samples[2] (mg/L)
VOLATILE ORGANIC COMPOUNDS SW-846 METHOD 1311 FOLLOWED BY METHOD 8260a/8260b	
1,1-Dichloroethene	0.001
1,2-Dichloroethane	0.001
1,4-Dichlorobenzene	0.001
2-Butanone	0.005
Benzene	0.001
Carbon tetrachloride	0.001
Chlorobenzene	0.001
Chloroform	0.001
Trichloroethene	0.001
Tetrachloroethene	0.001
Vinyl chloride	0.001
SEMIVOLATILE ORGANIC COMPOUNDS SW-846 METHOD 1311 FOLLOWED BY METHOD 8270b/8270c	
2,4,5-Trichlorophenol	0.01
2,4,6-Trichlorophenol	0.01
2,4-Dinitrotoluene	0.01
2-Methylphenol	0.01
3&4-Methylphenol	0.01
Hexachlorobenzene	0.01
Hexachlorobutadiene	0.01
Hexachloroethane	0.01
Nitrobenzene	0.01
Pentachlorophenol	0.01
Pyridine	NA
HERBICIDES SW-846 METHOD 1311 FOLLOWED BY METHOD 8151/8151a	
2,4-D	NA
2,4,5-T	NA
PESTICIDES SW-846 METHOD 1311 FOLLOWED BY METHOD 8081/8081a	
alpha-Chlordane	2E-05
Endrin	4E-05
gamma-BHC (Lindane)	2E-05
gamma-Chlordane	2E-05
Heptachlor	2E-05
Methoxychlor	2E-05
Toxaphene	0.001

NA - This information was not available from General Engineering Laboratories as part of their 21 October 1997 RFP response at the time of publication. It will be obtained from the lab prior to analysis.

1 Estimated quantitation limit, as specified by General Engineering Laboratories in their 21 October 1997 RFP response.

2 Solid investigation-derived waste (IDW) samples.

TABLE 1-4

ESTIMATION QUANTITATION LIMITS - TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) INORGANICS
NAS KEY WEST, FLORIDA

Parameter	Solid Samples[2] (mg/L)
Arsenic	0.005
Barium	0.005
Cadmium	0.005
Chromium	0.005
Lead	0.005
Mercury	0.002
Selenium	0.005
Silver	0.005

1 As specified by General Engineering Laboratories in their 21 October 1997 RFP response.
2 Solid investigation-derived waste (IDW) samples.

further discussed in Section 7.0 of this QA document. As discussed in Section 3.0 of the Workplan and presented in Appendix B of the Workplan, medium-specific action levels have been selected for each analytical parameter. In some cases, the standard EQLs associated with the applicable SW-846 methods may not be sufficient to meet the specified action levels. The action levels will be incorporated into the laboratory statement of work (SOW) so that, where possible, methods can be modified to decrease the EQLs to an acceptable level. In the event this is not technically possible, then action levels will be re-evaluated on a case-by-case basis.

1.4 SAMPLE NETWORK DESIGN AND RATIONALE

The design and rationale of the sampling and analysis plan is discussed in detail in Section 4.0 of the Workplan. Figures displaying the location of all proposed sampling locations are provided therein.

1.5 PROJECT SCHEDULE

The project schedule is provided in Section 7.0 of the project Workplan.

2.0 PROJECT ORGANIZATION

The management of all quality assurance aspects of the project are the ultimate responsibility of the Navy. Each contractor assigned to individual tasks has the responsibility to fulfill the objectives of each task and ensure the quality of the data generated by the task. At the direction of the Navy, B&R Environmental has overall responsibility for the BRAC SI to be performed at NAS Key West. Further discussion of project organization and management is provided in Section 7.0 of the Workplan.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall Quality Assurance (QA) objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will ensure quality, representative data. Intended data uses are described in Section 1.3.2 of this QA document. Procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field and laboratory equipment, and corrective action are described in other sections of this QA document.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and/or quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are discussed in the remainder of this section. Specific routine procedures used to assess the quantitative parameters (precision, accuracy, and completeness) are provided in Section 12.0.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for samples under similar conditions. The equation for determining precision is as follows:

$$RPD = \frac{\text{Amount in Sample} - \text{Amount in Duplicate}}{0.5\ (\text{Amount in Sample} + \text{Amount in Duplicate})} \ X\ 100\ \%$$

3.1.2 Field Precision Objectives

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. Field duplicate results for solid matrix samples are considered to be precise if the relative percent difference (RPD) is less than or equal to 50 percent. Field duplicate results for aqueous matrix samples are considered to be precise if the RPD is less than or equal to 30 percent. Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 environmental samples.

3.1.3 Laboratory Precision Objectives

Laboratory precision Quality Control samples are analyzed at a frequency of 5 percent (i.e., one quality control sample per 20 environmental samples). Laboratory precision is measured via comparison of calculated RPD values and Precision Control Limits specified in the analytical method or by the laboratory's QA/QC Program.

Precision for organic analyses will be measured via the RPDs for matrix spike/matrix spike duplicate (MS/MSD) samples. Precision for inorganic analyses will be measured via RPDs for laboratory duplicates. Internal laboratory control limits for precision, which are typically set at three times the standard deviation of a series of RPDs, will be used by the laboratory for evaluation of precision.

3.2 ACCURACY

3.2.1 Definition

Accuracy is the degree of agreement between an observed value and an accepted reference value. The equation for determining accuracy is as follows:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \text{ X } 100\,\%$$

3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of rinsate and trip blanks and is ensured through the adherence to all sample handling, preservation and holding times. Accuracy and precision requirements for field measurements (total volatile organics, pH, specific conductivity, temperature, and turbidity) are ensured through calibration as discussed in Section 6.0.

3.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample result against a known or calculated value expressed as a percent recovery (%R). Percent recoveries are derived from the analysis of known amounts of compounds spiked into deionized water (i.e., laboratory control sample (LCS) analysis), or into actual samples (i.e., surrogate or matrix spike analysis). Laboratory control samples measure the accuracy of laboratory operations, while surrogate and matrix spike analyses measure the accuracy of laboratory operations as affected by matrix. Laboratory control sample and/or matrix spike analyses are performed with a frequency of one per twenty associated samples of like matrix. Surrogate spike analysis is performed for all chromatographic organic analyses. Laboratory accuracy is assessed via comparison of calculated %R values with Accuracy Control Limits specified in the analytical method or by the laboratory's QA/QC Program. Evaluation of laboratory method blanks and calibrations is also a means of assessing laboratory accuracy.

Accuracy for organic analyses will be measured via the percent recoveries for surrogate spikes and matrix spike/matrix spike duplicates. Accuracy for inorganic analyses will be measured via percent recoveries for matrix spikes and laboratory control samples. Internal laboratory control limits for accuracy, which are typically set at three times the standard deviation of a series of %R values, will be used by the laboratory for evaluation of accuracy.

3.3 COMPLETENESS

3.3.1 Definition

Completeness is a measure of the amount of usable, valid analytical data obtained, compared to the amount expected to be obtained. Completeness is typically expressed as a percentage. The equation for completeness is as follows:

$$\text{Completeness} = \frac{\text{(number of valid measurements)}}{\text{(number of measurements planned)}} \times 100\,\%$$

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed), errors can be introduced during analysis (e.g., exceedance of holding time, loss of instrument sensitivity, introduction of ambient laboratory contamination), or sample inhomogeneity can become apparent (e.g., extremely high field duplicate RPDs).

These instances result in data that do not meet QC criteria. Based on these considerations, 95 percent is considered an acceptable target for the data completeness objective. If critical data points are lost, resampling and/or reanalysis may be required.

Laboratory data for the NAS Key West SI will be reviewed, involving the evaluation of results based on holding times, blank contamination, and field duplicate precision. Data rejected as a result of this review process will be treated as incomplete data.

3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. Field completeness for this project is expected to be at least 95 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid laboratory measurements obtained from all the laboratory measurements taken in the project. Laboratory completeness for this project is expected to be at least 95 percent. If critical data points are lost, resampling and/or reanalysis may be required.

3.4 REPRESENTATIVENESS

3.4.1 Definition

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point.

Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Workplan is followed and that proper sampling techniques are used. The sampling and analysis plan for the NAS Key West SI was designed to provide data representative of facility conditions. During development of the sampling and analysis plan, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the CERCLA program. The rationale of the sampling and analysis plan is discussed in detail in Section 4.0 of the Workplan.

3.4.3 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing duplicate samples.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods, and data reporting formats (including use of consistent units of measure and reporting of solid matrix sample results on a dry-weight basis). Additionally, consideration is given to seasonal conditions and other environmental variations that could exist to influence data results.

3.5.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Workplan is followed and that proper sampling techniques are used. It is also dependent on recording field measurements using the correct units. Field measurement units are further discussed in Section 9.1.1.

3.5.3 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented. Results will be reported in units that ensure comparability with previous data and with current state and Federal standards and guidelines. Laboratory measurement units are further discussed in Section 9.1.2.

3.6 LEVEL OF QUALITY CONTROL EFFORT

Trip blank, rinsate blank, method blank, field water blank, field and laboratory duplicate, laboratory control, and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. In addition, duplicate field measurements will be completed for temperature, pH, specific conductance, and turbidity.

External QC measures (i.e., field quality control samples) consist of field duplicates, trip blanks, and equipment rinsate blanks. Information gained from these analyses further characterizes the level of data quality obtained to support project goals. Each of these types of field quality control samples undergo the same preservation, analysis, and reporting procedures as the related environmental samples. Each type of field quality control sample is discussed below.

Field duplicates are either two samples collected independently at a sampling location (e.g., surface water), or a single sample homogenized and split into two portions. (Where volatile organic compounds (VOCs) are to be analyzed, the VOC sample aliquots are containerized first to avoid loss of constituents, then the remaining sample matrix is homogenized.) Field duplicates are collected and analyzed for chemical constituents to measure the precision of the sampling and analysis methods employed. The level of the QC effort will be one field duplicate for every 10 or fewer investigative samples.

Trip blanks, consisting of distilled water, will be submitted to the laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Trip blanks pertain to samples for VOC analysis only. Trip blanks are used to assess the potential for contamination of VOCs resulting from contaminant migration into sample containers during sample shipment and storage. Trip blanks are prepared by the laboratory prior to the sampling event, shipped to the site with the sample containers, and kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other VOC samples and sent for analysis. There should be one trip blank included in each sample shipping container that contains samples for VOC analysis. At no time after trip blank preparation are their sample containers opened before they reach the laboratory.

Equipment rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after decontamination and prior to use. One equipment blank will be collected per 20 pieces of like-equipment. If pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank per type of equipment used must be collected as a "batch blank." Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

One field water blank will be collected for each different water source used in cleaning and decontamination. These blanks will be analyzed for the complete set of environmental parameters presented in Tables 1-1 and 1-2, and will be used to ensure that field water sources are not a source of contamination.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Laboratory duplicate samples are analyzed for inorganic parameters to check for sampling and analytical reproducibility. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. All matrix spikes for organic analyses are performed in duplicate and are hereinafter referred to as MS/MSD samples.

MS/MSD samples are investigative samples. Soil MS/MSD samples require no extra volume for VOCs or extractable organics. However, aqueous MS/MSD samples must be collected at triple the volume for

VOCs and extractable organics. One MS/MSD sample will be collected/designated for every 20 or fewer investigative samples per sample matrix (i.e., groundwater, soil, surface water, sediment).

The level of QC effort provided by the laboratory will be equivalent to the level of QC effort specified under the appropriate SW-846 method parameters to be tested.

4.0 SAMPLING PROCEDURES

Field sampling procedures for the NAS Key West BRAC SI are discussed in detail in Section 4.0 of the Workplan. The Workplan addresses the following sampling procedures and field investigation tasks:

- Recordkeeping - Section 4.5.4
- Sample containers, preservatives, and volume requirements - Section 4.5.6
- Field equipment calibration- Section 4.5.8
- Surface soil sample collection - 4.5.11.1
- Sediment sample collection - 4.5.11.2
- Surface water sample collection - 4.5.11.3
- Groundwater screening sample collection - 4.5.11.4.1
- Temporary piezometer installation - 4.5.11.4.2
- Monitoring well construction, installation, development, and sampling - Section 4.5.11.4.3
- Groundwater-level measurement - Section 4.5.11.4.5
- Decontamination procedures - Section 4.5.12
- Sample packaging and shipping procedures - Section 4.6.1.4
- Sample Quality Control - Section 4.6.2.2
- Land survey - Section 4.7
- Geophysical survey-- Section 4.8
- Waste handling - Section 6.0

Standard Operating Procedures regarding sampling, recordkeeping, and field investigation tasks are included in appendix C to the Workplan.

5.0 CUSTODY PROCEDURES

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody if:

- the item is in the actual physical possession of an authorized person, or;
- the item is in view of the person after being in his or her possession, or;
- the item was placed in a secure area to prevent tampering; or
- the item is in a designated and identified secure area with access restricted to authorized personnel only.

The chain-of-custody (COC) report is a multi-part, standardized form used to summarize and document pertinent sample information, such as sample identification and type, matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the COC report documents sample custody and tracking. Custody procedures apply to all environmental and associated field quality control samples obtained as part of the data collection system.

5.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the analyzing laboratory or entrusted to a commercial overnight courier. COC reports are completed for each sample shipment. The reports are filled out in a legible manner, using waterproof ink, and are signed (and dated) by the sampler. Pertinent notes, such as whether the sample was field filtered, or whether the sample is suspected to be high in contaminant concentration, are also indicated on the COC report. Information similar to that contained in the COC report is also provided on the sample label, which is securely attached to the sample bottle. COC report forms and sample labels will be supplied by the laboratory subcontractor. In accordance with NFESC guidelines, samples for chemical constituent analysis must be sent (for next-day receipt) to the laboratory within 24 hours of collection.

Full details regarding sample chain-of-custody (including use of custody seals and sample shipment protocols) are contained in Section 4.6 of the BRAC SI Workplan. Section 4.5.4 of the BRAC SI Workplan discusses other field records. Copies of all field data forms are provided in Appendix D of the BRAC SI Workplan. All sample records are eventually docketed into the B&R Environmental project central file.

5.2 LABORATORY CUSTODY PROCEDURES

When samples are received by the laboratory subcontractor, the laboratory's sample custodian examines each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The sample custodian then signs the COC report. The custodian then opens the cooler and measures its internal temperature. The temperature reading is noted on the accompanying COC report. The sample custodian then examines the contents of the cooler. Sample container breakages or discrepancies between the COC report and sample label documentation are recorded. The pH of chemically preserved samples is checked using Hydrion paper and recorded. All problems or discrepancies noted during this process are to be promptly reported to the B&R Environmental Task Order Manager. Inter-laboratory chain-of-custody procedures and specific procedures for sample handling, storage, dispersement for analysis, and remnant disposal will be followed as specified by the subcontract laboratory's SOPs and/or QA Plan.

5.3 FINAL EVIDENCE FILES

The B&R Environmental central file will be the repository for all documents that constitute evidence relevant to sampling and analysis activities as described in this QA document. B&R Environmental is the custodian of the evidence file and maintains the contents of these files, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports and data reviews in a secure, limited access location and under custody of the B&R Environmental facility manager. The control file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs
- Drawings
- Soil boring logs
- Laboratory data deliverables

- Data review reports
- Data assessment reports
- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (chain-of-custody forms, airbills, etc.)

Upon completion of the contract, all pertinent files will be relinquished to the custody of the United States Navy.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. The requirement to properly calibrate instruments prior to use applies equally to field instruments as it does to fixed laboratory instruments. Field instrument calibration is discussed in Section 6.1. Laboratory instrument calibration is discussed in Section 6.2.

6.1 FIELD INSTRUMENT CALIBRATION

Field instrument calibration is discussed in Section 4.5.9 of the attendant Workplan.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibration (generally 3 to 5 points), initial calibration verification (inorganic methods only), and continuing calibration verification. In all cases, the initial calibration will be verified using an independently prepared calibration verification solution.

All standards used to calibrate analytical instruments must be obtained from National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards must be traceable to NIST reference standards, where possible, and appropriate documentation will be obtained from the supplier. In cases where documentation is not available, the laboratory will analyze the standard and compare the results to an EPA-supplied known or previous NIST-traceable standard.

The calibration procedures and frequencies used by the subcontract laboratory will comply with the applicable SW-846 analytical method. Brief descriptions of calibration procedures for major instrument types follow.

6.2.1 <u>GC/MS Volatile Organic Compound Analyses</u>

For volatile organic compounds, the GC/MS system will be tuned and calibrated in accordance with SW-846 method 8260a/8260b. A bromofluorobenzene (BFB) instrument performance check (tuning check) must be run prior to the initial and each continuing calibration and must meet all method-specified criteria before analyses may continue. Initial calibration is required before any samples are analyzed and must include a blank and a minimum of five different concentrations as specified in the method. A BFB tuning check and a continuing calibration check, including the mid-range standard and a blank, must be performed at the beginning of each 12-hour shift during which analyses are performed.

6.2.2 GC/MS Semivolatile Organic Compound Analyses

For semivolatile organic compounds, the GC/MS system will be tuned and calibrated in accordance with the SW-846 method 8270b/8270c. A decafluorotriphenyl phosphine (DFTPP) instrument performance check (tuning check) must be run prior to the initial and each continuing calibration and must meet all method-specified criteria before analyses may continue. Initial calibration is required before any samples are analyzed and must include a blank plus five different concentrations as specified in the method. A DFTPP tuning check and a continuing calibration check, including the mid-range standard and a blank, must be performed at the beginning of each 12-hour shift during which analyses are performed.

6.2.3 GC Pesticide Analyses

For pesticide analyses, the GC system will be calibrated in accordance with SW-846 method 8081/8081a. Initial calibration is required before any samples are analyzed. SW-846 method 8000 describes the proper calibration techniques for initial calibration and calibration verification. Analysts should use two calibration mixtures in order to minimize the impacts of co-elution on any single column and the specific mixtures should also be selected with this problem in mind. A mid-point calibration standard of all multi-component analytes must be included with the initial calibration (for pattern recognition) so that the analyst is familiar with the patterns and retention times on each column.

For calibration verification (each 12-hour shift), all pesticide target analytes must be injected. Analysts should alternate the use of high and low concentration mixtures of single component analytes and multi-component analytes for calibration verification. A calibration standard must also be injected at intervals of not less than every 20 samples and at the end of the analysis sequence.

6.2.4 GC PCB Analyses Under SW-846 Method 8082

For PCB analyses, the GC system will be calibrated in accordance with SW-846 method 8081/8082. Initial calibration is required before any samples are analyzed. SW-846 method 8000 describes the proper calibration techniques for initial calibration and calibration verification. PCBs are to be determined as aroclors for the NAS Key West BRAC SI. Therefore, the initial calibration includes the analysis of five standards containing a mixture of Aroclor 1016 and Aroclor 1260 as well as the analysis of a single standard of each of the other five Aroclors for pattern recognition.

Every 12 hours, a calibration verification standard must be injected prior to conducting any additional sample analyses. A calibration standard must also be injected at intervals of not less than every 20 samples and at the end of the analysis sequence.

6.2.5 GC Herbicide Analyses

For herbicide analyses, the GC system will be calibrated in accordance with SW-846 method 8151a. SW-846 method 8000 describes the proper calibration techniques for initial calibration and calibration verification. A minimum of five calibration standards should be prepared and analyzed for initial calibration of each parameter of interest. One of the standards should be at a concentration near, but above, the detection limit. The remaining standards should correspond to the expected range of concentrations found in environmental samples or the working range of the GC. Calibration verification must be performed using a mid-point standard at the beginning of each 12-hour shift. A calibration standard must be injected at intervals of no less than every 20 samples and at the end of the analysis sequence.

6.2.6 Metals Analyses

6.2.6.1 Inductively Coupled Argon Plasma Analyses

Inductively coupled plasma (ICP) spectrometry systems will be calibrated for the analysis TAL metals in accordance with the SW-846 method 6010a/6010b. For all analytes and determinations the laboratory must analyze a check standard and calibration blank immediately following the daily calibration, after every tenth sample, and at the end of the sample run. The calibration verification must be analyzed immediately following the daily calibration. Analysis of the check standard, calibration verification, and calibration blank must verify that the instrument is within 10 percent of calibration with a relative standard deviation of <3 percent from replicate (more than two) integrations.

6.2.6.2 Atomic Absorption Analyses

Graphite furnace and cold vapor atomic absorption (GFAA and CVAA) analyses will be calibrated in accordance with the appropriate SW-846 methods. Calibration curves are always required. A blank and at least three calibration standards in graduated amounts in the appropriate range of the linear portion of the curve should be prepared. A mid-range check standard must be run after every ten samples.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Samples will be subjected to field and laboratory parameter measurement as necessary based on the sample location under investigation. The analytical program for environmental samples collected at each anticipated location is provided in Section 4.0 of the Workplan.

Chemical/physical parameters to be measured using field instrumentation include volatile organics as methane equivalents (breathing zone air and soil vapors), temperature, specific conductance, pH, and turbidity (groundwater samples). Measurement of field parameters and calibration of field instruments are discussed in Section 4.5.9 of the Workplan.

All groundwater, surface water, soil, and sediment samples collected for fixed-laboratory analysis during the NAS Key West SI will be analyzed by a NFESC-approved laboratory. Table 7-1 provides a summary of the laboratory analytical methods for the NAS Key West SI.

A complete list of the target compounds/analytes and Estimated Quantitation Limits is provided in Section 1.3.2.2 of this QA document. All environmental data generated through use of SW-846 methods will be reported to the analyte's EQL. An analyte's EQL is based on the method detection limit with consideration given to required adjustments to ensure that the precision and accuracy requirements of the method are attainable. The EQLs provided in the tables in Section 1.3.2.2 are estimated since these values may vary based on the laboratory.

All solid sample results will be reported on a dry-weight basis. Quantitation limits will also be adjusted, as necessary, based on dilutions and sample volume.

TABLE 7-1

SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES[1]
SOLID AND AQUEOUS MATRICES
NAS KEY WEST

Analytical Parameter	Analytical Method
TCL Volatile Organics	SW-846 Method 8260a/8260b[2]
TCL Semivolatile Organics	SW-846 Method 8270b/8270c[2]
TCL Organochlorine Pesticides	SW-846 Method 8081/8081a[2]
TCL PCBs	SW-846 Method 8081/8082[2]
TAL Metals	SW-846 Method 6010a/6010b[2] and 7000a Series
TCLP Herbicides (Regulatory List)	SW-846 Method 1311 Followed by Method 8151/8151a[2]
TCLP Volatile Organics (Regulatory List)	SW-846 Method 1311 Followed by Method 8260a/8260b[2]
TCLP Semivolatile Organics (Regulatory List)	SW-846 Method 1311 Followed by Method 8270b/8270c[2]
TCLP Organochlorine Pesticides (Regulatory List)	SW-846 Method 1311 Followed by Method 8081/8081a[2]
TCLP Metals (Regulatory List)	SW-846 Method 1311 Followed by Method 6010a/6010b[2] and 7000a Series

1 U.S. EPA, 1997. Update and revisions to Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd ed.

2 Due to the June 1997 adoption of revisions to SW-846, two versions of most methods are designated here. Laboratories were given six months to adopt the revisions, and since the end of this grace period falls within the time frame of the BRAC SI, either version of a recently updated method may be employed.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related Quality Control checks were discussed in Section 3.0 of this QA document and in Section 4.6.2.2 of the attendant Workplan. This section provides additional information regarding internal quality control checks for the field and the laboratory.

8.1 FIELD QUALITY CONTROL CHECKS

Quality Control procedures for pH, specific conductance, temperature, and turbidity will include calibrating the instruments as described in Section 4.5.8 of the BRAC SI Workplan. Assessment of field sampling precision and bias will be made by collection of field duplicates and rinsate blanks for laboratory analysis as discussed in Section 3.6 of these QA Elements.

8.2 LABORATORY QUALITY CONTROL CHECKS

The subcontract laboratory will have a Quality Control program that ensures the reliability and validity of the analyses performed at the laboratory. Internal quality control procedures for SW-846 will comply with the applicable analytical method requirements.

Several internal laboratory Quality Control checks are briefly discussed in the remainder of this section.

Laboratory method blanks are prepared and analyzed in accordance with the analytical method employed to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. A method blank generally consists of an aliquot of analyte-free water (or purified sodium sulfate for soil/sediment samples) that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. With the exception of recognized volatile and semivolatile common laboratory contaminants (i.e., methylene chloride, acetone, 2-butanone, and phthalate esters) detected through use of the organic method, method blanks must not contain levels of target analytes above the reported quantitation limits. If method blank contamination is found to exist above allowable limits, corrective actions indicated in the appropriate method or laboratory SOPs must be followed. Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

Matrix spike analysis for organic fraction analyses is performed in duplicate as a measure of laboratory precision. For inorganic analyses, one matrix spike and one **laboratory duplicate** analysis are performed for every 20 environmental sample analyses of like matrix. With the exception of VOC MSD analyses, laboratory duplicates are prepared by thoroughly mixing and splitting a sample aliquot into two portions and analyzing each portion following the same analytical procedures that are used for the environmental sample analyses. For VOC MSD analyses, a second sample aliquot is used for analysis in order to avoid VOC constituent loss through the homogenization process. The field crew provides extra volumes of sample matrices designated for laboratory quality control analyses, as required. As discussed in Section 3.0 of this QA document, control limits for matrix spike and laboratory duplicate analyses are established by the laboratory for SW-846 analyses.

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled), which are similar in nature to the compounds of concern, and which are not likely to be present in environmental media. Surrogates are spiked into each sample, standard, and method blank prior to analysis, and are used only in organic chromatographic analysis procedures as a check of method effectiveness. As discussed in Section 3.0, surrogate recoveries are evaluated against control limits specified in the method, where applicable, or laboratory-derived control limits.

Laboratory control samples (LCS) serve to monitor the overall performance of each step during the analysis, including the sample preparation. Laboratory control sample analysis will be performed as specified in the applicable analytical method. Aqueous LCS results must fall within control limits specified in the method, where applicable, or established by the laboratory. Solid LCS results must fall within the control limits established by the supplier of the LCS standard. Aqueous and solid LCSs shall be analyzed utilizing the same sample preparations, analytical methods, and QA/QC procedures as employed for the samples.

Internal standard performance criteria ensure that GC/MS analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated 12-hour calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than ±30 seconds from the retention time of the associated 12-hour calibration standard.

9.0 DATA REDUCTION, REVIEW, AND REPORTING

This section describes the procedures to be used for data reduction, review, and reporting for the NAS Key West SI. All data generated during the course of the investigation will be stored by B&R Environmental in the Aiken Office central files. Upon completion of the contract, all files will be relinquished to the United States Navy.

9.1 DATA REDUCTION

Data reduction will be completed for both field measurements and laboratory-generated analytical data. Field data reduction will be relatively limited versus the degree of laboratory data reduction required for the project. Reduction of both field data and laboratory data are discussed in the remainder of this section.

9.1.1 Field Data Reduction

Field data will be generated as a result of real time measurement of organic vapor concentrations via a PID or FID (for health and safety monitoring and soil screening) and through on-site water quality testing for general indicator parameters including pH, specific conductance, turbidity, and temperature.

Field measurements of organic vapor concentrations (parts per million on a volume/volume basis relative to methane or benzene) will be recorded in the site logbook and incorporated into the BRAC SI Report. General water quality indicator parameters will also be recorded in the site logbook and on sample logsheets immediately after the measurements are taken and later encoded in the NAS Key West data base for presentation in the SI Report. If an error is made in the logbook, the error will be legibly crossed out (single-line strikeout), initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. No calculations will be necessary to reduce these data for inclusion in the SI Report. Field data will be entered in the electronic data base manually, and the entries will be verified by an independent reviewer to make sure that no "transcription" errors occurred. General groundwater quality data and field screening data will be recorded and reported in the following units:

- Hydronium ion concentration (standard pH units)
- Temperature (degrees Celsius)
- Specific Conductance (micromhos)
- Turbidity (Nephelometric turbidity units)

Standard pH units as specified above is the negative logarithm (base 10) of the hydronium ion concentration in moles/liter.

9.1.2 Laboratory Data Reduction

Data reduction for laboratory analytical data generated via SW-846 analyses will be completed in accordance with the applicable analytical method. Laboratory analytical data will be reported using standard concentration units to ensure comparability with regulatory standards/guidelines and previous analytical results. Reporting units for solid and aqueous matrices for the classes of chemicals under consideration are as follows:

Groundwater/Surface water samples:

- TCL volatiles, semivolatiles, and pesticides/PCBs - µg/L
- TAL metals - µg/L

Soil/Sediment samples:

- TCL volatiles, semivolatiles, and pesticides/PCBs - µg/kg
- TAL metals - mg/kg
- TCLP parameters - mg/L

Field Quality Control sample results will be included in the data base for the NAS Key West SI. Specifically, the analytical results for trip blanks, rinsate blanks, and field water blanks will be provided. The results for field Quality Control Samples will be considered during the course of data review (in concert with laboratory method blanks) to eliminate false positive results according to the 5- and 10-times rules specified in the National Functional Guidelines for Organic and Inorganic Data Review. The results for laboratory Quality Control samples such as method blanks will not be presented in the SI Report data base. In addition, only the original (unspiked) sample results for MS/MSD samples will be provided in the data base.

9.2 DATA REVIEW

Review of field measurements and laboratory analytical data are discussed in this section. Validation of field measurements is discussed in Section 9.2.1. Review of laboratory analytical data is discussed in Section 9.2.2.

9.2.1 Field Measurement Data Review

Field measurements will not be subjected to a formal data validation process. However, field technicians will ensure that the equipment used for field measurement is performing accurately via compliance with the Standard Operating Procedures discussed in Section 6.0 of this QA document. As described in Section 9.1.1, all field data entered into the electronic database will be independently reviewed for transcription errors.

9.2.2 Laboratory Data Review

All electronic laboratory data will be completely verified against supporting documentation including the COC and the results reported on the certificate of analysis.

All QC sample results will be reviewed, evaluated and used as basis for rejecting sample data. Particular emphasis will be placed on holding time compliance, calibrations, duplicate results, and blank results.

9.3 DATA REPORTING

9.3.1 Field Measurement Data Reporting

Field data will be reported in the units discussed in Section 9.1.1. The BRAC SI Report will include a comprehensive data base including all field measurements (specifically organic vapor concentrations, pH, specific conductance, temperature, and turbidity). Field measurements will be transferred from the site logbook or sample logsheets to the electronic data base manually and will be reviewed for accuracy by an independent reviewer. Transcription of field measurements to the electronic data base will be completed shortly after completion of the field investigation.

All records regarding field measurements (i.e., field logbooks, sampling logbooks, and sample logsheets) will be placed in the Aiken Office central files upon completion of the field effort. Entry of these results in the data base will require removal of these results from the files. Outcards will be used to document the removal of any such documentation from the files (date, person, subject matter). Field measurement data will be reported in an appendix of the SI Report at a minimum and may also be reported in summary fashion if they are indicative of the presence of contamination (e.g., high specific conductance readings).

9.3.2 Laboratory Data Reporting

Certificates of analysis (consisting of analytical results and qualifiers for each parameter) and associated initial and continuing calibration summaries will be provided by the laboratory for each Sample Delivery Group for all environmental samples, field quality control samples, and laboratory method blanks. Case narratives will also be provided.

All environmental and field Quality Control sample results (trip blanks, duplicates, rinsate blanks, field water blanks) will be included in the SI Report as an appendix. The data base will include pertinent sampling information such as sample number, sampling date, general location, depth, and survey coordinates (if applicable). Sample-specific detection limits will be reported for nondetected analytes. Units will be clearly summarized in the data base and will conform to those identified in Section 9.1.2. The analytical data may also be reported in summary fashion within the body of the SI Report text in tabular and graphic fashion.

Data will be handled electronically pursuant to the electronic deliverable requirements specified in B&R Environmental's Basic Ordering Agreement with analytical laboratories. This agreement requires the analytical laboratories to provide data in both hardcopy and electronic form (DBF files). The original electronic diskettes and the original hardcopy analytical data are maintained in the Aiken Office central files as received.

The data review process, as described in Section 9.2, will be completed using the hard copy data. Upon completion of the data review process, any rejected data will be appropriately qualified in the electronic database, and all electronic data will then be independently verified against the supporting documentation. Any discrepancies will be brought to the attention of the laboratory, as needed, clarified, and corrected.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be performed periodically to ensure that work is being implemented in accordance with the approved Project Plans and in an overall satisfactory manner. Such audits will be performed by various personnel and will include evaluation of field, laboratory, data review, and data reporting processes. Examples of pertinent audits are as follows:

- The FOL will supervise and check daily that the field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.

- Performance and system audits for the laboratory will be performed regularly by a U.S. Navy contractor in accordance with Naval Facilities Engineering Services Command (NFESC) requirements, and in accordance with the Laboratory Quality Assurance Plan.

- Data review, as described in Section 9.2, will occur in a timely manner. The data reviewer will generate a summary report describing data limitations, which will be reviewed internally by the Data Validation Coordinator prior to submittal to the Task Order Manager.

- A formal audit of the field sampling procedures may be conducted by the B&R Environmental Quality Assurance Manager (QAM) or designee in addition to the auditing that is an inherent part of the daily project activities. The purpose of this audit is to ensure that sample collection, handling, and shipping protocols, as well as equipment decontamination and field documentation procedures, are being performed in accordance with the approved Project Plans and SOPs.

- The Task Order Manager will maintain contact with the FOL and Data Review Coordinator to ensure that management of the acquired data proceeds in an organized and expeditious manner.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Measuring equipment used in environmental monitoring or analysis for the NAS Key West SI shall be maintained in accordance with the manufacturer's operation and maintenance manuals. Equipment and instruments shall be calibrated in accordance with the procedures, and at the frequency, discussed in Section 6.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment is discussed in the remainder of this section.

11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

B&R Environmental has established a program for the maintenance of field equipment to ensure the availability of equipment in good working order when and where it is needed. This program consists of the following elements:

- The B&R Environmental equipment manager keeps an inventory of the equipment in terms of items (model and serial number), quantity, and condition. Each item of equipment is signed out when in use, and its operating condition and cleanliness checked upon return.

- The equipment manager conducts routine checks on the status of equipment and is responsible for the stocking of spare parts and equipment readiness. The equipment manager also maintains the equipment manual library.

- The FOL is responsible for working with the equipment manager to make sure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturer's instructions and B&R Environmental SOPs before being taken to the job site and during field activities.

- During calibration, an appropriate maintenance check is performed on each piece of equipment. Any problems encountered while operating the instrument will be recorded in the field log book including a description of the symptoms and corrective actions taken.

- If problem equipment is detected or should require service, the equipment will be logged, tagged, and segregated from equipment in proper working order. Use of the instrument will not be resumed until the problem is resolved.

Preventive maintenance of field equipment is further described in Section 4.5.10 of the attendant Workplan.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential to ensuring their readiness when needed. Dependent on manufacturer's recommendations, maintenance intervals are established for each instrument. All instruments must be labeled with a model number and serial number, and a maintenance logbook must be maintained for each instrument. Personnel must be alert to the maintenance status of the equipment they are using at all times.

11.2.1 Major Instruments

Table 11-1 provides a summary of preventive maintenance procedures typically performed for key analytical instruments. Maintenance of key instruments is sometimes covered under service contracts with external firms. These contracts provide for periodic routine maintenance to help guard against unexpected instrument downtime. The contracts also provide for quick response for unscheduled service calls when malfunctions are observed by the operator.

The use of manufacturer recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the various gas chromatography and metals instruments are of sufficient grade to minimize fouling of the instrument. The routine use of septa, chromatographic columns, ferrules, AA furnace tubes, and other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime.

11.2.2 Refrigerators/Ovens

The temperatures of refrigerators used for sample storage and drying ovens will be monitored a minimum of once daily. The acceptable range for refrigerator temperatures is 4°C ±2°C. Required temperatures of ovens will vary based on the analytical methods for which the ovens are used. The temperatures will be recorded on temperature logs. The logs will contain the following information at a minimum:

- Date
- Temperature
- Initials of person performing the check

TABLE 11-1

TYPICAL PREVENTIVE MAINTENANCE FOR KEY ANALYTICAL INSTRUMENTS NAS KEY WEST

Instrument	Preventive Maintenance	Maintenance Frequency
GC/MS	Volatiles: Bake oven, replace septum, check carrier gas.	As required.
	Semivolatiles: Replace the septum, clean injection port, replace liner, bake oven, check carrier gas, clean the source.	As required.
	Replace solvent washes and clean syringe.	Daily.
GC	Replace solvent washes and clean syringe.	Daily.
	Clip column, clean injection port, replace liner, and bake oven.	As required.
ICP	Change sample introduction tubing, clean nebulizer, clean spray chamber, clean torch, manual profile, and automatic profile optics.	As required.
GFAA	Clean contact cylinders, replace/clean tube, check lamp alignment.	As required.
CVAA	Change sample introduction tubing, change drying cell, re-zero detector.	As required.

Maintenance of the logs is typically the responsibility of the sample custodian. However, assignment of responsibilities for temperature monitoring to specific personnel does not preclude the participation of other laboratory personnel. If unusual temperature fluctuations are noted, it is the responsibility of the observer to immediately notify the person in charge of the discrepancy before the condition of the samples is compromised.

Unstable or fluctuating temperatures may be indicative of malfunctions in the cooling or heating system. On the other hand, the instability may be due to frequent opening of the door. Regardless of the cause, such an observation must be investigated, and modifications must be made to access procedures or repairs to equipment must be made to prevent jeopardizing the integrity of the samples.

12.0 CORRECTIVE ACTION

Under the B&R Environmental QA/QC program, it is required that any and all personnel noting conditions adverse to quality report these conditions immediately to the Task Order Manager and QAM. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAM to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed.

12.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or quality of product is not compromised. The need for corrective action may arise based on deviations from Project Plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. If warranted by the severity of the problem (e.g., if a change in the approved Project Plan documents or SOPs is required), the Navy will be notified in writing via a Field Task Modification Request (FTMR), and Navy (in conjunction with U.S. EPA Region IV and FDEP) approvals will be obtained. The FOL is responsible for initiating FTMRs; an FTMR will be initiated for all deviations from the Project Plan documents, as applicable. An example of an FTMR is provided as Figure 13-1. Copies of all FTMRs will be maintained with the onsite project planning documents and will be placed in the final evidence file.

Minor modifications to field activities such as a slight offset of a boring location will be initiated at the discretion of the FOL, subject to onsite approval by NAS Key West personnel. Approval for major modifications (e.g., elimination of a sampling point) must be obtained via an FTMR.

12.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the

Client Identification | Project Number | TMR Number

To ____________________ Location ____________________ Date __________

Description:

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____
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Reason for Change:

____
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Recommended Disposition:

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____
____
____

____
Field Operations Leader (Signature, if applicable) Date

Disposition:

____
____
____
____

____
Task Order Manager (Signature, if required) Date

Distribution:
Program Manager
Quality Assurance Officer
Task Order Manager
Field Operations Leader

Others as required ____________________
____
____
____

FIGURE 12-1

BROWN & ROOT ENVIRONMENTAL
FIELD TASK MODIFICATION REQUEST FORM

nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

- QC data are outside established warning or control limits
- Method blank analyses yield concentrations of target analytes above acceptable levels
- Undesirable trends are detected in spike recoveries or in duplicate RPDs
- There is an unexplained change in compound detection capability
- Inquiries concerning data quality are received
- Deficiencies are detected by laboratory QA staff audits or from performance evaluation sample test results.

Corrective actions are typically documented for out-of-control situations on a corrective action form. Using a corrective action form, any employee may notify the QA/QC Officer of a problem. The QA/QC Officer generally initiates the corrective action by relating the problem to the appropriate Laboratory Manager and/or Internal Coordinator, who then investigates or assigns responsibility for investigating the problem and its cause. Once determined, an appropriate corrective action is approved by the QA/QC Officer. Its implementation is verified and documented on the corrective action form and is further documented through audits.

12.3 CORRECTIVE ACTION DURING DATA REVIEW AND DATA ASSESSMENT

The need for corrective action may become apparent during data review, interpretation, or presentation activities, or problems may be identified as a result of oversight findings. The performance of rework, instituting a change in work procedures, or providing additional/refresher training are possible corrective actions relevant to data evaluation activities. The Task Order Manager will be responsible for approving the implementation of corrective action.

13.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance reports to management will be provided in three primary formats during the course of the NAS Key West investigation. A data review summary will be prepared to summarize Quality Assurance issues for the subcontract laboratory data. In addition, written weekly reports summarizing accomplishments and Quality Assurance/Quality Control issues during the field investigation will be provided by the Field Operations Leader. Finally, monthly progress reports will be provided by the Task Order Manager.

13.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The contents of the specific Quality Assurance reports are as follows. The data review summary will address all major laboratory noncompliances as well as noted sample matrix effects. In the event that major problems occur with the analytical laboratory (e.g., extreme holding time exceedances or calibration noncompliances, etc.) the Data Review Coordinator will notify the Task Order Manager, the Technical Program Manager, and the Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. Such reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensational adjustments. Corrective actions are initiated at the program level.

The Field Operations Leader will provide the Task Order Manager with weekly reports regarding accomplishments, deviations from the Workplan, upcoming activities, and a Quality Assurance summary during the course of the field investigation. In addition, monthly project review meetings are held for all active Navy CLEAN projects. Issues discussed at the project review meeting include all aspects of budget and schedule compliance, and Quality Assurance/Quality Control problems. The Task Order Manager provides a monthly progress report to the Navy which addresses the project budget, schedule, accomplishments, planned activities, required revisions of this QA document, and Quality Assurance/Quality Control issues and intended corrective actions.

13.2 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS

Data review summaries are provided to the Task Order Manager for inclusion in the project files. In the event that major problems are observed for a given laboratory, the Program Manager, Deputy Program Manager, Quality Assurance Manager, Task Order Manager, and Laboratory Services Coordinator are provided with copies of the QA report. Weekly field progress reports are provided to the Task Order Manager. Monthly progress reports are provided to the Navy CLEAN Program Manager.