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CORRECTIVE MEASURES STUDY FINAL REPORT
SWMU 13 AND SWMU 46/AOC C

NAVAL STATION ROOSEVELT ROADS
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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
Baker	Baker Environmental, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
CMS	Corrective Measure Study
COCs	Contaminants of Concern
COPC	Chemicals of Potential Concern
CSF	Cancer Slope Factors
DoN	Department of the Navy's
DRMO	Defense Reutilization and Marketing Office
HI	Hazard Index
ICR	Incremental Cancer Risk
ILCR	Incremental Lifetime Cancer Risk
IR	Installation Restoration
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
mg/kg	milligrams per kilogram
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
MSDS	material safety data sheet
NCP	National Contingency Plan
NFPA	National Fire Protection Act
NSRR	Naval Station Roosevelt Roads
OU	Operable Unit
PAH	polynuclear aromatic hydrocarbons
PCB	Polychlorinated biphenyl
ppm	parts per million
RA	Risk Assessment
RBCs	Risk Based Concentrations
RCRA	Resource Conservation and Recovery Act
RfDs	Reference Doses
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigations
SWMUs	solid waste management units
SVOC	semivolatile organic compounds
TSCA	Toxic Substances Control Act
USEPA	United States Environmental Protection Agency
USTs	underground storage tanks
VOCs	volatile organic compounds

1.0 INTRODUCTION

This document presents the Corrective Measure Study (CMS) Report for Solid Waste Management Units (SWMUs) 13 and 46/Area of Concern (AOC) C at the Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. The report has been prepared under the Corrective Action provisions of the Station's Resource Conservation and Recovery Act (RCRA) permit (RCRA/HSWA Permit No. PR2170027203). This report has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV).

1.1 Regulatory Framework

In 1943, NSRR was commissioned as a Naval Operations Base. NSRR continued in this status until 1957 when it was redesignated a naval station with the mission of providing full support for Atlantic Fleet weapons training and development activities. Until 1993 all environmental operations, with the exception of underground storage tanks (USTs), were conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations as part of the Department of the Navy's (DoN) Installation Restoration (IR) Program. On October 20, 1994, a Final RCRA Part B permit was issued by the United States Environmental Protection Agency (USEPA) Region II to the Defense Reutilization and Marketing Office (DRMO), NSRR. This corrective action provisions of the permit required RCRA Facility Investigation (RFI) activities at 25 SWMUs and 4 AOCs.

RCRA regulations provide a procedure to investigate and remediate areas that may have been affected by a release of hazardous wastes. The first steps for investigating a site are the RCRA Facility Assessment (RFA) and the RFI. These assessments and investigations are studies on a property to determine if there has been a release of hazardous waste and to quantify any releases that have occurred. If these studies determine that a release has occurred, a CMS is performed to identify the most appropriate corrective measure for a given site.

A RFA was performed in 1988 and updated in 1993 by A.T. Kearney, Inc. for the USEPA to identify SWMUs and AOCs, and to assess the potential for the release of hazardous constituents from any areas or units. The RFA identified 47 SWMUs and 4 AOCs, and recommended additional investigation at 25 of the SWMUs and all four AOCs. In 1996, a Draft RFI report was prepared for Operable Units (OUs) 1, 6, and 7. Additional investigations, described in Section 2.0 of this report, were also conducted. Because the RFA and RFI indicated that releases had occurred, a CMS was deemed necessary. This report specifically focuses on the soil/sediment at

SWMU 13 and SWMU 46/AOC C which were found to be the only environmental media significantly impacted by past activities.

1.2 Intent of the Focused CMS

The purpose of a CMS is typically:

- to identify and evaluate remedial alternatives that may be used to address a release at a facility;
- to justify the recommended corrective action based upon technical, human health, and environmental considerations;
- to determine clean up levels;
- to provide a system for reporting compliance requirements and use this system to document remediation activities; and
- to provide information pertinent to the remedial design.

A highly focused or streamlined CMS is appropriate for facilities that have "straightforward remedial solutions" where standard engineering solutions can be applied that have proven effective in similar situations (USEPA 1994). The three areas that are the focus of this report have only one impacted media: soil/sediment. Because the SWMUs are located on the island of Puerto Rico, there are limited technologies that are time and cost effective in treating the impacted media. Also, the extent of contamination at the SWMUs/AOC has been fully characterized and was found to be limited. Therefore, the screening of clean-up technologies, normally conducted in a CMS, will not occur. The remedy selected and documented in this CMS will provide the quickest remediation of the SWMUs.

1.3 Goals of the Corrective Measure Process

The goal of this CMS is to identify the appropriate technical approach needed to address releases to the sediment at SWMU 13 and the surface and subsurface soil at SWMU 46/AOC C. The contaminant levels in the soil/sediment will be reduced to levels at or below the clean up goals established in this CMS. This CMS establishes the framework for the remediation of the SWMUs/AOC by providing remediation goals, a selected remediation method, and other information that is pertinent for the preparation of the remedial design and ultimately SWMU clean up.

1.4 Organization of the Report

The organization of this report is based on the Annotated Outlines for SWMU 13 and SWMU 46/AOC C that were provided to USEPA for their approval prior to the commencement of this report. As stated previously, this report is the consolidated CMS for the abovementioned SWMUs. This CMS is organized into six sections. Section 1.0 contains the introduction. Section 2.0 describes the sites, their investigative history, and the current site conditions. Section 3.0 establishes the corrective action objectives based upon the human health risk assessments and the developed risk-based remediation goals. The focused remedy for the remediation of the SWMUs is discussed in Section 4.0. Section 5.0 describes the technical elements of the selected remedy including conceptual design, confirmatory sampling, and reporting requirements. References are contained in Section 6.0.

2.0 DESCRIPTION OF CURRENT CONDITIONS

This section contains general site description of SWMU 13 and SWMU 46/AOC C. The investigative history and current site descriptions are also discussed in this section. Figure 2-1 shows the location of the SWMUs and AOC.

2.1 General Site Descriptions

General site descriptions of SWMU 13 and SWMU 46/AOC C are included in the subsections which follow.

2.1.1 SWMU 13

SWMU 13 consists of the area that contained the Old Pest Control Shop (Building 258). Pesticides for use on the base were mixed at this location and pesticide application equipment was cleaned. The Pest Control Shop was demolished in 1988 following excessive damage from a hurricane. The site consists of a concrete paved area surrounded by grass on the east and south. North and west of the paved area is heavily wooded. Two large areas in the southern portion of the site were discovered to be devoid of vegetation during a visual inspection conducted in 1988. These areas have been repeatedly monitored and since 1993 have shown no stressed or dead vegetation. SWMU 13 is bordered by a grass-covered concrete-lined drainage swale on the east. This drainage swale parallels Forrestal Road. The drainage swale leads to a culvert that directs water flow south-southwest under the site to an outlet in the wooded area. Figure 2-2 shows a site plan of SWMU 13.

2.1.2 SWMU 46/AOC C

SWMU 46 and AOC C are located adjacent to each other behind Buildings 2326 and 2042. Figure 2-3 depicts the SWMU and the AOC.

SWMU 46 consists of two concrete pads measuring approximately 25 feet by 40 feet. The pads are covered by a roof, but the sides remain open. The area containing the pads is surrounded by a chain link fence. The concrete pads are surrounded by grassy areas. Both pads are presently used as "under 90 day" hazardous waste storage/accumulating facilities for base operations. Prior to this, various materials of an electrical nature were stored on the pads.

AOC C is south and adjacent to SWMU 46. AOC C consists of three raised concrete pads with curbing. The two northern pads are divided into two sections by a concrete curb. The southern pad is one continuous pad. Each pad measures approximately 20 feet by 50 feet. The three pads contained numerous transformers during the RFA. They were accumulated at this location for sampling and staging for eventual off-site disposal at an approved facility. Staining was observed on all three pads. The eastern third of the middle pad was covered with tar. The area surrounding the pads is overgrown with tall grass and shrubs.

2.2 Summary of Site Conditions

The following sections describe the investigations and the current conditions of the SWMUs and AOC.

2.2.1 Investigation History

The histories of the SWMUs, as well as summaries of previous investigations, are discussed in the following paragraphs.

2.2.1.1 SWMU 13

SWMU 13 contained the former Pest Control Shop that was located in Building 258. It operated from the late 1950s through 1983. The approximate location of Building 258 is shown on Figure 2-2. Pesticides were stored in Building 258 and on the parking area adjacent to the building. In 1976, a 55-gallon drum containing malathion that was stored outside of the building ruptured. The contents washed into the drainage ditch. This ditch also received rinse water from the cleaning of pesticide application equipment. Excess pesticides were also reported to have been poured into the ditch. Pesticides typically used included DDT, Paris Green, maldane, malathion, and chlordane. There are no records of the concentrations or volumes of pesticides used at this location.

A number of environmental investigations have been conducted on SWMU 13. Table 2-1 summarizes the investigations, their scopes, and their results.

2.2.1.2 SWMU 46/AOC C

SWMU 46 has historically been used as a storage area, initially to store transformers and 55-gallon drums of polychlorinated biphenyl (PCB)-contaminated material. In 1988, this area

contained insulators, telephone poles, small cardboard boxes of electrical equipment, and several full 5-gallon pails. No evidence of release was noted. In 1993, the pad was clean except for some wire. The pad has been upgraded with spill control measures and is currently being used for an under 90-day storage facility by the base operations support contractor.

AOC C has also been historically used to store transformers and other electrical equipment. In 1988, this AOC was noted to be uncovered and containing at least 25 transformers and 20 to 40 batteries. The products were observed to be in good condition. Standing oil in the north pad had released to soil through cracks in the concrete. In 1993, the area was in the same condition as 1988, except that more transformers were stored on the pad. Oily stains had been observed both on and off the concrete pads. During maintenance activities at the site, in preparation for the 1996 hurricane season, the soil in the vicinity of the pads was stripped to a depth of approximately one foot and stockpiled nearby. This stockpile was rigorously characterized and with the consent of the USEPA, the pile was disposed in the base landfill. The highest concentration of PCBs detected in the soil pile was 8.6 parts per million (ppm).

A number of environmental investigations have been conducted at SWMU 46/AOC C. Table 2-2 summarizes the investigations, their scopes, and their results.

2.2.2 Site Conditions

The following subsections describe the current conditions of the SWMUs and AOC. Figures 2-4, 2-5, and 2-6 show the current extent of contamination at the SWMUs/AOCs.

2.2.2.1 SWMU 13

SWMU 13 has been characterized by many previous investigations which were summarized on Table 2-1. The most recent study, the Draft Additional Facility Investigations Report for Operable Units 1, 6, and 7, provides the most current information on SWMU 13. This study evaluated the sediment and the groundwater. The results are summarized in the following paragraphs.

Sediment Investigation

A total of five sediment samples were collected from SWMU 13 during the initial phase of the RFI investigation. A total of eleven sediment samples were collected from SWMU 13 during the second phase of the RFI investigation. Two volatile organic compounds (VOCs) (2-butanone and acetone) were detected in two samples (13SD03 and 13-SD04) during Phase I. One VOC (2-chloro-1,3-butadiene) was detected in one sample (13SD08) at a concentration of 180J micrograms per kilogram (μg/kg) collected in Phase II. These values are below the respective screening criteria.

Semivolatile organic compounds (SVOCs) were detected in four of the five sediment samples collected during Phase I, the majority of which were polynuclear aromatic hydrocarbons (PAHs). Only one of the SVOCs, benzo(a)pyrene was detected in excess of the USEPA Region III residential risk-based concentrations (RBCs) in two of the sediment samples (13SD02 and 13SD05). Eleven different SVOCs were detected in six of the eleven sediment samples collected during Phase II, the majority of which being PAHs. Only one of the SVOCs, benzo(a)pyrene was detected in excess of the residential RBCs in two of the sediment samples (13SD07 and 13SD09-00).

Three pesticides were detected from the sediment samples obtained in Phase I. Detections of pesticides occurred in all of the samples. All three of the pesticides detected (4,4'-DDD, 4,4'-DDE, and 4,4'-DDT) exceeded the residential RBCs in at least three of the samples. The industrial RBCs were exceeded for 4,4'-DDD, and 4,4'-DDT. No PCBs, dioxins, or chlorinated herbicides were detected in the sediment from the Phase I investigations. Six pesticides were detected from the sediment samples obtained from SWMU 13 during Phase II. Detections of pesticides occurred in all of the samples except for the background sample (13-SD10). All six of the pesticides detected (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-chlordane, dieldrin, and gamma-chlordane) exceeded the residential RBCs in at least two of the samples and in as many as seven of the samples. The industrial RBCs were exceeded for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin. The sediment sample obtained from the outfall of the drainage swale (13SD15) had the fewest detections of pesticides and at minor concentrations compared to the samples collected upstream. No PCBs were detected in these sediment samples.

A total of thirteen different inorganic compounds were detected in the five sediment samples. Only arsenic was detected above the residential RBC for soil in all five of the samples. Cadmium, lead, mercury, tin, and zinc were detected in excess of the 2 times the average detected background soil concentrations.

Groundwater

No VOCs, SVOCs, or PCBs were detected in the groundwater samples. The only positive detection was the pesticide 4,4'-DDD from groundwater sample 13GW04 at a concentration of 0.054 J micrograms per liter (µg/L). This value is below the tap water RBC value of 0.28 µg/L.

2.2.2.2 SWMU 46/AOC C

SWMU 46

Nine surface soil samples (46SS01 through 46SS09) were collected during the Phase I investigation. Eighteen additional surface soil samples (46SS10 through 46SS24 and ACSS39 through ACSS41) were obtained during the second phase of the investigation. It should be noted that the three samples (ACSS39 through ACSS41) collected from the formerly designated "contaminated soil area" were inadvertently labeled in the field for AOC C when they actually belong with SWMU 46. Sampling methodology was in accordance with the applicable SOP as provided in the USEPA approved Final RFI work plans. Combined with the nine surface soil samples from the initial phase of the investigation, the total number of surface soil samples collected from SWMU 46 is 27. Thirteen subsurface soil samples (46SB01 through 46SB13) were also collected from SWMU 46 during the second phase of the investigation.

Surface Soils

There were no significant detections of VOCs.

The SVOCs detected above residential RBCs were:

- Benzo(a)anthracene (in 1 of 27 samples)
- Benzo(a)pyrene (in 17 of 27 samples)
- Benzo(a)fluoranthene (in 5 of 27 samples)
- Dibenzo(a,h)anthracene (in 4 of 27 samples)
- Ideno(1,2,3-cd)pyrene (in 1 of 27 samples)

A number of other SVOCs were also detected sporadically but at levels below their residential RBC. Benzo(a)pyrene (in 2 samples) and dibenzo(a,h)anthracene (one sample) exceeded the industrial RBC in surface soils.

The PCB Aroclor 1260 exceeded residential RBCs in 19 of the 27 samples and exceeded industrial RBCs in 7 of the samples. Concentrations ranged from 390 - 35,000 µg/kg.

Arsenic and beryllium were the inorganic constituents exceeding criteria. Lead and cadmium also appeared at levels above comparison criteria although in a lesser number of samples than arsenic and beryllium.

Subsurface Soils

There were no exceedences of comparison criteria for any VOCs, SVOCs, or PCBs in the subsurface soil samples.

Arsenic (in 10 of 17 samples) and beryllium (in 13 of 15 samples) exceeded their respective residential RBCs . There were no exceedences of industrial RBCs.

AOC C

Twenty-six surface soil samples and fourteen subsurface soil samples were collected.

Surface Soils

No volatile organic compounds were detected in surface soils at AOC C at concentrations exceeding the industrial or residential RBCs.

The following semivolatile organic compounds were detected at concentrations exceeding their applicable residential RBCs:

- Benzo(a)anthracene (in 4 of 26 samples)
- Benzo(a)pyrene (in 16 of 26 samples)
- Benzo(b)fluoranthene (in 8 of 26 samples)
- Dibenzo(a,h)anthracene (in 7 of 26 samples)
- Ideno(1,2,3-cd)pyrene (in 2 of 26 samples)

Only benzo(a)pyrene (in 16 of 26 samples) exceeded its industrial RBC.

Aroclor 1260 was found in 19 of the 26 samples above the residential RBC. Seven of the PCB concentrations also exceeded the industrial RBC with a maximum detected concentration of 30,000 µg/kg.

Arsenic and beryllium were the only inorganics which exceeded the residential RBCs. Arsenic, found at levels above RBCs in 24 of 26 samples, ranged in concentration from 100J - 40,500J µg/kg. Beryllium, found at levels above RBCs in 9 of 26 samples, ranged in concentration from 150J - 270J µg/kg. Arsenic exceeded industrial RBCs in 12 of 26 samples.

Subsurface Soils

No VOCs or SVOCs were detected in the subsurface soil at levels exceeding the applicable residential RBCs. Also, no PCBs were seen at levels above the residential RBCs.

The inorganics analyzed in the subsurface soils indicated that there were no concentrations of any inorganic above the applicable residential RBC.

3.0 ESTABLISHMENT OF CORRECTIVE ACTION OBJECTIVES

This section determines the potential need for corrective action to mitigate potential risk to human health at SWMU 13 and SWMU 46/AOC C. Mitigation requires the determination of chemicals of concern (COCs) from a thorough review of the baseline risk assessment. COCs are those chemicals responsible for the majority (i.e., 90 percent or more) of an unacceptable human health risk for a given medium. Once COC are identified, current and potential future land use is evaluated to identify receptors and potential exposure routes. COCs, land use and exposure can then be more thoroughly evaluated to identify site specific corrective action objectives, if necessary.

3.1 The Process

The corrective action objectives consist of specific goals developed for the protection of human health and subsequently the environment. These objectives should be as specific as possible, but not so specific that the corrective actions to be developed are limited. Important components in the development of corrective action objectives include the identification of media of concern/contaminants of concern, identification of the potential exposure routes and receptors, the identification of regulatory criteria, the derivation of cleanup levels and the selection of clean up levels consistent with corrective action objectives for each site. The process components and corrective action objectives are presented below.

3.2 Identification of Media of Concern/Contaminants of Concern as Determined by the Human Health Risk Assessment

Results of the baseline risk assessment performed using Phase II data identified unacceptable human health risks for SWMU 13 and SWMU 46/AOC C. These risks are evaluated in the following subsections.

3.2.1 SWMU 13

The baseline RA for both Phase I and Phase II investigations identified sediment in a drainage ditch near the old Pest Control Shop (Building 258) as posing potentially unacceptable risks to human receptors. No other media were identified as producing unacceptable human health risks.

The potential for unacceptable human health risk was identified for both industrial (onsite workers) and residential (adults and children) scenarios. Incremental lifetime cancer risk (ILCR) values exceeded USEPA's generally acceptable risk range of 1×10^{-6} to 1×10^{-4} for onsite workers and future residents exposed to sediments affected by site related activities. COCs in sediment include the PAHs benzo(a)pyrene (maximum detected concentration = 290J µg/kg) and pesticides including dieldrin (maximum detected concentration = 1,800 µg/kg), DDT (maximum detected concentration = 34,000 µg/kg), DDD (maximum detected concentration = 50,000 µg/kg), DDE (maximum detected concentration = 21,000 µg/kg), alpha-chlordane and gamma-chlordane (maximum detected concentrations = 5,000 µg/kg, respectively). Onsite construction workers exposed to sediments containing these COCs exhibit an ILCR of 1.3×10^{-4}. Pesticides were responsible for approximately 90 percent of this value.

Adult residents exhibited ILCR values of 1.9×10^{-4} because of these same COCs. Children exhibited an ILCR value within the generally acceptable risk range (9.6×10^{-5}), but produced a noncarcinogenic hazard index value (HI) of 1.6. The pesticides dieldrin, DDT and chlordane accounted for approximately 90 percent of the unacceptable HI, affecting the liver.

3.2.2 SWMU 46/AOC C

The results of Phase I and Phase II investigation baseline risk assessments indicated that human receptors could experience unacceptable adverse health effects from contacting contaminants in surface soil at both SWMU 46 and AOC C. Both sites have similar contaminants.

Unacceptable ILCR values were observed for on-site workers and future residents exposed to contaminants in surface soil. The contaminant beryllium was responsible for approximately 65 percent of the unacceptable value. The CSF used in the baseline risk assessment has been withdrawn by USEPA from their IRIS database because of uncertainties in the database from which the CSF was extracted. The Reference Dose (RfD) for beryllium has been reduced, but no unacceptable systemic adverse health effects are associated with the change. As a result, beryllium will not be further addressed in the CMS because it does not pose a human health risk using most recent toxicity data.

A closer examination of contaminants comprising the remaining total cancer risk indicates that the PCB Aroclor-1260 and PAHs are present at SWMU 46/AOC C. Although these contaminants do not produce unacceptable risks in the Phase II baseline RA, they did contribute to the elevated ILCR and hot-spot areas of these contaminants may exist. For example, Aroclor-1260 was detected at a maximum concentration of 35,000 µg/kg at location 46SS21 and

benzo(a)pyrene was detected at 2,400 µg/kg at location 46SS11. Therefore, PAHs and PCBs were retained as COCs at SWMU 46/AOC C for further consideration in the CMS.

Unacceptable risks were not identified for any potential receptor to contaminants detected in subsurface soil.

Chemicals identified in the baseline RA as chemicals of potential concern (COPCs) at SWMU 46/AOC C that were not retained for further evaluation include:

Surface Soil

Dibenzo(a,h)anthracene, arsenic, beryllium and vanadium

Subsurface Soil

Arsenic, beryllium and vanadium

These contaminants do not pose unacceptable risks to human health and will not be further evaluated in the CMS.

3.3 Exposure Routes and Receptors

Exposure routes considered in the baseline RA include dermal contact and accidental ingestion of contaminants in soil or sediment. The inhalation of fugitive dust was also considered for both surface soil and subsurface soil in the event that construction activities would bring previously subsurface soil borne contaminants to the surface. On-site workers (i.e., commercial/utility), current construction workers and future potential residents could be exposed to contaminants by these pathways at each SWMU and AOC.

3.4 Selection of Cleanup Levels

The selection of cleanup levels begins with the consideration of site specific corrective action objectives. Cleanup levels can be regulatory criteria, risk-based criteria or a combination of both. This section presents all pertinent regulatory criteria and risk-based cleanup levels for media of concern and COCs identified for SWMU 13 and SWMU 46/AOC C. The purpose of this section

is to insure that all pertinent and applicable criteria are evaluated so that the most reasonable and conservative cleanup levels can be selected to protect human health for current and likely future property use.

3.4.1 Pertinent Regulatory Criteria

Pertinent regulatory criteria are limited to USEPA Region III Risk Based Concentrations and the Final PCB Disposal Rule (CFR Parts 750 & 761). A description of RBCs and the PCB - Final Disposal Rule are presented below.

USEPA Region III (Risk Based Concentrations) RBCs - RBC values are derived using conservative USEPA promulgated default values and the most recent toxicological criteria available. The RBCs for potentially carcinogenic chemicals are based on a target Incremental Cancer Risk (ICR) of $1x10^{-6}$. The RBCs for noncarcinogens are based on a target hazard quotient of 1.0. For potential carcinogens, the toxicity criteria applicable to the derivation of RBC values are oral and inhalation cancer slope factors (CSFs); for noncarcinogens, they are chronic oral and inhalation RfDs. These toxicity criteria are subject to change as more updated information and results from the most recent toxicological/epidemiological studies become available. Therefore, the use of toxicity criteria in the derivation of RBC values requires that the screening concentrations be updated periodically to reflect changes in the toxicity criteria. The RBC table is issued on a semi-annual basis and was recently updated in April, 1999.

PCB Final Disposal Rule - The final disposal rule amends previous rules under the Toxic Substances Control Act (TSCA). This rule (40 CFR Parts 750 & 761) provides flexibility in selecting disposal technologies as well as establishing bulk PCB remediation cleanup levels. These levels are established considering land use at the site which can be defined as either "high occupancy" or "low occupancy" areas. The cleanup level for high occupancy areas is 1 milligram per kilogram (mg/kg). High occupancy areas where PCB waste remains in place at concentrations between 1 mg/kg and 10 mg/kg must be capped or otherwise disposed. The cleanup level for low occupancy areas is 25 mg/kg, but PCBs can remain in place at 25 mg/kg to 50 mg/kg if the site is secured by a fence and marked with the appropriate signs. In the event of an actual or proposed change in use of an area, where the exposure of people or animal life in or at the area could reasonably be expected to increase resulting in a change in status from low occupancy to high occupancy area, the area will be cleaned in accordance with the high occupancy cleanup levels.

3.4.2 Human Health Risk-Based Cleanup Levels

In conjunction with pertinent regulatory criteria, site specific risk-based cleanup levels were developed for SWMU 13 and SWMU 46/AOC C and soil COCs. Risk-based cleanup goals are established using a logical process to identify those chemicals that pose the greatest risk to human health.

The first step in the process is to evaluate the summary risk results in the baseline risk assessment. Risks exceeding USEPAs target risk range of 1×10^{-6} to 1×10^{-4} for carcinogens are identified, as are hazard index (HI) values equal to or exceeding 1.0 for systemic (noncarcinogenic) contaminants. Once unacceptable risks have been identified, the carcinogenic contaminants responsible for 90 percent or more of the elevated incremental lifetime cancer risks are identified by medium as chemicals of concern. Noncarcinogenic contaminants affecting common target organs are then evaluated. If noncarcinogenic contaminants, segregated according to common target organs, produce HI values equal to or exceeding 1.0, these chemicals are also identified as COCs in the medium in which they occur.

Having identified both media of concern and COCs, an evaluation of current and future potential property use is conducted. Typically, receptors used in the baseline risk assessment are sufficient to begin the process of evaluating potential receptors and exposure pathways. In some cases, receptors and exposure pathways may be modified if new or additional information on property use becomes available. The following potential human receptors were considered at SWMU 13 and SWMU 46/AOC C.

- Military Residents (and dependents)
- Construction Workers
- Future Resident Adults
- Future Resident Children
- Future Commercial/Utility Workers

Military residents live at NSRR and the typical tour of duty is three years as per personal communication with Madeline Rivera, the RCRA Program Manager at Roosevelt Roads. A tour of 4 years was used as a conservative estimate of potential exposure duration for this receptor group.

Construction workers also were considered to evaluate potential exposure to contaminated subsurface soil. Construction workers were also assumed to contact contaminated groundwater during excavation activities. Commercial/utility workers were also evaluated to determine the

most likely potential future use of NSRR property in the event of a base closure. Commercial/utility workers are those individuals who could work at NSRR on a long-term basis (25 years). Although a change in NSRR property use is highly unlikely, future residents (adult and children) were also evaluated.

Once receptors and property uses are selected, risk-based cleanup goals are derived by a rearrangement of basic dose equations. The methodology used to derive the risk-based cleanup levels was in accordance with USEPA Risk Assessment Guidance for Superfund, Parts A and B (USEPA, 1989b and USEPA, 1991). For noncarcinogenic effects, risk-based cleanup levels were calculated for significant human exposure pathways that target a HI of 1.0, or unity. COC concentrations in a given medium that are less than a corresponding risk-based cleanup level indicate that systemic health effects will not occur subsequent to exposure for even sensitive populations. For carcinogenic effects, risk-based cleanup levels were calculated for an ICR of 1×10^{-6} (one additional cancer in a population of one million) that would be expected to result from exposure to a potential carcinogen over a lifetime, from all significant exposure pathways for a given medium. Based on the National Contingency Plan (NCP) (40 CFR 300.430), acceptable exposure levels, for known or suspected carcinogens, are generally concentrations that represent an ICR between 1×10^{-4} and 1×10^{-6}, with the latter ICR representing USEPA's point of departure.

Derivation of site specific cleanup goals involve the identification of the most significant exposure pathways and site specific exposure factors. The following exposure scenarios were considered in determining total site cleanup levels associated with soil at SWMU 13 and SWMU 46/AOC C.

- Accidental ingestion of soil (future adult and child residents, military residents and dependents, construction workers, future commercial/utility workers)
- Dermal contact with soil (future adult and child residents, military residents and dependents, construction workers, future commercial/utility workers)

Because of the non-volatile characteristics of COCs and the fact that no unacceptable risks were observed for any receptor group at any SWMU or AOC exposed via inhalation in the baseline RA, the inhalation pathway was not further evaluated in the establishment of cleanup goals.

In accordance with USEPA guidance, noncarcinogenic health effects were estimated as hazard indices for human populations (including sensitive subgroups, that may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety).

The cleanup level incorporated the exposure time (hours/day) and/or frequency (days/year) that represented the occurrence of exposure along with averaging time, which was the period over which exposure was averaged. Carcinogenic health effects were calculated as an incremental lifetime cancer risk in the baseline Risk Assessment (RA), expected over the course of a potentially exposed individual's lifetime (70 years). Exposure input parameters for receptors and exposure routes are presented in Tables 3-1 and 3-2.

The risk-based cleanup levels are the most applicable cleanup levels at SWMU 13 and SWMU 46/AOC C. The risk-based cleanup levels are site-specific, while the RBCs are designed to cover a broad range of sites and may be too conservative for NSRR, given the current potential and likely future use of the property. The use of site-specific cleanup goals is consistent with NCP guidance (40 CFR 300.430).

The estimation methods used in this section are consistent with current USEPA risk assessment guidance (USEPA, 1989b and 1991). This evaluation was conducted to assure that media and contamination at the site would be addressed on a site-specific basis. Potential cleanup levels were developed, with site-specific inputs, for soil and sediment COCs. Potential cleanup levels are presented in Tables 3-3 and 3-4. Risk-based cleanup level calculations are presented in Appendix A.

3.4.3 Selection of Remediation Levels

Because of the current property use at SWMU 13 and SWMU 46/AOC C and the continued operation of NSRR by the DoN, remediation levels were selected assuming current land use and the most likely current human receptors. Tables 3-5 and 3-6 presents the proposed remediation levels for SWMU 13 and SWMU 46/AOC C, respectively. These values were selected to protect construction workers from contaminants in soil and sediment. Selection of more conservative residential levels would be overly conservative because there is currently no on-Station housing at any site considered in this CMS, nor is residential use of the property likely to occur in the future.

Because remediation levels are established to protect construction workers, they may not be sufficient to provide adequate protectiveness for future alternative property uses. Any subsequently selected remedy may therefore include institutional controls (i.e., property use restrictions) as part of the selected corrective measures alternative.

A comparison of proposed soil remediation levels to soil RBC values provides an analysis of residual risk associated with the selection of construction worker based remediation levels at SWMU 13. Residual levels of dieldrin would produce a residual risk in excess of 1.0×10^{-4} if future residential property use occurs. All other COCs would produce risk that falls within USEPAs target risk range of 1×10^{-6} to 1×10^{-4}. Because of the nature of sediments in the drainage ditch and the disposition of the ditch itself, all contaminated sediments may be removed as part of the corrective measure. If sediments can be removed entirely, the corrective measure would be protective of any future property use scenario. Details concerning sediment in the SWMU 13 drainage ditch will be discussed in subsequent chapters of this CMS.

Selection of construction worker risk-based remediation levels for SWMU 46/AOC C would produce residual risks of approximately 5.6×10^{-5} for future residents. The PCB cleanup goal of 25 mg/kg would result in additional residual risk of 7.8×10^{-5}. The total residual risk to future residents (1.5×10^{-4}) would therefore exceed the upper value of USEPA's acceptable risk range of 1×10^{-4}. However, the PCB cleanup goal was selected in accordance with the final PCB disposal rule, whereby SWMU 46/AOC C have been identified as areas of low occupancy. Institutional controls will be necessary to prevent future use of the area which is inconsistent with the low occupancy designation. The final PCB disposal rule stipulates the remediation of PCBs to the high occupancy standard of 1.0 mg/kg in the event that future property use changes. Other contaminants (benzo(a)pyrene, benzo(b) fluoranthene and indeno (1,2,3-cd) pyrene) would also require additional corrective measures to protect human health in the event of future property use changes.

3.5 Corrective Action Objective

The corrective action identified for SWMU 13 and SWMU 46/AOC C is the selection of a corrective measure that protects human health and subsequently the environment by meeting or exceeding remediation levels established for the most likely use of the property. Remediation levels are presented in the previous section of this report. The Navy believes that achieving these remediation levels will provide an effective solution to contaminated media at these SWMUs and AOC C.

A consideration of institutional controls such as property use restrictions is consistent with other corrective actions taken at NSRR and is necessary to ensure that the selected corrective action will provide an adequate level of protection for human health.

4.0 RECOMMENDATION AND JUSTIFICATION OF THE FOCUSED REMEDY

The selected corrective measure for the clean up of sediment at SWMU 13, and surface soil at SWMU 46/AOC C are presented in the sections which follow. The remedies are described, and human health and environmental considerations are discussed.

4.1 Description of the Remedy

The selected corrective measure for each SWMU/AOC are discussed in the subsections which follow.

4.1.1 SWMU 13

The selected remedy for the sediments that have accumulated in the concrete-lined ditch at SWMU 13 is excavation and off-site disposal/treatment. The pesticide-contaminated sediment will be removed from the drainage channel and transported to a disposal facility. The concrete culverts connecting portions of the ditch will be pressure washed to remove any contaminated sediment. An on-island disposal facility will be used unless confirmatory testing indicates levels exceeding landfill acceptance criteria. All contaminated sediment, above or below the clean up levels, will be removed from SWMU 13.

4.1.2 SWMU 46/AOC C

The selected remedy for the PCB and PAH-impacted surface soil at SWMU 46/AOC C is excavation and off site disposal. Surface soil will be removed from areas where PCB and PAH contaminant concentrations exceed the risk-based clean up levels. The contaminated soil will be transported to an on-island, permitted, disposal facility. There are facilities located in Humaco and Ponce. Licensed waste haulers are available and will be used to transport the soil to the disposal facility. Institutional controls (land use restrictions) will be established to prevent property use other than low occupancy as described by the TSCA Final PCB Disposal Rules, (i.e., secured by a fence and marked with appropriate signs).

4.2 Justification of the Corrective Measure

The justification for the selection of excavation and disposal as the corrective measure is provided in this section. The corrective measure is evaluated based upon technical, human health, and environmental considerations.

4.2.1 Technical Considerations

Excavation and off-site disposal is proven and is commonly used at general construction and remediation sites. Because the contamination will be removed from the SWMUs/AOC, it is a permanent corrective measure. In terms of reliability, the contaminated media will be disposed in a permitted landfill which is considered a commonly accepted treatment alternative. With respect to implementability, this corrective measure requires commonly used earth moving equipment and disposal facilities. If confirmatory testing conducted during the excavation yields contaminant concentrations exceeding local landfill acceptance criteria, the media will require off-island transportation (i.e., barged to the United States) and disposal. In general, the SWMUs/AOC are easily accessible and have limited site features that would interfere with excavation. Safety concerns while implementing the corrective measure are anticipated to be minimal due to the limited areas of excavation, the shallow depths of excavation, and the low population density adjacent to the sites. In general, this technology will be effective, reliable, and easily implementable.

4.2.2 Human Health Considerations

Cleanup goals were established in Section 3.0 of this report. The proposed corrective measures will meet the cleanup goals since the contaminated media will be excavated and removed from the SWMUs/AOC. Therefore, the selected corrective measure is protective of human health and will reduce human health risk to an acceptable level.

4.2.3 Environmental Considerations

Removing the contaminated media from the SWMUs/AOC will provide an immediate benefit to the environment. Potential terrestrial receptors will no longer be in contact with the environmental media containing levels of hazardous constituents which exceed the cleanup goals.

5.0 TECHNICAL APPROACH TO THE CORRECTIVE MEASURE IMPLEMENTATION

This section details the selected remedies for impacted sediment at SWMU 13 and impacted surface soil at SWMU 46/AOC C. The layout of the conceptual design, design considerations, planning documents, and confirmatory sampling are presented in Section 5.1. The reporting requirements are presented in Section 5.2.

5.1 Conceptual Design

The design considerations and the technical approach are discussed in the paragraphs which follow.

5.1.1 Design Considerations

Many factors affect the ease with which a corrective measure can be performed at a site. Some of these items include site access, existing structures, disruption of adjacent facilities, available utilities, utility clearance, determination of extent of contamination, adequate space for staging areas, and availability of off-site waste disposal. Each of these design considerations is discussed with respect to SWMU 13 and SWMU 46/AOC C in Table 5-1.

5.1.2 Description of the Approach

The proposed approach for the corrective measure design, with respect to the technical approach and the required planning documents, is discussed in the subsections which follow.

5.1.2.1 Technical Approach

The anticipated technical approach for the remediation of SWMU 13 and SWMU 46/AOC C is detailed below. Figures 5-1 and 5-2 show conceptual design plans for the two areas where a corrective measure will be implemented. All remedial wastes generated as part of the clean up of SWMU 46/AOC C will be managed in accordance with the PCB requirements of 40 CFR, Part 761.60.

SWMU 13

- mobilization of a small backhoe or gradall, small front end loader, drainage diversion materials, roll-off boxes, and dewatering equipment
- construction of a decontamination pad
- installation of temporary drainage ditch diversion piping, straw bale check dams, and other erosion and sediment controls
- excavation of sediment in concrete-lined drainage channel. (The sediment thickness is estimated to average 4 inches.)
- transportation of the excavated sediment to lined roll-off boxes. (The roll-off boxes will be placed so that they slope to drain to one corner of the box)
- pressure washing of concrete culverts
- collection and analysis of representative sediment samples for toxicity characteristics in accordance with 40 CFR, Part 261.24.
- collection, analysis, and disposal of water from the roll-off boxes
- transportation and disposal of dewatered sediment
- pressure washing of concrete-lined channel (The wash water will be collected, combined with the water from the roll-off boxes, analyzed and disposed properly).
- removal of temporary diversion structures
- revegetation of any disturbed areas
- demobilization of all equipment, etc.

SWMU 46/AOC C

- mobilization of a bulldozer, front-end loader, and roll-off boxes
- construction of decontamination and equipment laydown areas
- installation of erosion and sediment controls
- removal of chain link fence from northern portion of SWMU 46
- location by survey of excavation limits
- excavation of six inches of surface soil from delineated areas
- transportation of excavated soil to lined roll-off boxes.
- characterization of soil in roll-off boxes (one composite sample per box analyzed for SVOCs, PCB, and toxicity characteristics in accordance with 40 CFR, Part 261.24.)
- transportation and disposal of soil to an approved disposal facility
- collection and analyses of confirmatory samples
- regrade and revegetate disturbed areas
- restoration of chain link fencing at SWMU 46

- removal of erosion and sediment control structures
- implementation of land use restrictions

5.1.2.2 Required Planning Documents

As part of the corrective measure design, the remedial contractor will be required to prepare a workplan documenting the proposed corrective measure. This workplan will include, at a minimum, an Environmental Protection Plan, an Accident and Analysis Plan, a Stormwater Pollution Prevention Plan, a Health and Safety Plan, and a Permitting Plan for the Transportation and Disposal of Hazardous Waste. A brief description of elements of the workplan is provided below.

Environmental Protection Plan

The Environmental Protection Plan should list the hazardous materials that may be brought onto the station. The Material Safety Data Sheets (MSDSs) for each material will be included. The contractor will also include employee training documentation, a hazardous waste storage plan, and a listing of hazardous waste to be generated on site. The contractor will be required to conduct a preconstruction survey of the results of which will be included in this plan.

Accident and Analysis Plan

This plan will identify the protocol for any and all potential accidents which may occur during the implementation of the proposed remedy.

Stormwater Pollution Prevention Plan

The Stormwater Pollution Prevention Plan will detail all erosion and sediment control measures to be in place during the proposed remediation.

Health and Safety Plan

The Health and Safety Plan will be site specific and will include, but not be limited to: the names of the health and safety officer and alternates; the requirements of 29 Code of Federal Regulations (CFR) 1910 and 1926; and the National Fire Protection Act (NFPA) 241.

Permitting Plan

The Permitting Plan will detail all permits that will be required for implementing the remedial action, including excavation, transportation of hazardous materials, and disposal of hazardous materials.

5.1.3 Confirmatory Sampling Plan

Confirmatory sampling will be conducted at SWMU 46/AOC C to verify that all PCB and PAH-contaminated soil with concentrations higher than the clean up levels has been removed from the site. A comparison of the proposed areas of excavation shown on Figure 5-2 with the lateral extent of PCB-impacted soil, shown on Figure 2-5, illustrates that the areas of soil with PCB concentrations above 25 ppm will be removed. The confirmatory sampling will consist of one sample per each 10 foot by 10 foot excavation and one sample every 2000 square feet in the larger excavations. The total number of samples is estimated to be 10. The sampling methods will be identical to those used in the Phase II RFI (Baker 1998). Soil samples will be submitted to the laboratory for fast turnaround SVOCs and PCBs analysis. Field test kits will be used for immediate verification on the three areas that contain PCB contamination. Should additional contamination be detected above the cleanup goals, the excavation will expand in small increments as directed by the Navy's Technical Representative.

All confirmatory data will be validated by a third party, independent, data validation firm. Data validation procedures will be identical to those followed for the Phase II RFI as these represent USEPA Region II protocol. The Quality Assurance Project Plan prepared for the RFI will be used to dictate quality control/quality assurance throughout the duration of the confirmatory sampling program.

No confirmatory sampling will be conducted at SWMU 13. All the sediments will be removed and the concrete channel will be power washed.

5.2 Reporting

To implement the corrective measure for SWMU 13 and SWMU 46/AOC C documents are required to report the progression of the sites from investigation to remediation. These documents include the CMS, the Corrective Measures Implementation (CMI) Design, and the CMI Final Report. This document is the CMS. The CMI design and CMI Final Report are discussed in the following sections.

5.2.1 Presumptive Remedy Design

Designs must be prepared for SWMU 13 and SWMU 46/AOC C to detail the proposed corrective measure. Because the corrective measure is an accepted construction practice (dig and haul), it is anticipated that the design will not be complicated. A draft and final design submittal should be adequate to document the proposed remedy. A listing detailing the proposed corrective measure at each site is shown in Section 5.1.2.1.

5.2.2 CMI Final Report

The CMI Final Report will be provided at the completion of the corrective measure. The report will include an introduction, summary of action, final health and safety report, summary of record documents, summary of field changes and contract modifications, final documents, a complete set of field test and analytical laboratory results, a complete set of validation reports, documentation of offsite transportation and disposal of sediment and soil, a quality control summary report, and final cost data. The CMI Final report will also include an evaluation of the corrective measure including the quantities of impacted media removed, problems encountered, and solutions implemented.

6.0 REFERENCES

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Baker, 1997b. Addendum. RCRA Facility Investigation Report for Phase I Investigations at Operable Unit 1, 6, and 7.

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Baker, June 1993. Draft Supplemental Investigation.

United States Environmental Protection Agency (USEPA), 1997a. "Risk-Based Concentration Summary Table", April 12, 1999. Region III, Philadelphia, Pennsylvania.

USEPA, 1997c. Exposure Factors Handbook - General Factors. EPA/600/P-95/002Fa. August, 1997.

USEPA, 1995. Assessing Dermal Exposure from Soil. Region III Technical Guidance Manual, December 1995. EPA/903-K-003.

USEPA, 1994. RCRA Corrective Action Plan. Office of Solid Waste and Emergency Response. OSWER Directive 9902.3-2A. May, 1994.

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TABLES

TABLE 2-1

SUMMARY OF PREVIOUS INVESTIGATIONS
SWMU 13, OLD PEST CONTROL SHOP
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Investigation	Date Conducted	Scope	Results
Initial Assessment Study	1983/1984	To provide a records search, site surveys, and interviews with station personnel	Identified 16 sites that required further investigation under the NACIP Program. Interviews revealed pesticide storage, spills, and aquatic kills in adjacent ditch.
Confirmation Study	1986	To determine if specific toxic or hazardous materials have contaminated the site. Two rounds of surface soil, sediment, and surface water samples were conducted. Three groundwater monitoring wells were installed and sampled.	DDD and DDE were detected in soil. Chlordane, DDD, DDE, and endosulfan were detected in the sediment. Chlordane, DDD, and DDE were detected in the surface water. Trace amounts of DDD were detected in one monitoring well. Recommended a preliminary risk assessment to determine threat to human health.
RCRA Facility Assessment	1988	To assess the potential for release of hazardous wastes and constituents to the environment.	Suggested further action at 25 of 47 SWMUs and 4 AOCs including SWMU 13.
Draft Supplemental Investigation	1993	To verify data collected during the Confirmation Study and to provide data for a RCRA Facilities Investigation. Groundwater, soil, surface water, and sediment were sampled.	Trace VOCs were found in groundwater. Trace to moderate concentrations of acetone and carbon disulfide were detected in the soil. Trace concentrations of pesticides (DDE & DDT) were detected in the surface water. Trace to high concentrations of pesticides were detected in the sediment.
Final RCRA Facility Investigation Workplans	1995	To provide workplans for proposed RFI.	
RCRA Facility Investigation Report for Phase I Investigations at OUs 1, 6, and 7	1996	Nine surface soil and five sediment samples were collected.	Benzo(a)pyrene, DDE, DDT, arsenic, and lead were found above residential RBC values in the surface soil. DDE, DDT, and benzo(a)pyrene were detected in the sediment. The soil results posed no significant risk to human health.
Draft Addendum RFI for Phase I Investigations at OUs 1, 6, and 7	1997	To address USEPA comments on the Draft RFI report. Specifically, a revised Risk Characterization was prepared for SWMU 13.	There were no unacceptable risks estimated for on-site, worker exposure to SWMU sediment. Calculated risks to future resident adults and children due to exposure to sediment exceed USEPA's generally accepted target risk.
Additional Investigations Report, OUs 1, 6, and 7	1998	To provide additional characterization and/or confirmatory sampling at SWMU 13. Eleven sediment samples were collected. Four groundwater monitoring wells were installed, seven groundwater samples were collected, and groundwater elevation measurements were taken.	One VOC (2-chloro-1,3 butadiene) was detected in one sediment sample. Six pesticides (DDD, DDE, DDT, alpha-chlordane, dieldrin, and gamma-chlordane) exceeded residential RBCs in at least two samples and as many as seven. No VOCs, SVOCs, or PCBs were detected in the groundwater. DDD was detected in one groundwater sample.

TABLE 2-2

SUMMARY OF PREVIOUS INVESTIGATIONS
SWMU 46/AOC C
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Investigation	Date Conducted	Scope	Results
Initial Assessment Study	1983/1984	To provide a records search, site surveys, and interviews with station personnel.	Identified 16 sites that required further investigation under the NACIP Program. SWMU 46/AOC C was not included in the IAS.
Confirmation Study	1986	SWMU 46/AOC C was not addressed in the Confirmation Study	
RCRA Facility Assessment	1988	To assess the potential for release of hazardous wastes and constituents to the environment.	Suggested further action at 25 of 47 SWMUs and 4 AOCs including SWMU 46 and AOC C.
Draft Supplemental Investigation	1993	SWMU 46/AOC C was not addressed in the Draft Supplemental Investigation	
Final RCRA Facility Investigation Workplans	1995	Provided workplans for the proposed RFI	
RCRA Facility Investigation Report for Phase I Investigations at OUs 1, 6, and 7	1996	SWMU 46: Collection of 11 surface soil samples, 4 subsurface soil samples, and 2 wipe samples. AOC C: Collection of 12 surface soil samples and 7 PCB wipe samples from 3 storage pads.	SWMU 46: Surface Soil: SVOCs were detected in the surface soil above residential RBCs. Aroclor-1260 concentrations exceeded industrial RBCs in 3 of 11 samples and residential RBCs in 9 of 11 samples. Arsenic concentrations were greater than the residential RBC in 5 samples. Beryllium was greater than the residential RBC in one sample. Subsurface Soil: Arsenic concentrations exceeded the residential RBC in one sample. Wipe: No PCBs were detected. AOC C: Surface Soil: VOCs, SVOCs, pesticides, and Aroclor-1260 were detected. Dioxin constituents were detected in two samples. Arsenic, beryllium, and lead were detected at levels above residential RBCs. Concrete: Six of ten wipe samples indicated Aroclor-1260.
Additional Investigations Report, OUs 1, 6, and 7	1998	SWMU 46: Collection of 18 surface soil samples and 13 subsurface soil samples AOC C: Collection of 26 surface soil and 14 subsurface soil samples.	SWMU 46: Surface Soil: Five SVOCs were detected above residential RBCs. Three samples contained SVOCs above industrial RBCs. Aroclor-1260 was detected exceeding residential and industrial RBCs. Arsenic, beryllium, lead, and cadmium exceeded screening criteria. Subsurface Soil: There were no exceedences of comparison criteria for VOCs, SVOCs, or PCBs. Arsenic and beryllium exceeded residential RBCs. AOC C: Surface Soil: Five SVOCs exceeded residential RBCs and one SVOC (detected in 16 of 26 samples) exceeded industrial RBCs. Aroclor-1260 was detected in 19 of 26 samples above residential RBC, with 7 samples exceeding industrial RBCs. Arsenic and beryllium exceeded residential RBCs. Subsurface Soil: No VOCs, SVOCs, PCBs, or inorganics exceeded residential RBCs.

TABLE 3-1

EXPOSURE INPUT PARAMETERS FOR RESIDENT CHILDREN AND ADULTS EXPOSED TO SURFACE SOIL SWMU 13 AND SWMU 46/AOCC NAVAL STATION ROOSEVELT ROADS PUERTO RICO

Input Parameter	Media	Units	Input Values		Comments/References
			Child (1 to 6 years)	Adult	
ED, Exposure Duration	Soil	years	6/4	24/4	USEPA, 1991a/Site Specific Information[4]
EF, Exposure Frequency	Soil	days/year	350	350	USEPA, 1991a
IR, Ingestion Rate	Soil	mg/day	200	100	USEPA, 1989b
SA, Surface Area	Soil	cm^2	2,006[2]	5,300[2]	USEPA, 1989a and 1992
ABS, Absorbance Factor	Soil	unitless	Chemical Specific[3]	Chemical Specific[3]	USEPA, 1995a
AF, Adherence Factor	Soil	mg/cm^2	0.2	0.2	USEPA, 1997
BW, Body Weight	Soil	kg	15	70	USEPA, 1989b
AT_{nc}, Averaging Time - Noncarcinogens	Soil	day	2,190/1460	8,760/1460	USEPA, 1989b/Site Specific Information[4]
AT_c, Averaging Time - Carcinogens	Soil	day	25,550	25,550	USEPA, 1989b

Notes:

(1) Frequency conservatively assumes 2 days per weekend, every weekend for 12 months.

(2) Represents approximately 25% of the total body surface area.

(3) The following USEPA Region III default absorbance factors will be applied to estimate dermal intake of COPCs in soil (USEPA, 1995a):

VOCs (Vapor Pressure > 95.2 mmHg) - 0.05%
VOCs (Vapor Pressure < 95.2 mmHg) - 3%
SVOCs - 10%
Arsenic - 3.2%
Inorganics - 1%

(4) Assumes a 4 year tour of duty for enlisted personnel and dependents, a conservative assumption. A three year tour of duty is the norm at NSRR (Personal communication with Station Personnel).

References:

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USEPA, 1989b. Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A) Interim Final. EPA/540/1-89/002. December, 1989.

TABLE 3-2

EXPOSURE INPUT PARAMETERS FOR FUTURE CONSTRUCTION WORKERS AND COMMERCIAL/UTILITY WORKERS EXPOSED TO SOIL SWMU 13 AND SWMU 46/AOC C NAVAL STATION ROOSEVELT ROADS PUERTO RICO

Input Parameter	Units	Input Values	Comments/References
ED, Exposure Duration	years	1/25	USEPA, 1991a
EF, Exposure Frequency	days/year	180/250	USEPA, 1991a
ET, Exposure Time	hrs/day	8	USEPA, 1991a
IR, Ingestion Rate	mg/day	480/100	USEPA, 1991a
SA, Exposed Surface Area	cm^2/day	4,100[1]	USEPA, 1992a
FI, Fraction Ingested	unitless	1.0	Professional Judgement
ABS, Dermal Absorption Factor	unitless	Chemical-specific[2]	USEPA, 1995a
AF, Adherence Factor	mg/cm^2	1/0.2	USEPA, 1992a/USEPA 1997
BW, Body Weight	kg	70	USEPA, 1989b
AT_{nc}, Averaging Time - Noncarcinogens	days	365	USEPA, 1989b
AT_c, Averaging Time - Carcinogens	days	25,550	USEPA, 1989b

Notes:

(1) Represents exposure to hands, forearms and face.

(2) The following USEPA Region III default absorbance factors will be applied to estimate dermal intake of COPCs in soil (USEPA, 1995a):

VOCs (Vapor Pressure > 95.2 mmHg) - 0.05%
VOCs (Vapor Pressure < 95.2 mmHg) - 3%
SVOCs - 10%
Arsenic - 3.2%
Inorganics - 1%

References:

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TABLE 3-3

POTENTIAL CLEANUP LEVELS
SWMU 13
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Concern	PERTINENT CRITERIA		RISK-BASED CRITERIA			
	Region III RBCs		Military Residents	Construction Workers	Future On-Site Residents	Commercial/ Utility Workers
	Soil (Industrial)	Soil (Residential)	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Dieldrin	0.36	0.04	0.6	4.8	0.4	1.0
DDT	17	1.9	3.3	31	2.2	7.4
DDE	17	1.9	3.3	31	2.2	7.4
DDD	24	2.7	4.7	45	3.1	10.5
alpha-chlordane	16	1.8	2.8	22	1.9	4.8
beta-chlordane	16	1.8	2.8	22	1.9	4.8
Benzo(a)pyrene	0.78	0.087	0.13	1.1	0.09	0.25

TABLE 3-4

POTENTIAL CLEANUP LEVELS
AOC C AND SWMU 46
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Concern	PERTINENT CRITERIA		RISK-BASED REMEDIATION GOALS			
	Region III RBCs		Military Residents	Construction Workers	Future On-site Residents	Commercial/Utility Workers
	Soil (Industrial)	Soil (Residential)	Soil/Sediment	Soil	Soil	Soil
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Benzo(a)pyrene	0.78	0.087	0.13	1.1	0.09	0.25
Benzo(b)fluoranthene	7.8	0.87	1.8	24	1.2	7.4
Indeno(1,2,3-cd)pyrene	7.8	0.87	1.8	24	1.2	7.4
PCB-1260	2.9	0.32	0.6	5.3	0.4	1.3

TABLE 3-5

PROPOSED SEDIMENT REMEDIATION LEVELS
SWMU 13
NAVAL STATION ROOSEVELT ROADS

Chemical of Concern	Sediment Remediation Level[1]
	mg/kg
Dieldrin	4.8
DDT	31
DDD	31
DDE	45
alpha-Chlordane	22
beta-Chlordane	22
Benzo(a)pyrene	1.1

Notes:

[1] Based on the Construction Worker scenario. Assumes digging in affected sediments and subsequent dermal and accidental ingestion exposure.

TABLE 3-6

PROPOSED SOIL REMEDIATION LEVELS
SWMU 46 AND AOC C
NAVAL STATION ROOSEVELT ROADS

Chemical of Concern	Soil Remediation Level[1]
	mg/kg
Benzo(a)pyrene	1.1
Benzo(b)fluoranthene	24
Indeno(1,2,3-cd)pyrene	24
PCB-1260	25*

Notes:

[1] Based on the Construction Worker scenario. Assumes digging in affected soils and subsequent dermal and accidental ingestion exposure.

* - Value adopted as a result of the Final PCB Disposal Rule. Area determined to be low occupancy.

TABLE 5-1

DESIGN CONSIDERATIONS
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Design Consideration	Remedial Area	Applicability
Site Access	SWMU 13 SWMU 46/AOC C	Site partially paved and easily accessible Site accessible from gravel road
Existing Structures	SWMU 13 SWMU 46/AOC C	Existing concrete pad in poor repair, proposed remediation should not further degrade concrete. The buildings surrounding SWMU 46 and AOC C should not be disturbed by remedial activities. The concrete pads in AOC C are in poor repair and should not be further degraded by remedial activities.
Disruption of Adjacent Facilities	SWMU 13 SWMU 46/AOC C	No adjacent facilities exist. Adjacent buildings (2326 and 2042) should not be affected by remedial activities.
Available Utilities	SWMU 13 SWMU 46/AOC C	Utilities are available at both sites.
Utility Clearance	SWMU 13 SWMU 46/AOC C	Utility clearance will be coordinated with the station's public works department prior to starting excavations.
Extent of Contamination	SWMU 13 SWMU 46/AOC C	The extent of contamination is limited to the drainage swale. The extent of contamination in the areas to be remediated has been fully defined by previous investigations. Contaminant removal will be verified with confirmatory testing.
Staging Areas	SWMU 13 SWMU 46/AOC C	Both sites have adequate room for staging and decontamination areas.
Off-Site Disposal	SWMU 13 SWMU 46/AOC C	Off-site disposal could include disposal at the station's landfill, disposal at a permitted on-island facility, or disposal at a permitted facility in the continental United States.

FIGURES

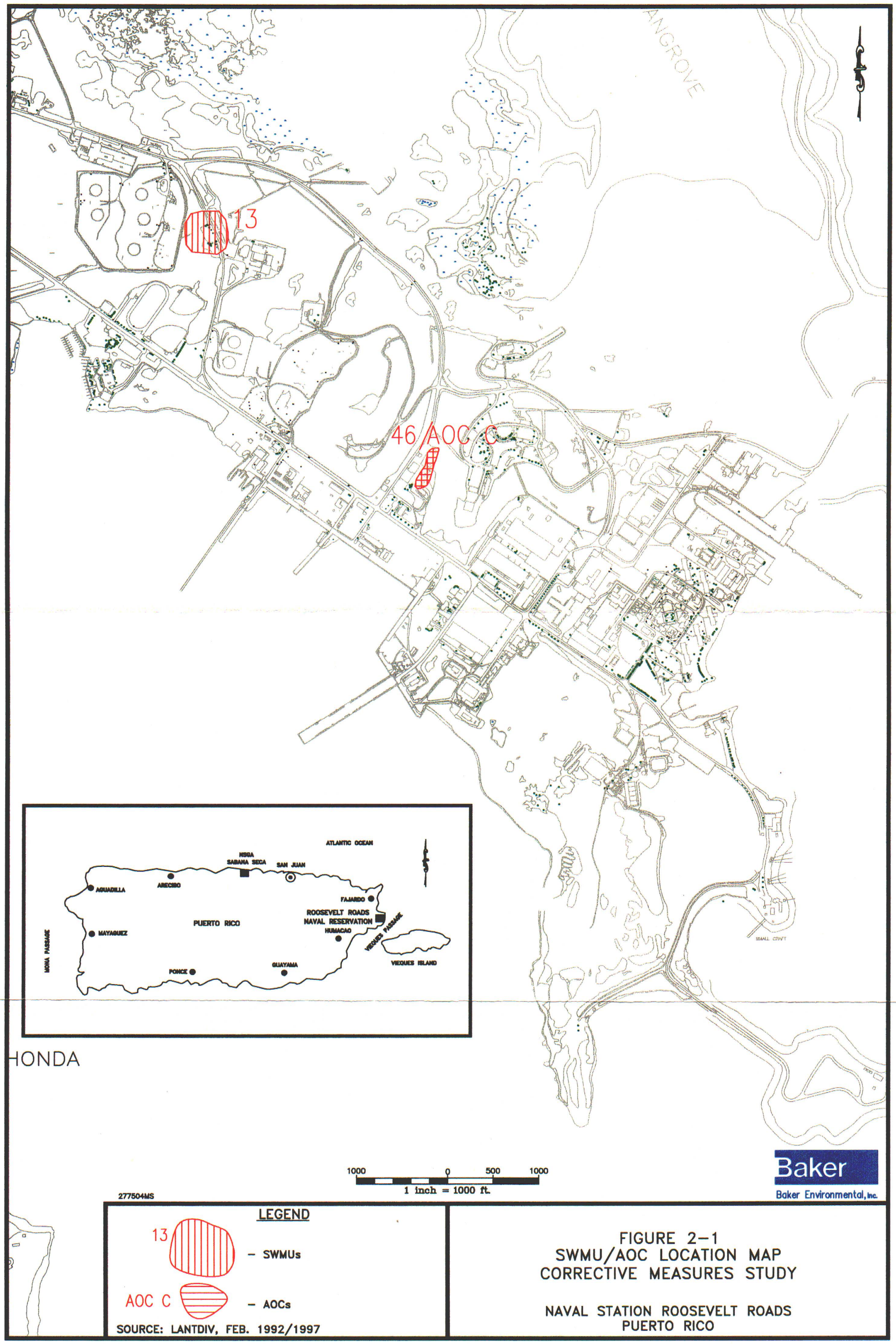
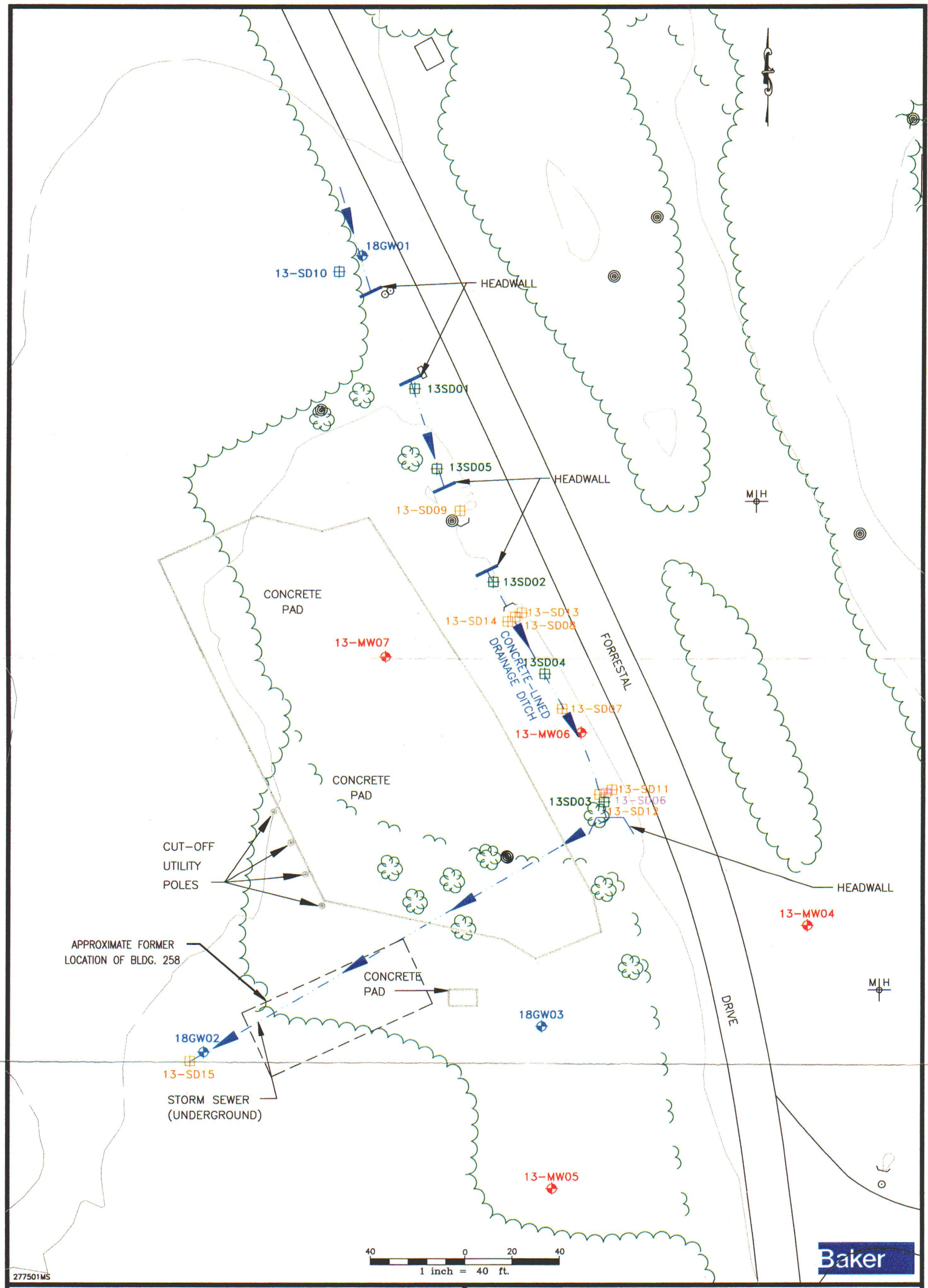


FIGURE 2-1
SWMU/AOC LOCATION MAP
CORRECTIVE MEASURES STUDY

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- PREVIOUS SEDIMENT SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION (PHASE II RFI)
- DEEP SEDIMENT SAMPLE LOCATION (PHASE II RFI)
- BACKGROUND SEDIMENT SAMPLE LOCATION (PHASE II RFI)
- MONITORING WELL LOCATION (PHASE II RFI)
- DRAINAGE DITCH/SURFACE DRAINAGE FLOW DIRECTION
- UTILITY POLE

SOURCE: LANTDIV, FEB. 1992/1997.

FIGURE 2-2
SWMU 13 SITE PLAN
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

277507MS

BUILDING 2326

COVERED STORAGE DRUMS AND BATTERIES

BUILDING 2042

VALLEY FORGE ROAD

SWMU 46

AREA FORMERLY DESIGNATED "CONTAMINATED SOIL AREA"

APPROXIMATE LOCATION OF AOC C

TRANSFORMER STORAGE

CONCRETE PADS

CONCRETE PAD

46-SB01 46-SB02 46-SB03 46-SB04 46-SB05 46-SB06 46-SB07 46-SB08 46-SB09 46-SB10 46-SB11 46-SB12 46-SB13

46SS01 46SS02 46SS03 46SS04 46SS05 46SS06 46SS07 46SS08 46SS09

46SB01 46SB02

ACSS01 ACSS02 ACSS03 ACSS04 ACSS05 ACSS07 ACSS08 ACSS09 ACSS10 ACSS11 ACSS12

ACWS06

10-TW03

Baker

Baker Environmental, Inc.

LEGEND

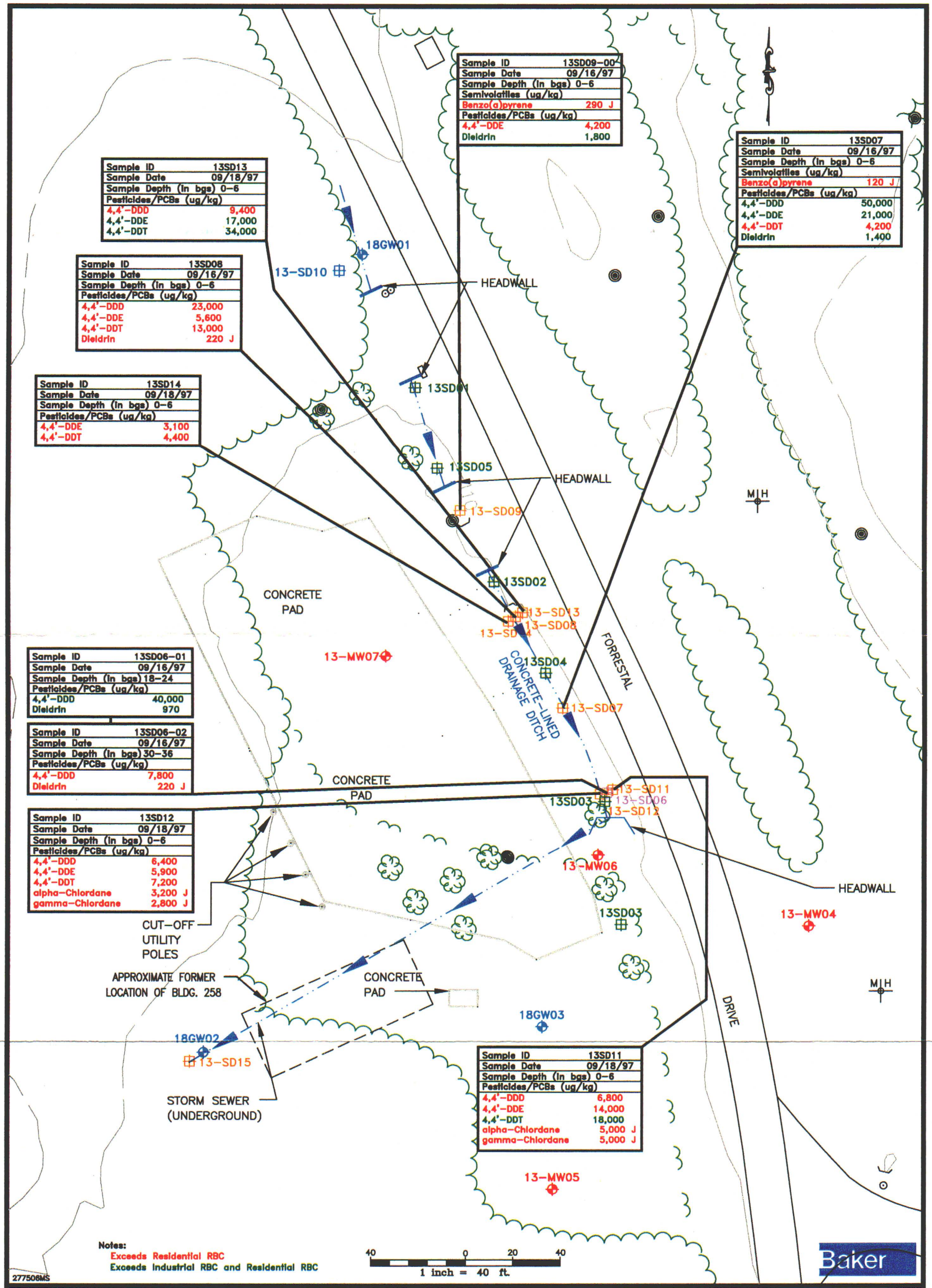
- SOIL BORING LOCATIONS (PHASE I RFI)
- SOIL SAMPLING LOCATIONS (PHASE I RFI)
- SURFACE SOIL SAMPLING LOCATIONS (PHASE II RFI)
- SUBSURFACE SOIL SAMPLING LOCATION (PHASE II RFI)
- SURFACE ELEVATION CONTOUR
- UTILITY POLE

SOURCE: LANTDIV, FEB. 1992/1997

60 0 30 60

1 inch = 60 ft.

FIGURE 2-3
SWMU 46/AOC C SITE PLAN
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



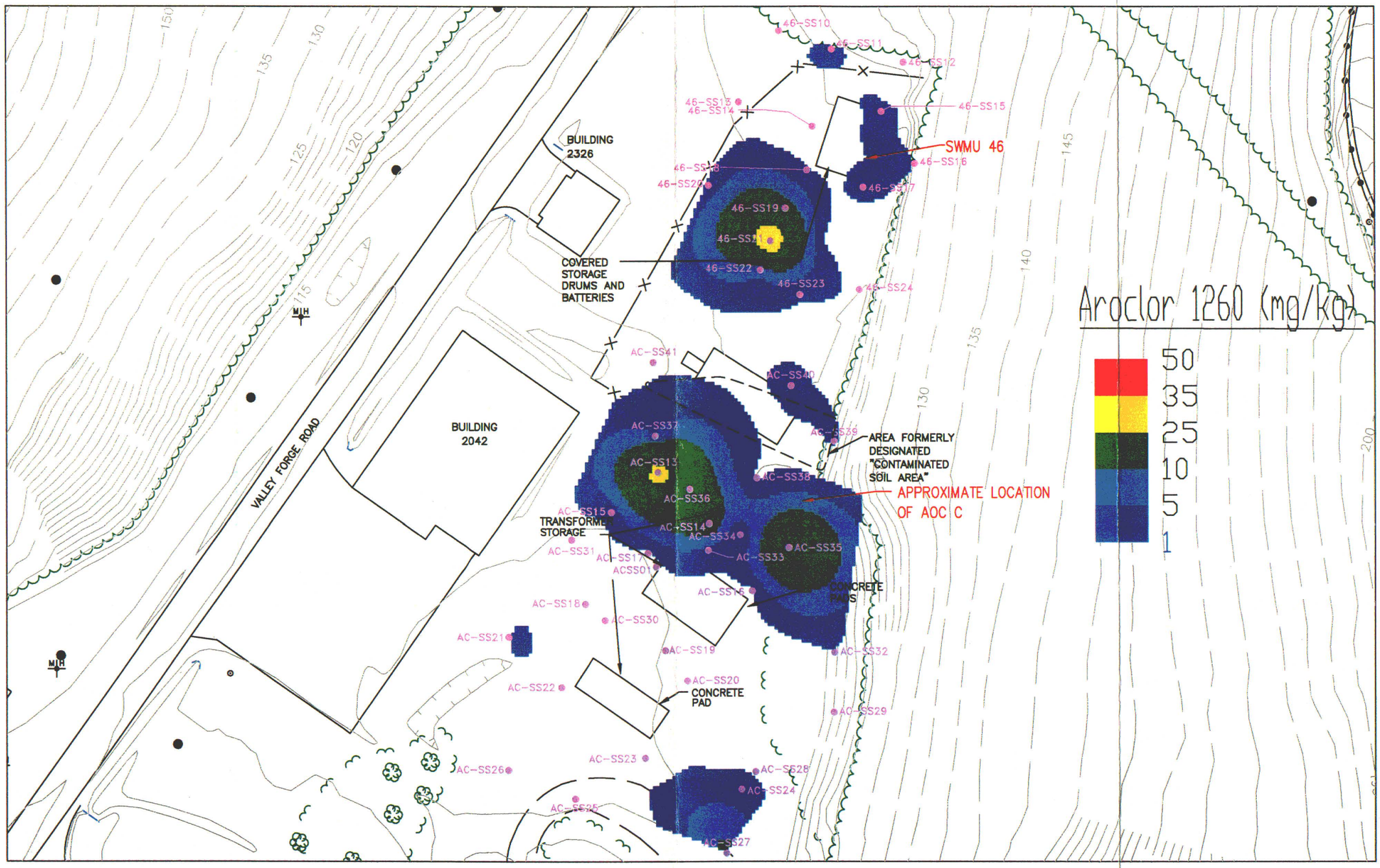
LEGEND

- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- PREVIOUS SEDIMENT SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION (PHASE II RFI)
- DEEP SEDIMENT SAMPLE LOCATION (PHASE II RFI)
- BACKGROUND SEDIMENT SAMPLE LOCATION (PHASE II RFI)
- MONITORING WELL LOCATION (PHASE II RFI)
- DRAINAGE DITCH/SURFACE DRAINAGE FLOW DIRECTION

SOURCE: LANTDIV, FEB. 1992/1997

FIGURE 2-4
SEDIMENT DETECTIONS ABOVE SCREENING CRITERIA
SWMU 13
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

277510MS



Baker

Baker Environmental, Inc.

LEGEND

- SURFACE SOIL SAMPLING LOCATIONS (PHASE II RFI)
- 115 SURFACE ELEVATION CONTOUR
- UTILITY POLE

SOURCE: LANTDIV, FEB. 1992/1997

60 0 30 60

1 inch = 60 ft.

FIGURE 2-5

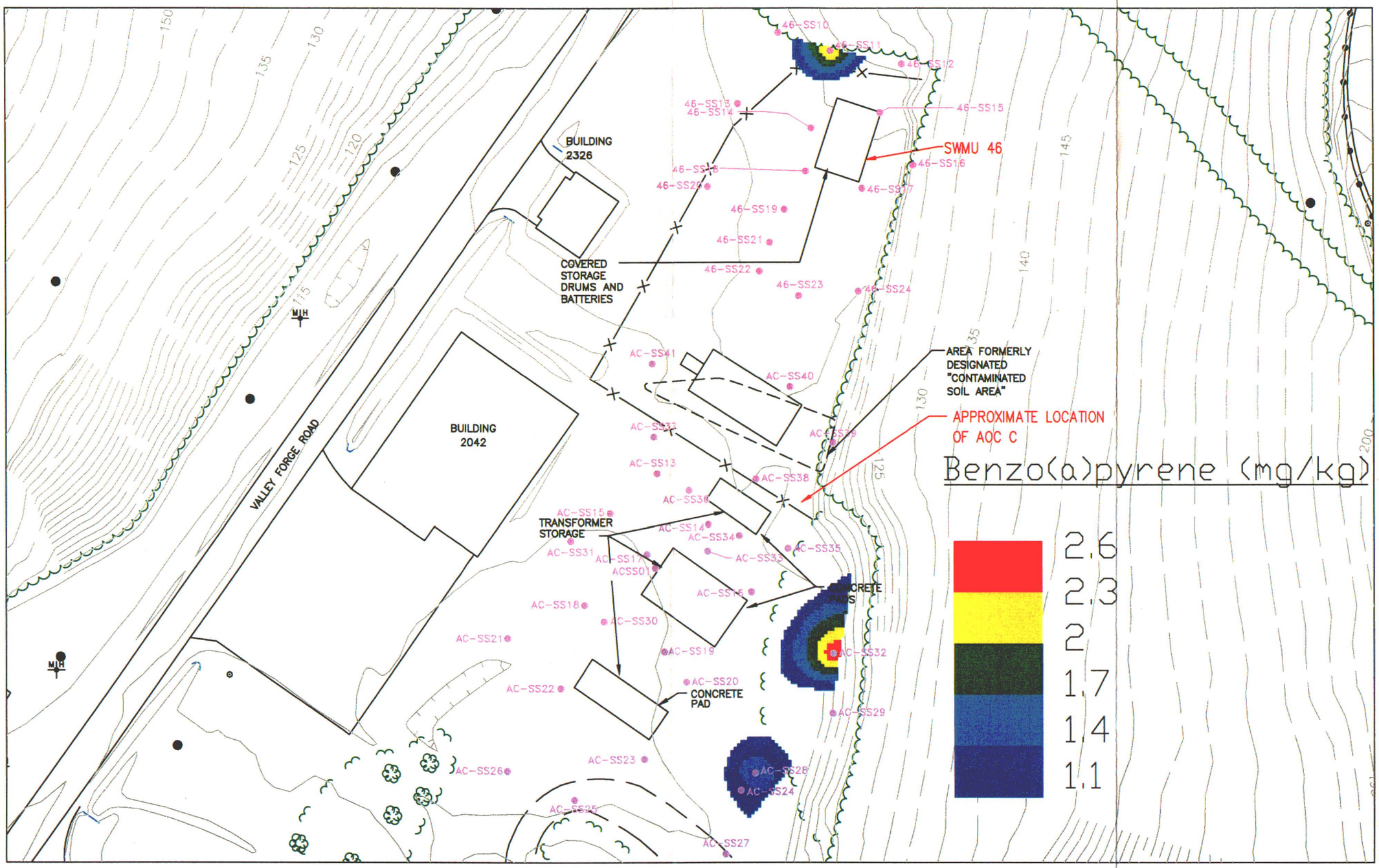
SWMU 46/AOC C PCB DETECTIONS IN SURFACE SOIL

CORRECTIVE MEASURES STUDY

NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

277511MS



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LEGEND

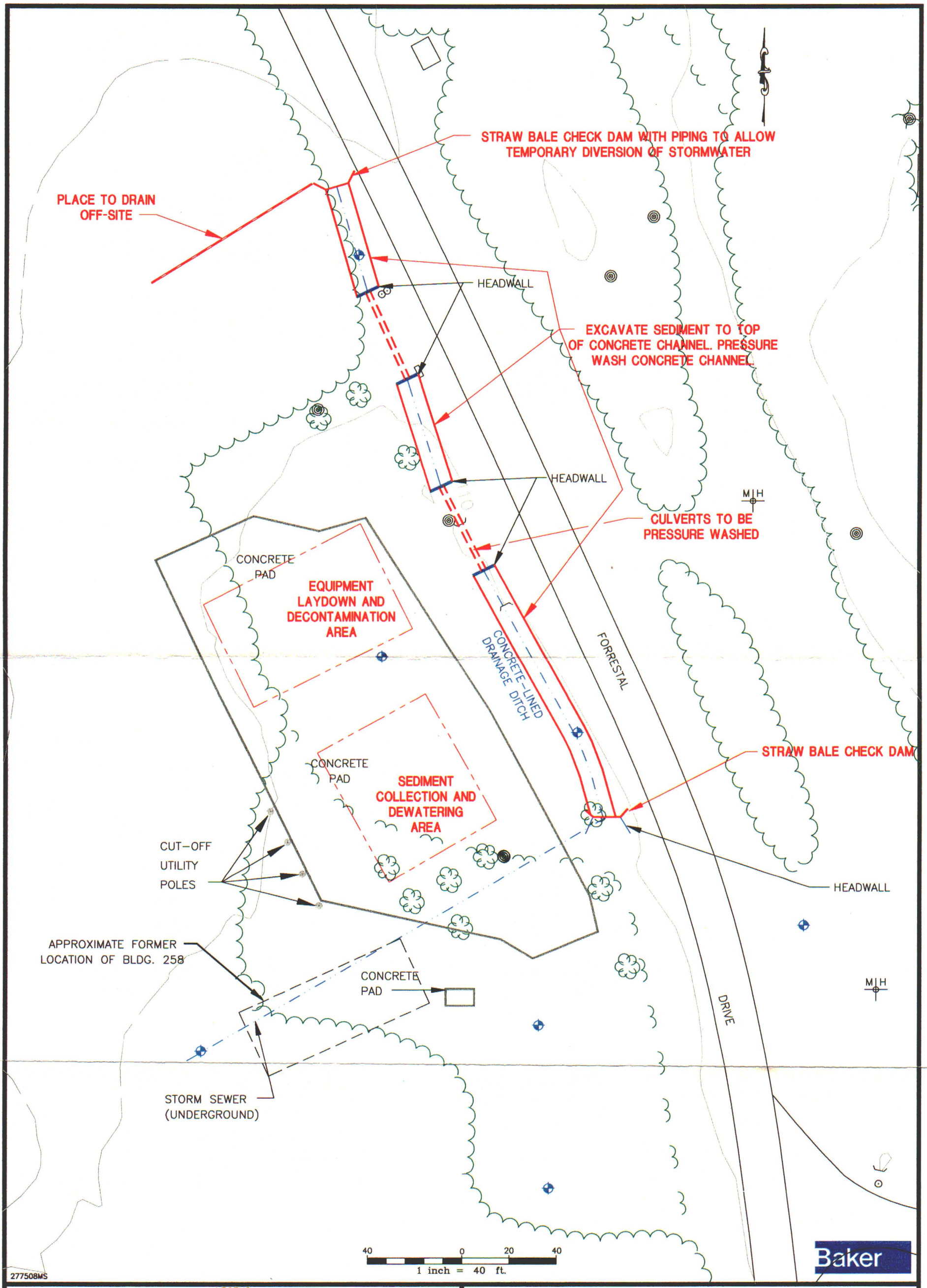
- SURFACE SOIL SAMPLING LOCATIONS (PHASE II RFI)
- 115 SURFACE ELEVATION CONTOUR
- UTILITY POLE

SOURCE: LANTDIV, FEB. 1992/1997

60 0 30 60

1 inch = 60 ft.

FIGURE 2-6
SWMU 46/AOC C BENZO(a)PYRENE DETECTIONS IN SURFACE SOIL ABOVE CLEAN UP GOALS
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- MONITORING WELL
- DRAINAGE DITCH/SURFACE DRAINAGE FLOW DIRECTION
- UTILITY POLE
- PROPOSED LIMITS OF EXCAVATION
- TREE LINE
- CULVERT

SOURCE: LANTDIV, FEB. 1992/1997.

FIGURE 5-1
SWMU 13 CONCEPTUAL DESIGN PLAN
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

277509MS

APPROXIMATE LOCATION OF CONFIRMATORY SAMPLES. PRECISE LOCATION TO BE DETERMINED IN DESIGN PHASE.

SWMU 46

EXCAVATE TOP 6" OF SOIL

BUILDING 2326

COVERED STORAGE DRUMS AND BATTERIES

EQUIPMENT LAYDOWN AND DECONTAMINATION AREA

BUILDING 2042

VALLEY FORGE ROAD

AREA FORMERLY DESIGNATED "CONTAMINATED SOIL AREA"

APPROXIMATE LOCATION OF AOC C

TRANSFORMER STORAGE

EQUIPMENT LAYDOWN AND DECONTAMINATION AREA

CONCRETE PADS

CONCRETE PAD

EXCAVATE TOP 6" OF SOIL

MH

MH

150 135 130 125 120 115 145 140 135 130 200

Baker

Baker Environmental, Inc.

LEGEND

- PROPOSED LIMITS OF EXCAVATION
- 115 SURFACE ELEVATION CONTOUR
- UTILITY POLE
- PCB FIELD TEST KIT SAMPLING LOCATION
- APPROXIMATE CONFIRMATORY SAMPLING LOCATIONS

SOURCE: LANTDIV, FEB. 1992/1997

60 0 30 60

1 inch = 60 ft.

FIGURE 5-2
SWMU 46/AOC C CONCEPTUAL DESIGN PLAN
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

APPENDIX A
CLEANUP LEVEL CALCULATIONS

SWMU 13

MILITARY RESIDENTIAL CHILD
SEDIMENT EXPOSURE-PRELIMINARY REMEDIATION GOALS (PRGs)
COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE
SWMU 13
US NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	2190	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	4	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	200	
BW = body weight, kg	15	
SA = skin surface area available for contact, cm2	2006	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Dermally Adj Slope Factor (mg/kg-day)-	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
PESTICIDES													
Dieldrin	1.00E-06	1.0	0.10	1.60E+00	5.00E-05	3.20E+00	2.50E-05	7.31E-07	1.47E-07	8.52E-06	1.71E-06	0.6	4
DDT	1.00E-06	1.0	0.10	3.40E-01	5.00E-04	3.80E-01	5.60E-04	7.31E-07	1.47E-07	8.52E-06	1.71E-06	3.3	50
DDE	1.00E-06	--	0.10	3.40E-01	--	3.80E-01	8.00E-02	7.31E-07	1.47E-07	8.52E-06	1.71E-06	3.3	--
DDD	1.00E-06	--	0.10	2.40E-01	--	2.70E-01	1.60E+00	7.31E-07	1.47E-07	8.52E-06	1.71E-06	4.7	--
a-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	7.31E-07	1.47E-07	8.52E-06	1.71E-06	2.8	42
b-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	7.31E-07	1.47E-07	8.52E-06	1.71E-06	2.8	42
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	7.31E-07	1.47E-07	8.52E-06	1.71E-06	0.1	--

MILITARY RESIDENTIAL ADULT
SEDIMENT EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)
COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE
SWMU 13
US NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]

RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW

Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	8760	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	4	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	100	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	5300	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Dermally Adj Slope Factor (mg/kg-day)-1	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
PESTICIDES													
Dieldrin	1.00E-06	1.0	0.10	1.60E+00	5.00E-05	3.20E+00	2.50E-05	7.83E-08	8.30E-08	2.28E-07	2.42E-07	2.6	70
DDT	1.00E-06	1.0	0.10	3.40E-01	5.00E-04	3.80E-01	5.60E-04	7.83E-08	8.30E-08	2.28E-07	2.42E-07	17.2	1,125
DDE	1.00E-06	--	0.10	3.40E-01	--	3.80E-01	8.00E-02	7.83E-08	8.30E-08	2.28E-07	2.42E-07	17.2	--
DDD	1.00E-06	--	0.10	2.40E-01	--	2.70E-01	1.60E+00	7.83E-08	8.30E-08	2.28E-07	2.42E-07	24.3	--
a-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	7.83E-08	8.30E-08	2.28E-07	2.42E-07	11.7	702
b-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	7.83E-08	8.30E-08	2.28E-07	2.42E-07	11.7	702
SEMIVOLATILES													
Benzo(a)pyrene	1.0E-06	--	0.10	7.30E+00	--	1.46E+01	--	7.83E-08	8.30E-08	2.28E-07	2.42E-07	0.6	--

FUTURE RESIDENTIAL CHILD
SEDIMENT EXPOSURE-PRELIMINARY REMEDIATION GOALS (PRGs)
COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE
SWMU 13
US NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	2190	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	6	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	200	
BW = body weight, kg	15	
SA = skin surface area available for contact, cm2	2006	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor mg/kg-day)-	Reference Dose (mg/kg-day)	ermally Adj Slope Facto mg/kg-day)-	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
PESTICIDES													
Dieldrin	1.00E-06	1.0	0.10	1.60E+00	5.00E-05	3.20E+00	2.50E-05	1.10E-06	2.20E-07	1.28E-05	2.56E-06	0.41	3
DDT	1.00E-06	1.0	0.10	3.40E-01	5.00E-04	3.80E-01	5.60E-04	1.10E-06	2.20E-07	1.28E-05	2.56E-06	2.19	33
DDE	1.00E-06	--	0.10	3.40E-01	--	3.80E-01	8.00E-02	1.10E-06	2.20E-07	1.28E-05	2.56E-06	2.19	--
DDD	1.00E-06	--	0.10	2.40E-01	--	2.70E-01	1.60E+00	1.10E-06	2.20E-07	1.28E-05	2.56E-06	3.10	--
a-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	1.10E-06	2.20E-07	1.28E-05	2.56E-06	1.86	28
b-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	1.10E-06	2.20E-07	1.28E-05	2.56E-06	1.86	28
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	1.10E-06	2.20E-07	1.28E-05	2.56E-06	0.09	--

FUTURE RESIDENTIAL ADULT
SEDIMENT EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)
COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE
SWMU 13
US NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]

RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW

Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	8760	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose mg/kg-day	CS	
ED = exposure duration, years	24	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	100	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	5300	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (mg/kg-day)-	Reference Dose (mg/kg-day)	Dermally Adj Slope Factor (mg/kg-day)-	Derm Adj Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
PESTICIDES													
Dieldrin	1.00E-06	1.0	0.10	1.60E+00	5.00E-05	3.20E+00	2.50E-05	4.70E-07	4.98E-07	1.37E-06	1.45E-06	0.43	12
DDT	1.00E-06	1.0	0.10	3.40E-01	5.00E-04	3.80E-01	5.60E-04	4.70E-07	4.98E-07	1.37E-06	1.45E-06	2.87	188
DDE	1.00E-06	--	0.10	3.40E-01	--	3.80E-01	8.00E-02	4.70E-07	4.98E-07	1.37E-06	1.45E-06	2.87	--
DDD	1.00E-06	--	0.10	2.40E-01	--	2.70E-01	1.80E+00	4.70E-07	4.98E-07	1.37E-06	1.45E-06	4.05	--
a-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	4.70E-07	4.98E-07	1.37E-06	1.45E-06	1.95	117
b-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	4.70E-07	4.98E-07	1.37E-06	1.45E-06	1.95	117
SEMIVOLATILES													
Benzo(a)pyrene	1.0E-06	--	0.10	7.30E+00	--	1.46E+01	--	4.70E-07	4.98E-07	1.37E-06	1.45E-06	0.09	--

CONSTRUCTION WORKERS
SEDIMENT EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)
COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE
SWMU 13
US NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

*RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]*
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

*Ing = IR*ED*EF*CF/ATc or ATnc*BW*
*Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW*

Where:

	INPUTS	
ICR = apportioned target incrementat cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, m	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	365	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	1	
EF = exposure frequency, days/year	180	
IR = ingestion rate, mg/day	480	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	4100	
AF = soil to skin adherence factor, mg/cm2	1	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg	Reference Dose (mg/kg-day)	ermally Adj Slope Facto (Kg/day-mg	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
PESTICIDES													
Dieldrin	1.00E-06	1.0	0.10	1.60E+00	5.00E-05	3.20E+00	2.50E-05	4.83E-08	4.13E-08	3.38E-06	2.89E-06	4.78	5
DDT	1.00E-06	1.0	0.10	3.40E-01	5.00E-04	3.80E-01	5.60E-04	4.83E-08	4.13E-08	3.38E-06	2.89E-06	31.15	84
DDE	1.00E-06	--	0.10	3.40E-01	--	3.80E-01	8.00E-02	4.83E-08	4.13E-08	3.38E-06	2.89E-06	31.15	--
DDD	1.00E-06	--	0.10	2.40E-01	--	2.70E-01	1.60E+00	4.83E-08	4.13E-08	3.38E-06	2.89E-06	43.98	--
a-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	4.83E-08	4.13E-08	3.38E-06	2.89E-06	21.84	55
b-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	4.83E-08	4.13E-08	3.38E-06	2.89E-06	21.84	55
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	4.83E-08	4.13E-08	3.38E-06	2.89E-06	1.05	--

COMMERCIAL/UTILITY WORKERS
SEDIMENT EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)
COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE
SWMU 13
US NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	7300	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	20	
EF = exposure frequency, days/year	250	
IR = ingestion rate, mg/day	50	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	4100	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg)	Reference Dose (mg/kg-day)	ermally Adj Slope Facto (Kg/day-mg)	Derm. Adj Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
PESTICIDES													
Dieldrin	1.00E-06	1.0	0.10	1.60E+00	5.00E-05	3.20E+00	2.50E-05	1.40E-07	2.29E-07	4.89E-07	8.02E-07	1.04	24
DDT	1.00E-06	1.0	0.10	3.40E-01	5.00E-04	3.80E-01	5.60E-04	1.40E-07	2.29E-07	4.89E-07	8.02E-07	7.43	415
DDE	1.00E-06	--	0.10	3.40E-01	--	3.80E-01	8.00E-02	1.40E-07	2.29E-07	4.89E-07	8.02E-07	7.43	--
DDD	1.00E-06	--	0.10	2.40E-01	--	2.70E-01	1.60E+00	1.40E-07	2.29E-07	4.89E-07	8.02E-07	10.48	--
a-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	1.40E-07	2.29E-07	4.89E-07	8.02E-07	4.78	239
b-Chlordane	1.00E-06	1.0	0.10	3.50E-01	5.00E-04	7.00E-01	2.50E-04	1.40E-07	2.29E-07	4.89E-07	8.02E-07	4.78	239
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	1.40E-07	2.29E-07	4.89E-07	8.02E-07	0.23	--

SWMU 46/AOC C

MILITARY CHILDREN RESIDENTS

SOIL EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)

COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE

AOC C AND SWMU 46

US NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	2190	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	4	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	200	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	15	
SA = skin surface area available for contact, cm2	2006	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg)	Reference Dose (mg/kg-day)	ermally Adj Slope Facto (Kg/day-mg)	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	7.31E-07	1.47E-07	8.52E-06	1.71E-06	0.13	--
Benzo(b)fluoranthene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	7.31E-07	1.47E-07	8.52E-06	1.71E-06	1.8	--
Indeno(1,2,3-cd)pyrene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	7.31E-07	1.47E-07	8.52E-06	1.71E-06	1.8	--
PCBs													
PCB-1260	1.00E-06	--	0.10	2.00E+00	--	2.25E+00	--	7.31E-07	1.47E-07	8.52E-06	1.71E-06	0.6	--

MILITARY ADULT RESIDENTS

SOIL EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)

COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE

AOC C AND SWMU 46

US NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	8760	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	4	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	100	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	5300	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg)	Reference Dose (mg/kg-day)	ermally Adj. Slope Facto (Kg/day-mg)	Derm. Adj Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	7.83E-08	8.30E-08	2.28E-07	2.42E-07	0.6	--
Benzo(b)fluoranthene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	7.83E-08	8.30E-08	2.28E-07	2.42E-07	14.4	--
Indeno(1,2,3-cd)pyrene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	7.83E-08	8.30E-08	2.28E-07	2.42E-07	14.4	--
PCBs													
PCB-1260	1.00E-06	--	0.10	2.00E+00	--	2.25E+00	--	7.83E-08	8.30E-08	2.28E-07	2.42E-07	2.9	--

FUTURE CHILDREN RESIDENTS

SOIL EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)

COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE

AOC C AND SWMU 46

US NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	2190	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	6	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	200	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	15	
SA = skin surface area available for contact, cm2	2006	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg)	Reference Dose (mg/kg-day)	ermally Adj Slope Facto (Kg/day-mg)	Derm Adj Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	1.10E-06	2.20E-07	1.28E-05	2.56E-06	0.09	--
Benzo(b)fluoranthene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	1.10E-06	2.20E-07	1.28E-05	2.56E-06	1.2	--
Indeno(1,2,3-cd)pyrene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	1.10E-06	2.20E-07	1.28E-05	2.56E-06	1.2	--
PCBs													
PCB-1260	1.00E-06	--	0.10	2.00E+00	--	2.25E+00	--	1.10E-06	2.20E-07	1.28E-05	2.56E-06	0.4	--

FUTURE ADULT RESIDENTS

SOIL EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)

COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE

AOC C AND SWMU 46

US NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	8760	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	24	
EF = exposure frequency, days/year	350	
IR = ingestion rate, mg/day	100	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	5300	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note. Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg)	Reference Dose (mg/kg-day)	Dermally Adj. Slope Factor (Kg/day-mg)	Derm Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	4.70E-07	4.98E-07	1.37E-06	1.45E-06	0.09	--
Benzo(b)fluoranthene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	4.70E-07	4.98E-07	1.37E-06	1.45E-06	2.4	--
Indeno(1,2,3-cd)pyrene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	4.70E-07	4.98E-07	1.37E-06	1.45E-06	2.4	--
PCBs													
PCB-1260	1.00E-06	--	0.10	2.00E+00	--	2.25E+00	--	4.70E-07	4.98E-07	1.37E-06	1.45E-06	0.5	--

CONSTRUCTION WORKERS

SOIL EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)

COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE

AOC C AND SWMU 46

US NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	365	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	1	
EF = exposure frequency, days/year	180	
IR = ingestion rate, mg/day	480	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	4100	
AF = soil to skin adherence factor, mg/cm2	1	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg	Reference Dose (mg/kg-day)	Dermally Adj. Slope Factor (Kg/day-mg)	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	4.83E-08	4.13E-08	3.38E-06	2.89E-06	1.05	--
Benzo(b)fluoranthene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	4.83E-08	4.13E-08	3.38E-06	2.89E-06	24.2	--
Indeno(1,2,3-cd)pyrene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	4.83E-08	4.13E-08	3.38E-06	2.89E-06	24.2	--
PCBs													
PCB-1260	1.00E-06	--	0.10	2.00E+00	--	2.25E+00	--	4.83E-08	4.13E-08	3.38E-06	2.89E-06	5.3	--

COMMERCIAL/UTILITY WORKERS

SOIL EXPOSURE - PRELIMINARY REMEDIATION GOALS (PRGs)

COMBINED INGESTION AND DERMAL ROUTES OF EXPOSURE

AOC C AND SWMU 46

US NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

RGOs from accidental ingestion and dermal contact with soil are calculated as follows:

RGOc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
RGOnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
RGOc = carcinogenic contaminant concentration in surface soil mg/kg	calculated	
RGOnc = noncarcinogenic contaminant concentration in surface soil mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen days	7300	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose mg/kg-day	CS	
ED = exposure duration, years	20	
EF = exposure frequency, days/year	250	
IR = ingestion rate, mg/day	50	
Ef = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	4100	
AF = soil to skin adherence factor, mg/cm2	0.2	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Absorption Factor (unitless)	Slope Factor (Kg/day-mg)	Reference Dose (mg/kg-day)	Dermally Adj. Slope Factor (Kg/day-mg)	Derm Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	RGO Carc (mg/kg)	RGO Noncarc (mg/kg)
SEMIVOLATILES													
Benzo(a)pyrene	1.00E-06	--	0.10	7.30E+00	--	1.46E+01	--	1.40E-07	2.29E-07	4.89E-07	8.02E-07	0.23	--
Benzo(b)fluoranthene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	1.40E-07	2.29E-07	4.89E-07	8.02E-07	7.4	--
Indeno(1,2,3-cd)pyrene	1.00E-06	--	0.10	7.30E-01	--	1.46E-01	--	1.40E-07	2.29E-07	4.89E-07	8.02E-07	7.4	--
PCBs													
PCB-1260	1.00E-06	--	0.10	2.00E+00	--	2.25E+00	--	1.40E-07	2.29E-07	4.89E-07	8.02E-07	1.3	--