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Site-Specific Human Health Risk Assessment

Buildings 2009, 2009A, 2009B, 2009C, and 2009D Area

Defense Reutilization and Marketing Office

U.S. Naval Activity Puerto Rico

Ceiba, Puerto Rico

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Acronyms

ABS	Absorption factor
AF	Adherence factor
AT	Averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
BW	Body weight
CDI	Chronic daily intake
CF	Conversion factor
COC	Chemical of concern
COPC	Chemical of potential concern
CSF	Cancer slope factor
CSM	Conceptual site model
CT	Central tendency
DRMO	Defense Reutilization and Marketing Office
DRO	Diesel range organics
ED	Exposure duration
EF	Exposure frequency
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
EV	Event frequency
FI	Fraction ingested
ft	Feet
FTSM	Fraction transferred from hands to mouth
FTSS	Fraction transferred as dust to skin from concrete surface
HHRA	Human health risk assessment
HI	Hazard index
HQ	Hazard quotient
IF	Intake factor
IRIS	Integrated Risk Information System
JV I	AGVIQ-CH2M HILL Joint Venture I
kg	Kilogram

LUC	Land use control
mg	Milligram
mg/kg	Milligrams per kilogram
mg/kg-day	Milligrams per kilogram per day
NAPR	U.S. Naval Activity Puerto Rico
PAH	Polycyclic aromatic hydrocarbon
RAGS	*Risk Assessment Guidance for Superfund*
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RME	Reasonable maximum exposure
SA	Exposed skin surface area
TRPH	Total recoverable petroleum hydrocarbons
UCL	Upper confidence limit
UF	Uncertainty factor
WOE	Weight of evidence
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter

Closure Certification

The closure decontamination and sampling activities at Building 2009 and former Buildings 2009A, 2009B, 2009C, and 2009D have been completed in accordance with the Closure Plan included as Attachment E of the Facility's 1994 RCRA Permit, the October 27, 2005 and November 17, 2005 letters from Lieutenant Commander A. Ferguson to Mr. Timothy Gordon of the U.S. Environmental Protection Agency (EPA), and the EPA-approved sampling and analysis plans listed below.

- *Site-Specific Sampling and Analysis Plan, Building 2009, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico,* (AGVIQ-CH2M HILL Joint Venture I [JV I], December 2004)
- *Site-Specific Sampling and Analysis Plan, Building 2009A, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV I, December 2004)
- *Site-Specific Sampling and Analysis Plan, Buildings 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV I, December 2004)
- *Phase II Closure Sampling and Analysis Plan, Buildings 2009, 2009A, 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (April 2006)

The results of the building decontamination and disposal, and sampling activities are presented in the following reports.

- *Phase II Closure Report, Buildings 2009, 2009A, 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico,* (JV I, January 2007)
- *Closure Sampling Report, Building 2009, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, December 2005)
- *Closure Sampling Report, Building 2009A, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, December 2005)
- *Closure Sampling Report, Buildings 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, December 2005)

Based on the sampling and analysis results presented in the documents listed above, and the results of the Site-Specific Risk Assessment for the Building 2009 area presented herein, Building 2009 has been adequately closed and decontaminated, and Building 2009 and immediate surrounding area (including the area of former Buildings 2009A, 2009B, 2009C, and 2009D) are suitable for industrial use due to the absence of significant risks to human health.

This is based on the implementation of appropriate Land Use Controls, consistent with the requirements of the 7003 Administrative Order on Consent from the U.S. Environmental Protection Agency (i.e., restriction to preclude future residential or similar use of the property).

James E. Anderson

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Director, Navy BRAC PMO Southeast

Date: 3/15/07

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SECTION1

Introduction

The sampling and analysis results for the closure investigations of Buildings 2009, 2009A, 2009B, 2009C, and 2009D conducted by AGVIQ-CH2M HILL Joint Venture I (JV I, 2007, 2005a, 2005b, 2005c) at the Defense Reutilization and Marketing Office (DRMO) facility at Naval Activity Puerto Rico (NAPR) indicated that the closure standards for arsenic and total recoverable petroleum hydrocarbons (TRPH) diesel range organics (DRO) were not met. Specifically, the arsenic levels found in the soil samples collected from the areas underlying and surrounding the buildings exceeded the arsenic closure standard (background level), as well as the U.S. Environmental Protection Agency (EPA) Region III Risk Based Concentration (RBC) for arsenic (1.91 milligrams per kilogram [mg/kg]). The TRPH DRO levels in site soils underlying the concrete pavement north-northwest of Building 2009 exceeded the closure standard of 100 mg/kg. In addition, the arsenic and TRPH DRO levels in the concrete core samples collected from the floor of Building 2009 exceeded their respective closure standards (background levels). Buildings 2009A, 2009B, 2009C, and 2009D (which were portable steel buildings specifically designed for flammable material storage) were decontaminated, demolished, and disposed of in Class I landfills as part of the facility closure activities.

This site-specific human health risk assessment (HHRA) was performed to address the elevated arsenic concentrations in site soils in the Building 2009 area, and the elevated arsenic and TRPH DRO levels in the concrete core samples from the Building 2009 floor. The Building 2009 area addressed in this assessment includes the area of former Buildings 2009A, 2009B, 2009C, and 2009D. This HHRA was performed in accordance with the EPA-approved Site-Specific Risk Assessment Work Plan (RAWP) (JV I, 2006) and EPA guidance for conducting human health risk assessments (EPA, 1989). As such, it provides an assessment of human health risks associated with potential exposure to arsenic-impacted soils at the site, and arsenic- and TRPH-impacted concrete floor dust inside Building 2009 under future industrial land use conditions.

Although the TRPH DRO levels in site soils underlying the concrete pavement north-northwest of Building 2009 exceeded the closure standard, EPA approved of the Navy's adoption of land use controls to address the TRPH-impacted soils at the site due to the limited nature of the TRPH DRO-impacted soils. This is in lieu of performing an HHRA to evaluate potential exposure of human receptors to TRPH-impacted soils at the site under future industrial land use conditions. Specifically, the RCRA § 7003 Administrative Order on Consent between the Navy and EPA includes provisions requiring the maintenance of the existing concrete pavement north-northwest of Building 2009 to effectively serve as a cap over the underlying TRPH-impacted soils, and to prohibit intrusive activities in this area that will result in direct contact with the TRPH-impacted soil.

The soil arsenic sampling data for closure investigations of Buildings 2009 and former Buildings 2009A, 2009B, 2009C, and 2009D, as presented the Phase II Closure Sampling Report (JV I, 2007), and the concrete core sampling data for arsenic and TRPH DRO, as

presented in the Closure Sampling Report for Building 2009 (JV I, 2005a), was used in the performance of this HHRA.

1.1 Background

NAPR was commissioned in 1943 as a Naval Operations Base and re-designed as a Naval Station in 1957. It occupies more than 33,500 acres on the northern side of the eastern coast of Puerto Rico, along the Vieques Passage. The primary mission of NAPR was to provide support for Atlantic Fleet weapons training and development activities (Baker Environmental, Inc., 1996). The closure of NAPR was approved by Congress in September 2003.

Exhibit 1-1 shows the location of NAPR on the main island of Puerto Rico. NAPR is located approximately 35 miles east of San Juan, 10 miles south of Fajardo, and 10 miles west of Vieques Island. Exhibit 1-2 shows the location of the former DRMO in the northeast section of NAPR. Exhibit 1-3 shows the layout of the DRMO facility area. The DRMO facility consisted of an administrative/hazardous waste storage building (Building 1973), a large metal building used for non-hazardous waste storage (Building 2010), a flammable storage building (Building 2009), and a large open fenced area where surplus material (nonhazardous) was stored. Prior to June 2005, four portable flammable material storage buildings (Buildings 2009A, 2009B, 2009C, and 2009D) were located adjacent to Building 2009. These buildings were demolished and disposed of in Class I landfills on NAPR and offsite as part of the facility closure activities.

The results of the Resource Conservation and Recovery Act (RCRA) closure investigation of Building 1973 indicated that the closure standards were met, and EPA has approved the RCRA closure of this building for future industrial use.

1.2 Description of Building 2009 and Former Buildings 2009A, 2009B, 2009C, and 2009D

Building 2009 was constructed in the early 1980s as part of the DRMO. No reportable spills occurred in Building 2009, and small releases were contained and promptly cleaned up. Building 2009 consists of a one-story structure constructed with a concrete slab floor and corrugated metal walls. Exhibit 1-4 provides a site plan of Building 2009, and former Buildings 2009A, 2009B, 2009C and 2009D. As shown, Building 2009 contains a sump in the center with drum storage space against the interior walls. Building 2009 occupies 360 square feet (sf) in one continuous open area. The building was constructed and designated for the storage of flammable hazardous wastes in containers. The structure conforms to the standards required for storage of hazardous wastes in containers. The building is equipped with a spill containment structure, consisting of concrete curbing around its perimeter and a floor sump, covered by a steel grate. The floor in the building slopes toward the sump so that any spills or leaks are collected in the sump. The sump is fully contained with no outlet pipes. The floor and sump are coated with an epoxy sealant to protect the concrete surface. Expansion joints were constructed in the floor slab to minimize cracking and the floor joints have been filled with a weatherproofing epoxy sealant. The floor joints are not evident as they are covered with the epoxy coating.

Building 2009A was a prefabricated portable storage building constructed of heavy gauge steel. The building was located on concrete pavement adjacent to the western side of Building 2009, as shown in Exhibit 1-4. The floor of the structure consisted of metal grating equipped with secondary containment beneath the grating. Building 2009A was approximately 198 sf in size, separated into two compartments (132 sf at north end, and 66 sf at south end) with three exterior doors on the western side of the building. Former Building 2009A was decontaminated, demolished, and disposed of as part of the previous closure activities. The demolished building was disposed of in the NAPR landfill during the week of June 20, 2005. The area where former Building 2009A was located now consists of an open area paved with concrete.

Buildings 2009B, 2009C, and 2009D were prefabricated portable storage buildings constructed of heavy gauge steel. The buildings were located on concrete supports adjacent to the eastern side of Building 2009 and were surrounded by unpaved gravel areas with patches of grass. Former Buildings 2009B, 2009C, and 2009D were each 67 sf in size with one exterior door on one side of each building. As previously stated, each of these former buildings was decontaminated, demolished, and disposed of as part of previous closure activities. The demolished buildings were disposed of in the Fajardo Municipal Landfill (Class I) on March 15, 2005. The area where former Buildings 2009B, 2009C, and 2009D were located now consists of a relatively flat open area covered with gravel and sparse vegetation.

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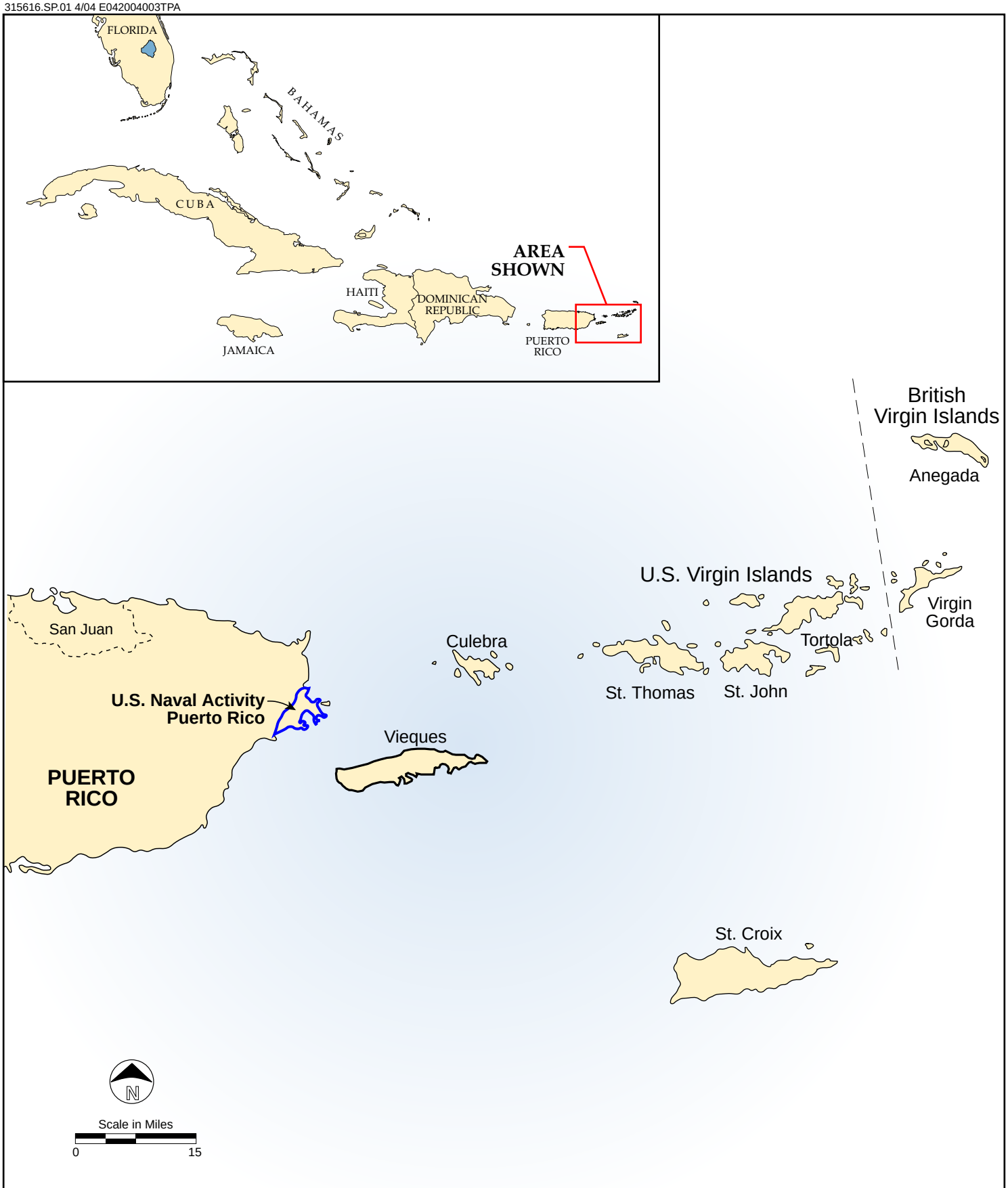

Exhibit 1-1
Regional Location Map
U.S. Naval Activity Puerto Rico
Ceiba, Puerto Rico

AGVIQ ENVIRONMENTAL SERVICES
CH2M HILL JOINT VENTURE

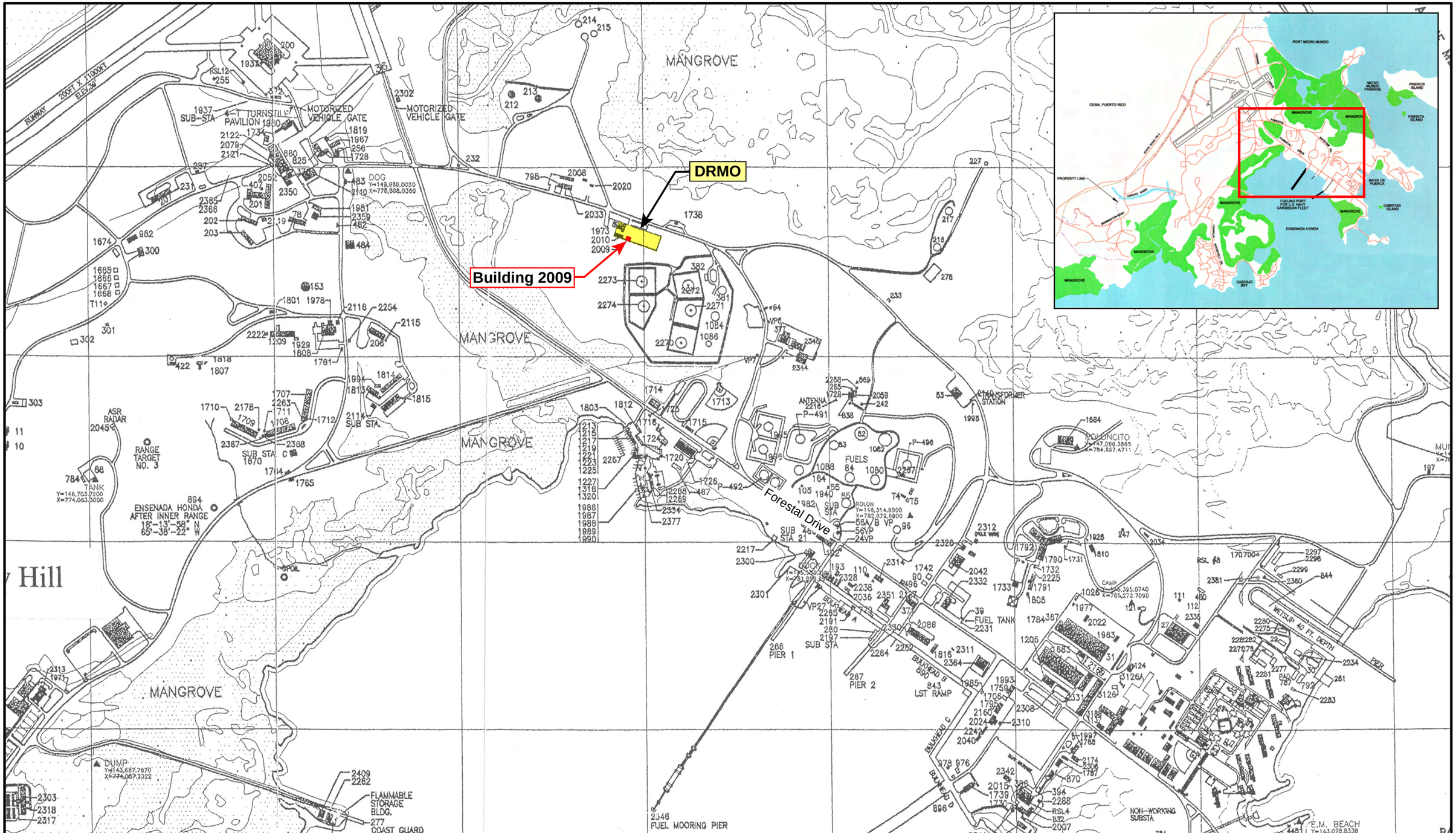

Exhibit 1-2
NAPR Building Location Map
U.S. Naval Activity Puerto Rico
Ceiba, Puerto Rico

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CH2M HILL JOINT VENTURE

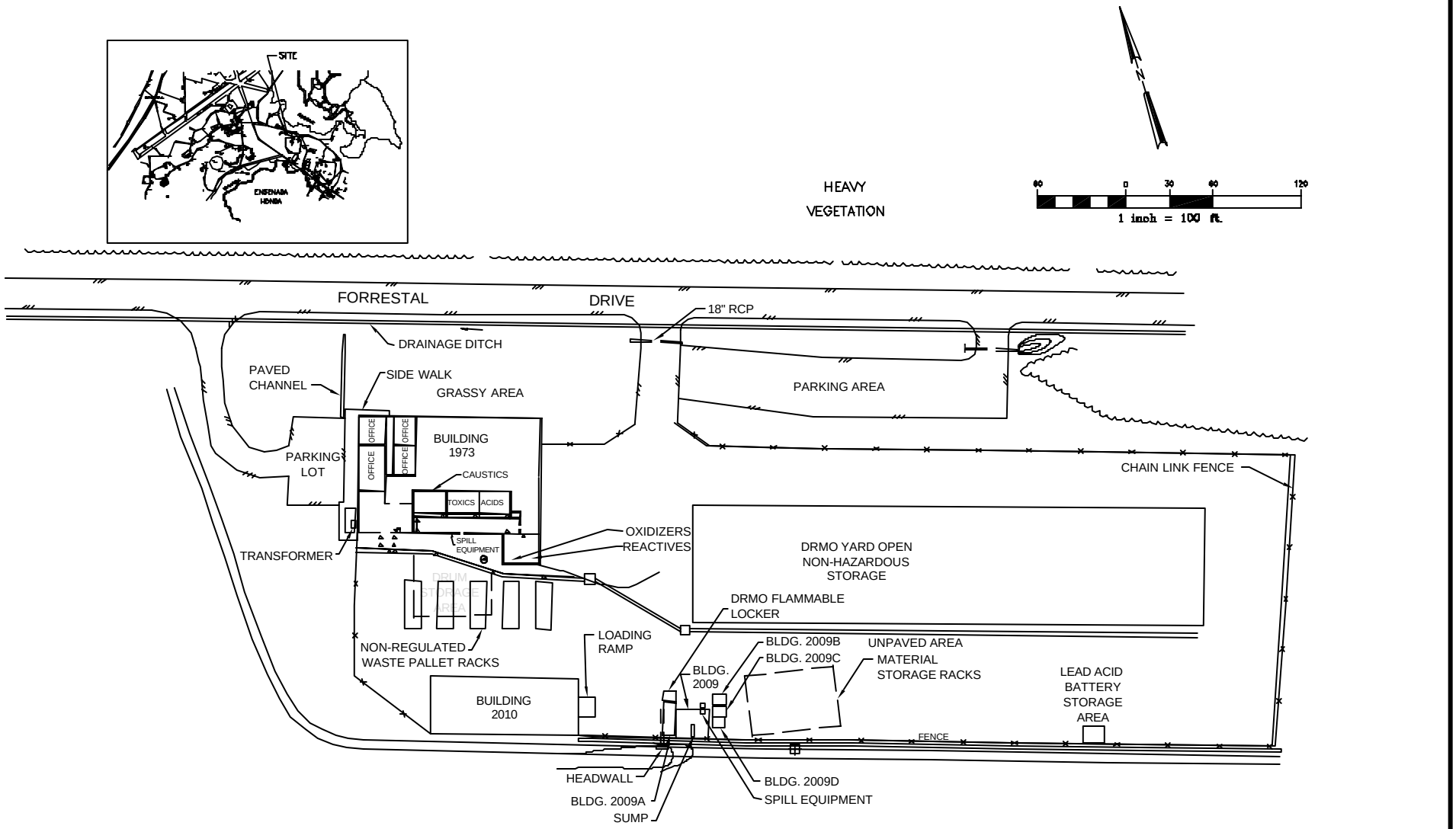

Exhibit 1-3
DRMO Facility Layout
U.S. Naval Activity Puerto Rico
Ceiba, Puerto Rico

Source: Baker Environmental, 1995.

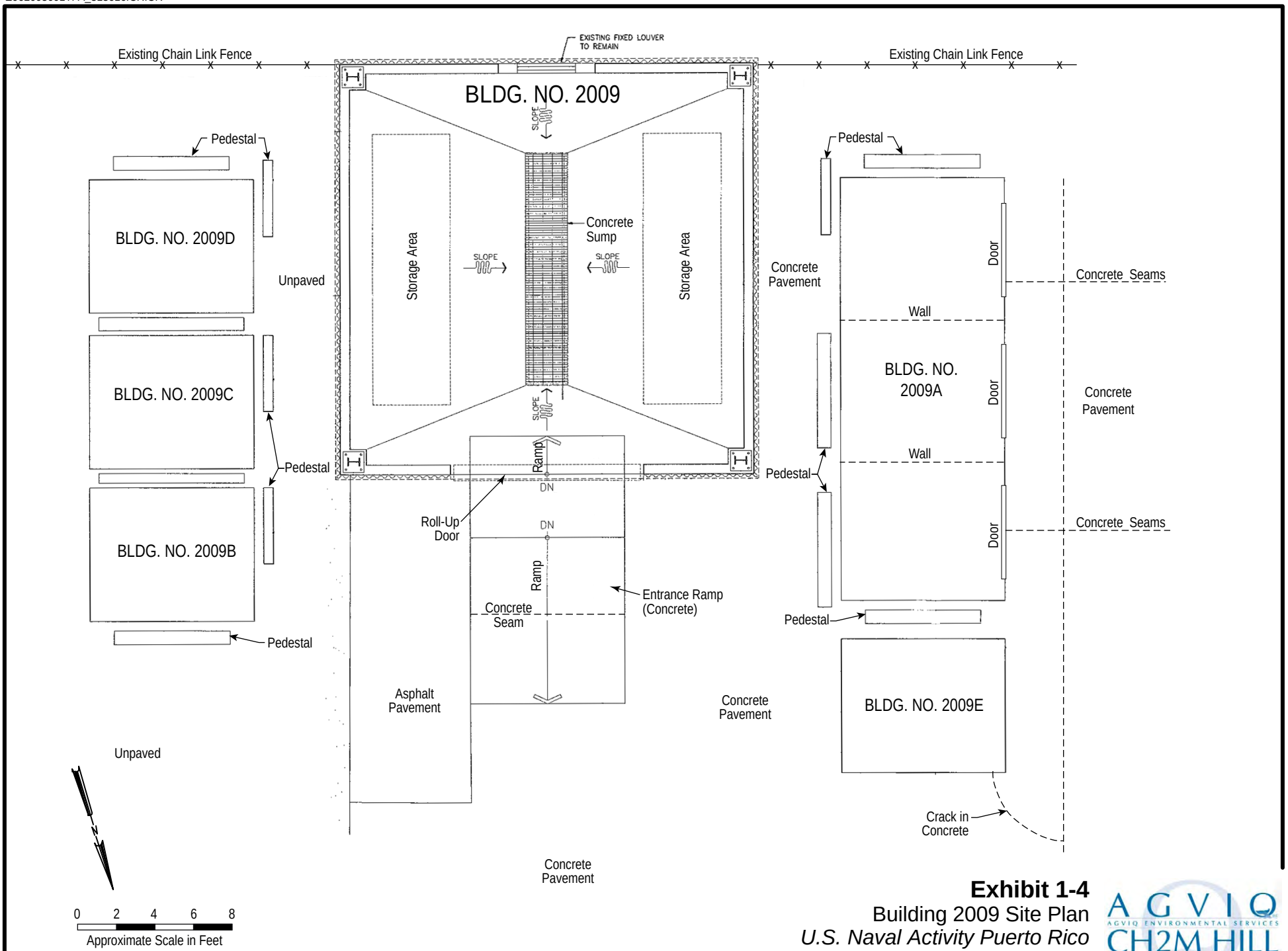

Exhibit 1-4
Building 2009 Site Plan
U.S. Naval Activity Puerto Rico
Ceiba, Puerto Rico

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CH2M HILL JOINT VENTURE

SECTION 2

Human Health Risk Assessment

The HHRA conservatively evaluates the potential for adverse human health effects from exposures related to the Building 2009 area, and indicates whether or not a risk-based closure of Building 2009 and the surrounding area is appropriate. The HHRA evaluated potential risks and hazards that could result from exposures to surface soil around Building 2009, and dust emitted from the concrete floor inside Building 2009. The assumptions used for the quantitative exposure and risk estimates were the same as those presented in the Site-Specific Risk Assessment Work Plan (RAWP) (JV I, 2006), as approved by EPA.

The RCRA § 7003 Administrative Order on Consent between the Navy and EPA includes land use controls (LUCs) for the Building 2009 area, which restrict the use of Building 2009 and the immediate surrounding area against future residential or similar use of the property. Therefore, future use of Building 2009 and the surrounding area will be limited to industrial or commercial use. For this reason, the HHRA evaluated exposures to various types of workers associated with potential future industrial use of the property. The analysis also included a trespasser exposure scenario.

2.1 Overview of the HHRA Methodology

As presented in EPA guidance documents, the HHRA includes the following components:

- Selection of Chemicals of Potential Concern (COPCs)
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis

These steps are discussed in detail in the following subsections. The primary references used in the HHRA are the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (HHEM) (Part A) (EPA, 1989), and the *Site-Specific Risk Assessment Work Plan, Buildings 2009, 2009A, 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico, Ceiba, Puerto Rico* (JV I, 2006).

2.2 Summary of Closure Sampling and Analysis

During the closure investigations, site soil and concrete samples were collected and analytical results were compared against closure standards (JV I, 2007, 2005a, 2005b, 2005c). As discussed in Section 1, site soil arsenic levels and levels of arsenic and TRPH DRO in the concrete core samples from the floor of Building 2009 did not meet the closure standards developed for the site. Accordingly, the Phase II Closure Report (JV I, 2007) recommended a risk-based closure for the site to determine whether the residual soil arsenic levels and levels of arsenic and TRPH DRO in the concrete floor of Building 2009 present unacceptable exposure conditions. If the exposures were within acceptable levels, then a risk-based

closure would be recommended for the site. Therefore, this HHRA was conducted to determine whether site soil arsenic levels and the levels of arsenic and TRPH DRO in the Building 2009 concrete floor meet risk-based closure standards. Although concrete typically does not generate significant amounts of dust, dust was assumed to be generated as a result of abrasion caused by the occasional movement of 55-gallon drums into and out of the building. This is a conservative assumption given that the concrete floor in Building 2009 is covered with an epoxy coating to provide an impermeable barrier to potential spills in the building, which also provides protection against abrasion.

The soil arsenic sampling data for closure investigations of Buildings 2009 and former Buildings 2009A, 2009B, 2009C, and 2009D, as presented the Phase II Closure Sampling Report (JV I, 2007), and the concrete core sampling data for arsenic and TRPH DRO, as presented in the Closure Sampling Report for Building 2009 (JV I, 2005a), were used in the performance of this HHRA. Appendix A provides the analytical data used in this human health risk assessment.

2.2.1 Data Evaluation for Arsenic in Soil

The initial closure investigations of the Building 2009 area were conducted in 2005 as three separate investigations, one for Building 2009, one for Building 2009A, and one for Buildings 2009B, Building C, and Building 2009D. The soil sampling and analysis results for these initial closure investigations were presented in the following reports:

- *Closure Sampling Report, Building 2009, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, 2005a)
- *Closure Sampling Report, Building 2009A, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, 2005b)
- *Closure Sampling Report, Buildings 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, 2005c)

EPA and the Puerto Rico Environmental Quality Board (EQB) submitted comments (dated September 27, 2005) on the above-referenced Closure Sampling Reports. The comments included the following:

- Approval of the recommendation included in the reports to conduct additional background soil sampling to establish a new background arsenic concentration that is more representative of either natural conditions, or non-waste-related, anthropogenic activities at NAPR.
- Requirement to conduct additional soil sampling in the vicinity of Building 2009 to more fully delineate the nature and extent of elevated TRPH levels.
- Approval of the recommendation to perform a site-specific HHRA of the approximate 0.25-acre area that encompasses Building 2009 and former Buildings 2009A, 2009B, 2009C, and 2009D to address the arsenic-impacted and TRPH-impacted soils, if appropriate, following determination of the new soil background arsenic level and the full nature and extent of TRPH-impacted soils. The HHRA will also address the arsenic and TRPH detected in the concrete floor samples collected in Building 2009.

Subsequently, the Phase II closure investigation was completed in 2006, which included additional background soil sampling to establish a new background arsenic concentration, and additional soil sampling in the vicinity of Building 2009 to more fully delineate the nature and extent of elevated TRPH levels.

The Phase II Closure Sampling Report (JV I, 2007) presented the combined surface soil sampling results from the initial closure investigations and the Phase II investigation. The expanded soil arsenic background data were used during site closure evaluations to determine whether site arsenic levels were higher than background levels. The findings of this investigation indicated that site arsenic levels were above background arsenic levels. The combined surface soil arsenic data set included the following:

- Building 2009 - 21 native soil samples
- Building 2009A - 11 native soil samples
- Buildings 2009B, 2009C, and 2009D - 18 native soil samples

All of this data were used to determine the arsenic exposure point concentrations in this risk assessment, and are included in Appendix A.

2.2.2 Data Evaluation for TRPH DRO in Soil

As mentioned in Section 2.2.1, the Phase II closure investigation included additional soil sampling in the vicinity of Building 2009 to more fully delineate the nature and extent of elevated TRPH levels. The additional sampling results indicated that TRPH DRO levels in site soils underlying the concrete pavement north-northwest of Building 2009 exceeded the closure standard and were not completely delineated. However, EPA approved of the Navy's adoption of land use controls to address the TRPH-impacted soils at the site due to the limited nature of the TRPH DRO-impacted soils at the site, and the fact that the impacted soils are overlain by concrete and underlain by a clay layer, effectively isolating the impacted soils. This is in lieu of performing an HHRA to evaluate potential exposure of human receptors to TRPH-impacted soils at the site under future industrial land use conditions. Specifically, the RCRA § 7003 Administrative Order on Consent between the Navy and EPA includes provisions requiring the maintenance of the existing concrete pavement north-northwest of Building 2009 to effectively serve as a cap over the underlying TRPH-impacted soils, and to prohibit intrusive activities in this area that will result in direct contact with the TRPH-impacted soil.

2.2.3 Data Evaluation for Chemicals in Concrete Samples

The initial closure investigation of Building 2009 (JV I, 2005a) included the collection and analysis of 10 concrete cores samples in Building 2009 as follows:

- Six samples from the hazardous waste storage area
- Three samples from the bottom of the sump
- One sample from the concrete entrance ramp of the building

This investigation also included the collection and analysis of 5 concrete core samples from Building 2010 as background samples. Building 2010 was similar in construction to Building 2009 but had not been used for hazardous waste storage. Appendix B includes the background arsenic and TRPH DRO data for the concrete core samples. The results of this

investigation indicated that both the arsenic and TRPH DRO levels in the Building 2009 core samples exceeded their respective background levels, which were the closure standards.

2.3 Selection of Chemicals of Potential Concern

Based on the statistical analysis of the all of the surface soil arsenic levels in the area of Building 2009, 2009A, 2009B, 2009C, and 2009D relative to the background arsenic level, the site arsenic levels exceeded the background level (closure standard). In addition, the site arsenic levels exceeded the EPA Region 3 Industrial Risk Based Concentration (RBC). Therefore, arsenic was selected as a COPC for this risk assessment of site soils. Exhibit 2-1 presents a statistical analysis summary of the soil arsenic data supporting the selection of arsenic as a COPC for site soils.

Similarly, because the arsenic and TRPH DRO levels in the Building 2009 concrete core samples exceeded their respective background levels (closure standards), arsenic and TRPH DRO were selected as COPCs for the risk assessment of concrete dust within Building 2009. Exhibit 2-2 presents a statistical analysis summary of the concrete core arsenic and TRPH DRO data supporting the selection of arsenic and TRPH as COPCs for the concrete floor in Building 2009.

2.4 Exposure Assessment

The exposure assessment consists of two main steps:

1. Evaluating exposure pathways and identifying appropriate receptors
2. Selecting appropriate exposure-point concentrations (EPCs)

A conceptual site model (CSM) is presented in Exhibit 2-3, depicting the types of potential exposures to chemicals at, or migrating from, the Building 2009 area. The CSM depicts the primary site source, potentially affected environmental media, chemical fate and transport mechanisms, potentially exposed receptors, and potential exposure pathways.

The type of potentially exposed receptors at the site depends on the type of land use. The current site conditions for Building 2009 and the surrounding area were described in Section 1 of this document. Building 2009 is intact and currently not in use. For this reason, no human receptors are currently present at in the building or the immediate surrounding area. The site is located within a fenced area of the DRMO facility, and the land surface in the Building 2009 area slopes to the north-northeast direction toward the entry road into the DRMO complex from Forrestal Drive. Most of the area surrounding Building 2009 is paved with a gradual downward slope to the north-northwest. Runoff either enters a drop inlet in the paved area north-northwest of Building 2009 or flows off the site via sheet flow. The drop inlet conveys stormwater to an underground storm sewer that leads to drainage swale along Forrestal Drive, and sheet flow from the site also enters this drainage swale which conveys the stormwater to the west. The drainage swale is vegetated with grass and is normally dry, except during or immediately following a rainfall event.

The RCRA § 7003 Administrative Order on Consent between the Navy and EPA includes land use controls (LUCs) for the Building 2009 area, which restrict the use of Building 2009

and the immediate surrounding area against future residential or similar use of the property. Therefore, future use of Building 2009 and the surrounding area will be limited to industrial or commercial use.

2.4.1 Evaluation of Exposure Pathways

An exposure pathway evaluation describes how a receptor could be exposed to chemicals at, or migrating from, the Building 2009 area. A potentially complete exposure pathway consists of four necessary elements:

- A source and chemical release
- An environmental transport medium
- A point of potential contact with a receptor
- A feasible route of exposure at the exposure point

As shown in Exhibit 2-1, potential exposure media for the Building 2009 area include surface soil and the concrete floor inside Building 2009. Arsenic present in surface soils in the unpaved area east of Building 2009 could potentially migrate by fugitive dust emissions into the ambient air. This would result in a potential inhalation exposure to future maintenance, utility, and industrial workers, and trespassers (adult, youth, and child). The surface soil would also present a potential risk to human health by incidental ingestion and dermal contact, which represent exposure pathways for future maintenance, utility, and industrial workers, and trespassers (adult, youth, and child).

Arsenic present in surface soils in the unpaved area east of Building 2009 could potentially migrate offsite via erosion into the drainage swale sediments along Forrestal Drive north of the DRMO facility. However, a RCRA Facility Investigation conducted in 1996 (Baker 1996), which included the collection and analysis of sediment samples from this drainage swale, determined that no unacceptable human health risk was posed by the constituents detected in the sediment samples. Therefore, this does not represent a complete exposure pathway.

It is highly unlikely that the arsenic present in site surface soils would migrate via stormwater runoff and impact surface waters because the nearest surface water body to the Building 2009 area is over ½ mile away (flow path distance). Therefore, this is considered an insignificant exposure pathway.

The arsenic present in the surface soil in the unpaved area east of Building 2009 could also potentially leach to groundwater. Leaching to the subsurface is likely to be limited, however, because only a portion of the total arsenic is soluble. Further, depth to groundwater at the site is greater than 20 feet below ground surface such that dermal contact with shallow groundwater is highly unlikely. Future use of groundwater at the site for potable or irrigation water is not expected because the area is already served by a reliable potable water supply. Therefore, this is considered an insignificant exposure pathway.

Although potentially impacted groundwater may migrate laterally and seep into a surface water body, the nearest possible seep is over 500 feet away from the Building 2009 area. Therefore, it is highly unlikely that a surface water body would be so impacted, and this is considered an insignificant pathway.

The other primary source of human exposure to impacted media in the Building 2009 area is the concrete floor inside Building 2009. This is because the concrete core sample results from the floor during the closure investigation indicated that the arsenic and TRPH DRO levels exceeded their respective closure standards. Concrete dust was not observed on the floor of Building 2009 during the closure investigations. To the contrary, the floor is covered with an epoxy coating to protect it from potential spills and leaks, and the floor was generally free from any appreciable quantities of dirt and dust during the closure investigation. Nevertheless, it is assumed that future uses of the building will include the movement of 55-gallon drums into and out of the building, which could potentially lead to abrasion of the floor surface and generation of concrete dust. The concrete dust would present a potential risk to human health by incidental ingestion and dermal contact, which represent exposure pathways for future maintenance, utility, and industrial workers. These exposure pathways were not assumed to apply to trespassers because it was assumed that the building would be kept locked as it had been in the past when the facility was active.

In addition, it was assumed that inhalation of concrete dust was not an exposure pathway because of the assumed absence of wind or other activities that would generate fugitive dust emissions inside the building.

Thus, the primary migration and exposure pathways for the arsenic detected in site surface soils are inhalation of fugitive dust emissions, and incidental ingestion of and dermal contact with the soil. These represent complete exposure pathways for future maintenance, utility, and industrial workers, and trespassers (adult, youth, and child). Regarding concrete dust inside Building 2009, incidental ingestion and dermal contact are the primary exposure pathways for future maintenance, utility, and industrial workers.

2.4.2 Identification of Potential Human Receptors

The DRMO site has been inactive since 2004 and the site is currently abandoned with no current receptors at the site. Due to the remoteness of the site on the Base, trespassing is not expected. However, because of the uncertainty associated with presence of access restrictions in the future, a trespasser scenario will be evaluated under a future land use. An adult, youth, and child receptor will be evaluated under the trespasser scenario.

As previously discussed, the Navy will implement LUCs at Building 2009 and the immediate surrounding area, which will limit future land use to industrial or commercial uses. Accordingly, the likely receptors to be present in the Building 2009 area in the future are maintenance workers, construction/utility workers, and industrial workers. The exposure pathways considered appropriate for these receptors are discussed in the following sections and are summarized in Exhibit 2-4.

2.4.2.1 Future Maintenance Workers

Future maintenance workers may be engaged in landscape maintenance, pest control, and minor utility repair activities in the Building 2009 area, and could contact arsenic in surface soil (0-6 inches) through incidental ingestion, dermal contact, or inhalation of suspended particulates.

Maintenance workers may also be engaged in building maintenance activities inside Building 2009, and exposures to arsenic and TRPH DRO contained in the dust eroding from

the concrete floor may occur in the future. The potential pathways for worker exposure to arsenic and TRPH DRO in dust from the concrete floor surface are ingestion and dermal contact. Ingestion exposure could potentially result from skin contact with dust followed by hand-to-mouth contact through smoking or eating.

Inhalation exposures could potentially result from windblown dust, or mechanical suspension producing dust concentrations in air; however, inhalation of dust from the concrete floor surface is considered negligible since organic chemicals tend to volatilize from refined dust particles, and inorganic chemicals have a low tendency to be absorbed.

2.4.2.2 Future Construction/Utility Workers

Future utility workers may be engaged in maintenance of buried pipelines and minor utility repair activities in the Building 2009 area, and could contact arsenic in surface soil (0 to 6 inches) through incidental ingestion, dermal contact, or inhalation of suspended particulates or volatile emissions. A utility worker could be present at the site for longer exposure duration than a construction worker. For a conservative assessment of potential exposure to these two populations, a utility worker scenario involving longer exposure duration was included in this risk assessment. The utility worker exposure scenario would be protective of construction workers as well, if such a scenario were to occur in the future.

The exposure evaluation will be conducted using the existing surface soil sampling data for arsenic (0 to 6 inches). Use of the existing surface soil data for arsenic will provide a conservatively protective risk evaluation. This is because any possible past releases of hazardous constituents in the Building 2009 area would have been to surface soil, causing the surface soil concentrations for less soluble chemicals such as metals (including arsenic) to be higher in surface soil than those that could occur in deeper soils.

Although some underground utilities at the DRMO facility are deeper than 2 ft below ground surface (bgs), any underground construction work on these utilities for major repairs or replacement would be infrequent, no more than once or twice per year. The only significant buried utilities in the Building 2009 area consist of small-diameter potable water pipelines and a storm sewer. Therefore, exposure to arsenic in site surface soil was assessed for a future utility worker scenario. The potential exposure routes for a future utility worker include incidental ingestion, dermal contact and inhalation exposure to arsenic in site surface soil.

The potential exposure pathways to a future construction or utility repair worker for arsenic and TRPH DRO in dust from the concrete floor surface include ingestion and dermal contact. Ingestion exposure could potentially result from skin contact with dust followed by hand-to-mouth contact through smoking or eating.

Inhalation exposures could potentially result from windblown dust, or mechanical suspension producing dust concentrations in air. However, inhalation of dust from the concrete floor surface is considered negligible since organic chemicals tend to volatilize from refined dust particles, and inorganic chemicals have a low tendency to be absorbed.

2.4.2.3 Future Industrial Workers

The soil in the Building 2009 area is partially covered with vegetation or paved with asphalt or concrete. Future industrial workers may contact arsenic in exposed surface soil (0 to

6 inches) through incidental ingestion, dermal contact, or inhalation of suspended particles or volatile emissions. Future industrial workers may also be engaged in work activities inside Building 2009, and exposures to arsenic and TRPH DRO in concrete dust may occur. The potential exposure pathways for arsenic and TRPH DRO in concrete dust are ingestion and dermal contact. Ingestion exposure could potentially result from skin contact with dust followed by hand-to-mouth contact through smoking or eating.

Inhalation exposures could potentially result from windblown dust, or mechanical suspension producing dust concentrations in air. However, inhalation of dust from the concrete floor surface is considered negligible as organic chemicals tend to volatilize from refined dust particles, and inorganic chemicals have a low tendency to be absorbed.

2.4.2.4 Future Trespasser Receptors

Trespassing visitors could pass through the Building 2009 area and be exposed to surface soil at the site through incidental ingestion, dermal contact and inhalation of emissions from surface soil.

The trespassing visitors are assumed to include adults, youth (between the ages of 7 and 17 years), and children (6 year olds). The visitors are assumed to be at the site once every week throughout the year. Because the site is very small and is industrial in nature, they are conservatively assumed to spend 4 hours at the site per weekly visit for dermal exposure and are assumed to include 50 percent of the incidental ingestion rate of the soil from the site.

Future trespassing visitors (adult, youth or child) may contact arsenic in exposed surface soil (0 to 6 inches) through incidental ingestion, dermal contact, or inhalation of suspended particles or air-borne volatile emissions. The trespassers are not expected to be exposed to concrete inside Building 2009. No indoor concrete exposure was assumed for these receptors.

2.5 Selection of Exposure Point Concentrations

EPCs are the chemical concentrations in an environmental medium to which a receptor may be exposed at a specific location (the "exposure point"). EPCs can be based on analytical data obtained from onsite sampling or they may be estimated through modeling.

Exposure point concentrations (EPCs) were calculated for the surface soil and concrete dust samples. Reasonable maximum exposure (RME) was used as the exposure estimate for the calculation of EPCs. The EPA's ProUCL, Version 3.00.02 was used to calculate an upper bound estimate of the average concentrations in the exposure area (EPA, 2004a). Appendix C provides the summary and output of the ProUCL calculations.

2.5.1 Surface Soil

Exhibit 2-5 includes the EPC for arsenic in surface soil. A 95 percent upper confidence limit (UCL95) was estimated for surface soil as the EPC value.

2.5.2 Concrete Floor Dust

Exhibit 2-6 includes the EPCs for arsenic and TRPH in concrete core samples. UCL95's were estimated for concrete as the EPC values. A fraction of the concrete is assumed to be

released as dust due to foot traffic and movement of stored equipment and 55-gallon drums into and out of the building. The concentration of arsenic and TRPH in concrete floor dust is assumed to be the same as arsenic and TRPH levels in the concrete samples.

2.6 Intake Estimates

Exposure factors were used to estimate arsenic intake by receptors relative to site surface soils, as well as receptor intake of arsenic and TRPH exposed to concrete floor dust in Building 2009. Because exposure factors are often assumed values, they can contribute to uncertainty in the calculation of intake estimates.

2.6.1 Surface Soil

The exposure factors used to estimate chemical intakes and inhalation exposure concentrations associated with ingestion, dermal, and inhalation exposures to site soils are provided in Exhibit 2-7. The references cited in Exhibit 2-7 were used to identify pathway-specific intake factors for potential exposure pathways. Where appropriate, site-specific information was used to identify reasonable conservative exposure factors. Appendix D includes the intake estimates for the site soils.

2.6.2 Concrete Floor Dust

The dose estimations for concrete were performed by using the concrete core sample data and the dust generated from concrete. As discussed in the Site-Specific Risk Assessment Work Plan (JV I, 2006), the EPA guidance does not address exposure scenarios to concrete; however, some EPA Region III guidance exists for exposure to indoor dust from concrete or other solid surfaces of building interiors. Based on this guidance, the methods used to estimate chemical intake from dusts generated from the concrete floor in Building 2009 are described below. Appendix D includes the exposure factors and intake estimates for various receptors to the concrete dust.

The dust generation rate from concrete floors is expected to be minimal, particularly because of the presence of epoxy resin coating on the concrete floor. However, for conservative risk estimation purposes, dust emission was assumed to occur from the concrete floor of Building 2009. Ten (10) percent of the dust deposited on skin is assumed to be incidentally ingested during hand-to-mouth activities. The dust loading rate to the skin is assumed to be same as the adherence factor (0.2 or 0.3 milligrams per square centimeter [mg/cm^2]), depending on the exposure scenario. Ingestion and dermal contact exposures to concrete dust was quantified for all worker scenarios. Exposure to trespassers to indoor dust was not included because these receptors are not expected to access the inside of the building.

An intake dose was calculated to determine chemical intake from concrete. A measured value for the amount of dust was not available (because the site is inactive) for the assumed future exposure scenario. Therefore, a conservatively assumed amount of dust per square centimeter of the floor's surface area was assumed. The intake factor reflected assumptions describing rate of contact with arsenic and TRPH in dust, exposure frequency and duration, and body weight. Equation 1 shows how the dermal intake factor was calculated.

Dermal intake factor: (1)

$$IF_{dermal} = \frac{C_{concrete} \times SA \times AF \times ABS_d \times FTSS \times EF \times ED \times EV \times CF}{BW \times AT \times 365\, days / year}$$

Where:

IF_{dermal} = Intake factor-dermal (mg/kg-day)
$C_{concrete}$ = Concentration in concrete (mg/kg)
SA = Exposed skin surface area (cm^2)
AF = Dust-to-skin adherence factor (quantity of dust adhering to the skin) (mg/cm^2)
ABS_d = Dermal absorption factor (chemical specific - unitless)
FTSS = Fraction transferred as dust to skin from concrete surface (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
EV = Event frequency (events/day)
BW = Body weight (kg)
AT = Averaging time (years)
CF = Conversion Factor (1.00E-06 kg/mg)

From the amount of dust adhered to the skin, oral intake can be estimated as follows (see Equation 2):

(2)

$$IF_{oral} = \frac{D_{dermal} \times C_{concrete} \times FTSM \times ABS_{GI} \times EF \times ED \times EV \times CF}{BW \times AT \times 365\, days / year}$$

where:

IF_{oral} = Intake factor –oral (mg/kg-day)
D_{dermal} = Deposited amount on the skin (mg)
$C_{concrete}$ = Concentration in concrete (mg/kg)
FTSM = Fraction transferred from hands to mouth (unitless)
ABS_{GI} = Gastrointestinal (GI) absorption factor (chemical specific - unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
EV = Event frequency (events/day)
BW = Body weight (kg)
AT = Averaging time (years)
CF = Conversion Factor (1.00E-06 kg/mg)

The exposure factors used to estimate chemical intakes associated with dermal contact and ingestion exposures to concrete floor dust in Building 2009 are provided in Exhibit 2-8. The references cited in Exhibit 2-8 were used to identify pathway-specific intake factors for potential exposure pathways. Site-specific information was used to identify conservative, yet reasonable exposure factors whenever possible. When neither site-specific nor default

values were available, professional judgment was used to develop exposure parameters. Appendix D includes the intake estimates for various receptors to the concrete dust.

The deposited amount of dust on skin was estimated using Equation 3:

(3)

D_{dermal} :

$$D_{dermal} = SA \times AF \times FTSS$$

where:

D_{dermal} = Deposited amount on the skin (mg)
SA = Exposed skin surface area (cm^2)
AF = Dust-to-skin adherence factor (quantity of dust adhering to the skin (mg/cm^2)
FTSS = Fraction transferred to skin from concrete surface (unitless)

2.7 Toxicity Assessment

The toxicity assessment consisted of three steps:

1. Identifying the health effects of arsenic and pertinent TRPH DRO compounds
2. Obtaining the toxicity factors for arsenic from the EPA's Integrated Risk Information System (IRIS), which includes current toxicity and dose-response information for arsenic (http://www.epa.gov/iris/)
3. Selecting conservatively representative TRPH toxicity factors from the range of toxicity values proposed by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG, 1997)

2.7.1 Health Effects of Arsenic and TRPH DRO

The noncarcinogenic effects of arsenic include skin hyperpigmentation, keratosis, and possible vascular complications, which are dose-related (EPA, 2007). Other noncarcinogenic effects include peripheral neuropathy, renal failure, hepatotoxicity, and bone marrow depression (ATSDR, 2006).

Sufficient human data has indicated that arsenic is a human carcinogen. It is evident that the inhalation of arsenic may cause lung cancer in humans, and the ingestion of arsenic is associated with cancer of the bladder, liver, skin, and kidneys (EPA, 2007).

The detection of TRPH DRO in the concrete core samples collected from the floor of Building 2009 indicates the presence of the heavier longer chain hydrocarbons contained in various petroleum products. Petroleum products are complex mixtures containing hundreds to thousands of hydrocarbon compounds, including aliphatic and aromatic compounds. Once released into the environment, the composition of the petroleum products will change due to weathering (i.e., fate and transport of the various hydrocarbons present in the petroleum product, such as volatilization of the lighter constituents).

Although some toxicity data are available for whole, un-weathered petroleum products, toxicity data is generally not available for the many variations of weathered petroleum products, which consist of a vast variety of combinations of hydrocarbon compounds. Therefore, it is not practical to attempt to assess the health effects of TRPH as an aggregate of many and varied hydrocarbon compounds.

Although toxicity data are available for about 95 of the identified compounds contained in various petroleum-derived fuels and crude oil, only about 25 were found by the EPA Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) (TPHCWG, 1997) to have EPA toxicity values or sufficient data to develop toxicity criteria.

Due to absence of volatile fractions, and age of the potential spills/releases in Building 2009, it is assumed that TRPH compounds detected in the concrete core samples are likely to be slower degrading heavier hydrocarbon fractions. The polycyclic aromatic hydrocarbons (PAHs) detected in the site samples were mostly below health-based RBC levels, thus the hydrocarbons reported in the site samples are likely to be from straight chain hydrocarbons.

A carcinogenic effect associated with exposure to the heavier aliphatic hydrocarbons is the formation of liver granulomas (Smith, et al., 1996), and exposure to certain PAHs, including fluorene, phenanthrene, and pyrene (although these compounds are believed to be present in very low levels), produce renal, hepatic, and hematological effects (EPA, 2007).

2.7.2 Toxicity Factors

The toxicity factors selected for arsenic and TRPH are listed in Exhibit 2-9. Cancer and non-cancer toxicity factors were available from IRIS for arsenic; therefore, no interim toxicity factors were used in this risk assessment.

As described above for TRPH, the hydrocarbons present in the concrete core samples in Building 2009 are likely to consist of the heavier, straight chain hydrocarbons. The RfD for the medium range hydrocarbons (C9-C18) ranges from 0.1 to 0.6 mg/kg/day, and the RfD for longer (heavier) chain hydrocarbons ranges from 2 to 6 mg/kg/day. A more conservatively protective RfD value of 0.2 mg/kg/day from the EPA TPHCWG was used for TRPH in this HHRA (which is consistent with the Risk Assessment Work Plan).

2.8 Risk Characterization

Risk characterization is the final component in an HHRA, integrating the information obtained in all preceding steps of an HHRA. Risk characterization involves quantifying the magnitude of potential adverse health effects from exposure to COPCs. Noncarcinogenic health effects and potential excess lifetime cancer risks were estimated for each exposure pathway for each receptor.

Noncarcinogenic hazards are estimated by comparing the calculated exposure levels to threshold concentrations (or Reference Doses [RfDs]). The calculated intake of each constituent is divided by the RfD. This ratio is referred to as the hazard quotient (HQ) and calculated as follows:

$$HQ = Intake/RfD$$

To assess the potential for noncarcinogenic health effects posed by exposure to multiple chemicals and exposure routes, a hazard index (HI) approach is used (EPA, 1989). This approach assumes that noncarcinogenic hazards associated with exposure to more than one chemical and exposure route are additive. Synergistic or antagonistic interactions between chemicals are not accounted for in the HHRA. The HI may exceed 1.0 even if all of the individual HQs are less than 1.0. The constituents may then be separated by similar mechanisms of toxicity and toxicological effects, and separate HIs derived based on each specific toxic mechanism and target organ affected. However, because only two COPCs were identified for the Building 2009 area (arsenic and TRPH DRO), possible synergistic or antagonistic interactions between these COPCs is not considered to be significant.

The potential for carcinogenic effects as a result of exposure to site-related contamination is evaluated by estimating the excess lifetime carcinogenic risk (ELCR). ELCR is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cancer.

Potential carcinogenic risks associated with exposure to individual carcinogens were calculated using cancer slope factors (CSFs) and the intakes. The carcinogenic risk is calculated by multiplying the intake by the CSF.

The linear low-dose equation is used to estimate the risk of an individual developing cancer over a lifetime as a result of exposure to a carcinogen for sites where cancer risks are below 0.01 (1E-2). ELCRs are calculated by multiplying the intake by the CSF, as follows:

$$\text{ELCR} = \text{Intake} \times \text{CSF}$$

Risks were added across the pathways, if an individual would be exposed through multiple pathways.

The exposure and toxicity information were integrated to estimate the potential cancer risks and noncancer hazards (or hazard index [HI]). The estimated ELCR and HI provide a basis for site-specific risk management decisions. The cumulative risks and HIs are then compared against the acceptable risk ranges. For the purposes of regulatory decision-making, the EPA recommends an acceptable risk range of 1E-4 to 1E-6 (1 to 100 in 1 million). Results falling within or below this range will serve as a basis for achieving risk-based closure of Building 2009 and the immediate surrounding area.

An HI value above 1.0 is further evaluated to determine if any individual target organ HIs exceed a value of 1.0. Unless the cumulative HI to a target organ exceeds an HI of 1.0, it is typically not considered an exceedance or unacceptable hazard. The conservative nature of the analysis and the uncertainty inherent in the risk assessment were considered when interpreting the results. The uncertainty associated with the risk estimations is discussed in the Section 2.9. Both carcinogenic risk and HI were estimated for arsenic in soil, and for arsenic and TRPH DRO in concrete dust.

Exhibit 2-10 includes a summary of the risks and HIs estimated for the various receptors with potential exposure to surface soil and concrete floor dust. Appendix D includes the details of the risk calculations. A target organ specific HI for the receptor scenarios was not included, as no scenario-specific HI exceeded 1.0 from arsenic in surface soil in the Building 2009 area, and from arsenic and TRPH in concrete in Building 2009.

The ELCR for a **future maintenance worker** exposed to surface soil is 7.2E-07, which is within the acceptable risk range of 1E-06 to 1E-04. The derived HI of 0.004 is below the target HI of 1. The concrete dust exposure resulted in an ELCR of 9.2E-8 and an HI of 0.0006. The cumulative ELCR from both soil and concrete combined for a future maintenance worker is 8.1E-7 and the HI is 0.005, both well within acceptable risk and HI levels. Therefore, arsenic and TRPH from the site are not identified as chemicals of concern (COCs) for a future maintenance worker.

For the **future utility/construction worker,** exposure to surface soil resulted in an ELCR of 1E-06 which is within the acceptable risk range of 1E-04 to 1E-06. The estimated HI is 0.006 which is also below the target HI of 1 for noncarcinogenic exposure. The concrete dust exposure resulted in an ELCR of 6.7E-8 and an HI of 0.0004. The cumulative ELCR from both soil and concrete combined for a future utility worker is 1.1E-6 and the HI is 0.007, both well within acceptable risk and HI levels. Therefore, neither arsenic nor TRPH is identified as a COC for the future utility worker.

The ELCR for a **future industrial worker** exposed to arsenic in surface soil was calculated to be 3.5E-6 and the HI from surface soil was estimated at 0.022, both within acceptable limits. The concrete dust exposure resulted in an ELCR of 2.2E-7 and an HI of 0.0014. The combined ELCR from soil and concrete dust was estimated at 3.7E-6 and the HI at 0.023, both well within acceptable risk and HI levels. Therefore, neither site arsenic nor TRPH is identified as a COC for the future industrial worker.

The estimated ELCRs for the **future trespasser** are 5.1E-07 for the adult, 3E-7 for a youth, and 8.4E-7 for a child. All of the estimated cancer risks fall within the acceptable risk range of 1E-06 to 1E-04. The derived HIs are 0.003 for the adult, 0.005 for a youth, and 0.022 for a child trespasser, all below the target HI of 1. Thus, potential exposures of trespassers to arsenic in site surface soil are within acceptable limits. Therefore, site arsenic was not identified as a COC in surface soil for the future site trespassers at Building 2009.

In summary, none of the exposure scenarios indicated unacceptable risks or HIs above acceptable limits. Therefore, arsenic detected in site soils, and arsenic and TRPH detected in the Building 2009 concrete floor are not COCs. As such, potential exposures to arsenic in site soils and to arsenic and TRPH in concrete dust inside Building 2009 under industrial or commercial use conditions do not present unacceptable risks to humans.

2.9 Uncertainty Characterization

The following section summarizes the general uncertainties associated with various risk assessment steps.

The risk estimations included several exposure assumptions, exposure factors, EPC estimations, site conditions, and receptor behaviors. Because these are assumed values, an inherent uncertainty is associated with these hypothetical scenarios, and there are practical limitations to obtaining an actual value versus an assumed value. The toxicity factors supplied by the EPA use several extrapolation methods that contain inherent uncertainty and tend to include conservatively protective assumptions during such extrapolations. Such uncertainty in toxicity factors is not addressed in this assessment, because EPA sources provide adequate documentation of such uncertainty.

2.9.1 COPC Selection

As with any other risk estimation, uncertainty exists in COPC selection process. This focused risk assessment addresses arsenic in surface soil, and arsenic and TRPH in the concrete floor of Building 2009. The uncertainty in the selection of arsenic as a COPC for site soils is minimized, however, due to the large number of site samples (total of 50) collected from a small area (approximately 0.25 acre), and the large number of background soil samples (total of 29). Similarly, the uncertainty in the selection of arsenic and TRPH DRO as COPCs for the concrete floor in Building 2009 is also reduced by the large number of samples collected. A total of 10 concrete core samples were collected from the concrete floor in Building 2009, which encompasses an area of only 360 square feet, and 5 background samples were collected from Building 2010.

2.9.2 Exposure Assessment

Most of the exposure pathways evaluated tend to be associated with high uncertainty because the dose estimations require several hypothetical assumptions. The receptor behavior assumptions leading to an exposure and intake dose are typically based on the upper bound levels on typical behavior in order to be protective of high-end exposure individuals. Also, if the future land use is altered for an area, then actual exposures could much less than those assumed. For example, a planned office space could be altered to a storage unit with far fewer workers or workers only occasionally visiting such a storage unit. In this case, if only occasional visits by workers occur as opposed to the assumed full-time employees, the assumed exposure scenario would be overly conservative with high uncertainty of the estimated dose. However, selecting conservatively protective assumptions will protect all lower level exposure populations.

Because the arsenic and TRPH concentrations in the concrete core samples were used for the concentrations in concrete dust, there may be an overestimation of risk from exposure to concrete floor dust. Additionally, the dust generated from the floor itself is likely to be minimal because of the presence of the epoxy coating on the concrete floor surface.

2.9.3 Toxicity Assessment

Toxicity criteria are developed by EPA and the uncertainty associated with the development of toxicity factors is provided by EPA. For example, the uncertainty associated with extrapolation of toxicity from animal data to humans is described in the EPA databases. The arsenic toxicity is well characterized and documented by EPA in its online databases.

For TRPH, however, the TRPH analysis provides a measurement of the overall concentration of the various petroleum hydrocarbon fractions (carbon chain lengths), and toxicity information is not available for TRPH as a whole. Toxicities are available for hydrocarbon groups with defined carbon chain lengths and they vary significantly. The uncertainty introduced by this, however, is reduced because the TRPH compounds detected at the site are likely to be slower degrading heavier hydrocarbon fractions, and the toxicity factor selected for the TRPH risk evaluation was representative of the longer chain, heavier hydrocarbons. This is supported by the absence of volatile hydrocarbons fractions in the site samples, and the age of potential spills/releases at the site.

2.9.4 Risk Characterization

The propagation of uncertainty in the other steps such as COPC selection, exposure assessment, and toxicity assessment also introduces uncertainty into the risk estimates.

EXHIBIT 2-1

Selection of Chemicals of Potential Concern (COPCs) - Surface Soil

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Matrix	Units	Parameter Name	Number Analyzed	Number Detected	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration [1]	STDEV	Background Limit [2]	Regulatory Criteria for Surface Soil [3]	COPC	Rationale for Contaminant Selection [4]
SS	mg/Kg	Arsenic	50	47	5.68E-01 - 7.07E-01	2.84E-01	2.98E+01	4.50E+00	4.66E+00	3.70E+00	1.91E+00	Yes	ASL

Notes:

[1] For data sets containing nondetected values, mean concentration was calculated using ½ of the minimum detection limit value.

[2] Background Limit is the calculated Upper Tolerance Limit (UTL) for normally distributed data, calculations provided in Phase II Closure Sampling Report, Buildings 2009, 2009A, 2009B, 2009C, and 2009D. NAPR DRMO, January 2007 (JV I, 2007).

$$UTL_{1-\alpha}(x_{0.95}) = \overline{x} + sK_{1-\alpha,0.95}$$

[3] RBC values from the April 07, 2005 Region 3 Risk Based Concentrations for industrial soils (EPA, 2005).

[4] Rationale Code

Selection Reason:

Above Screening Levels (ASL)

ProUCL, Version 3.00.02 used to determine the mean concentration and standard deviation.

NA = Not Applicable or Not Available

mg/Kg = milligrams per kilogram

EXHIBIT 2-2

Selection of Chemicals of Potential Concern (COPCs) - Concrete

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Matrix	Units	Parameter Name	Number Analyzed	Number Detected	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration [1]	Background Limit [2]	STDEV	Regulatory Criteria for Concrete Dust [3]	COPC	Rationale for Contaminant Selection [4]
CD	mg/Kg	Arsenic	10	10	0 - 0	7.60E-01	1.35E+01	5.12E+00	6.85E+00	4.11E+00	1.91E+00	Yes	ASL
CD	mg/Kg	TRPH	10	10	0 - 0	2.93E+01	3.27E+02	1.68E+02	2.93E+01	1.00E+02	1.00E+02	Yes	ASL

Notes:

[1] For data sets containing nondetected values, mean concentration was calculated using ½ of the minimum detection limit value.

[2] Background Limit is the calculated Upper Tolerance Limit (UTL) for normally distributed data, see Appendix B

$$UTL_{1-\alpha}(x_{0.95}) = \bar{x} + sK_{1-\alpha,0.95}$$

[3] Regulatory criteria for soils were used a surrogate for concrete dust.

RBC values from the April 07, 2005 Region 3 Risk Based Concentrations for industrial soils (EPA, 2005).

TRPH value derived from Criterion from *Commonwealth Government of Puerto Rico, Office of the Governor,* Environmental Quality Board, Water Quality Area (November 7, 1990, Amendments 2002)

[4] Rationale Code

Selection Reason:

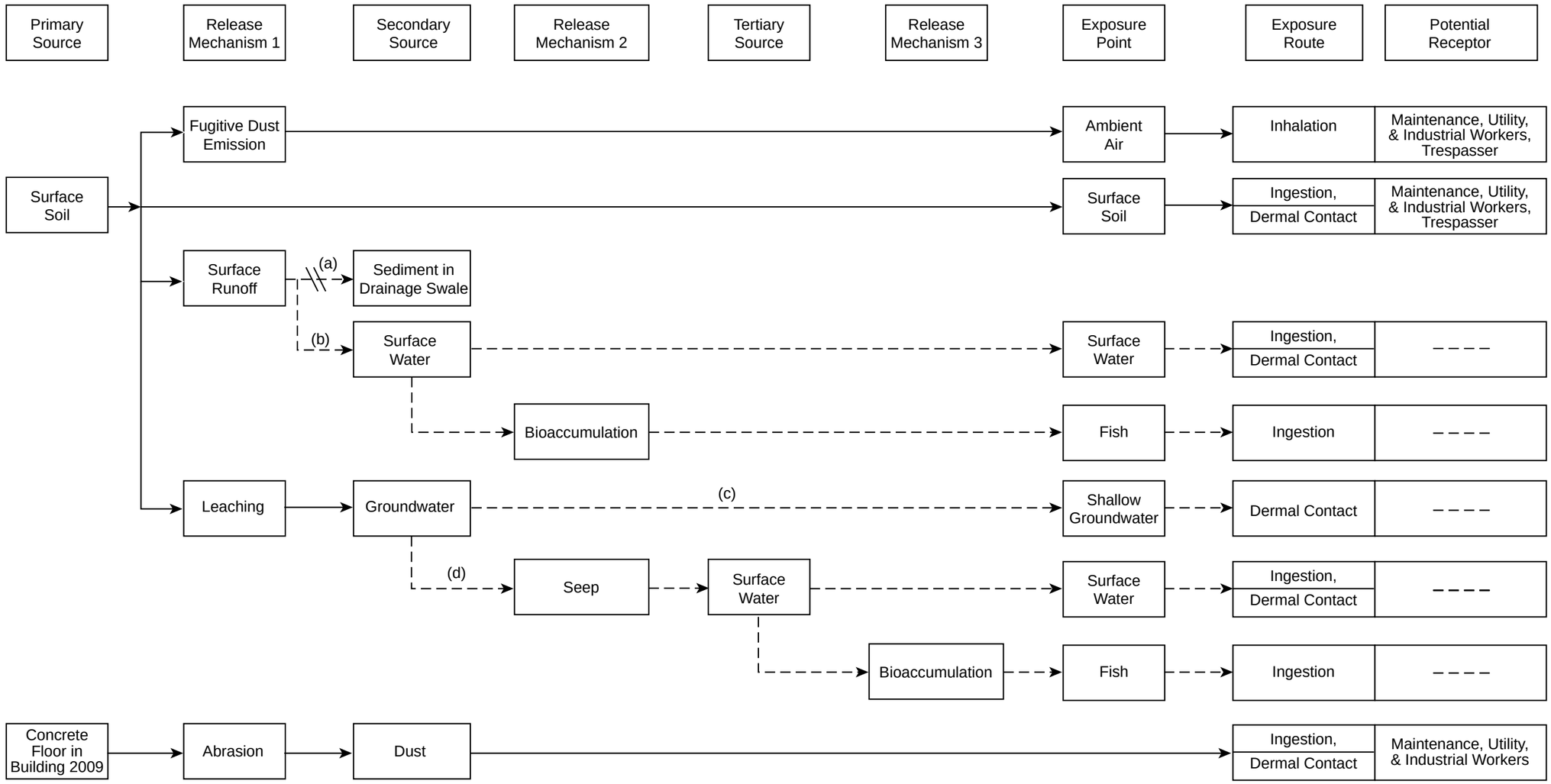
Above Screening Levels (ASL)

ProUCL, Version 3.00.02 used to determine the mean concentration and standard deviation.

NA = Not Applicable or Not Available

mg/Kg = milligrams per kilogram

CD = Concrete Dust (from concrete core samples)



Notes:

Incomplete Pathway
(a) Sediment sampling results indicate no unacceptable risks to human health

Insignificant Pathway
(b) Impacts to surface water will likely be neglibile because nearest surface water body is over 1/2 mile away
(c) Depth to groundwater is greater than 20 feet below land surface
(d) Nearest possible seep is over 500 feet away and possible impacts to surface water will likley be negligible

Exhibit 2-3
Conceptual Site Model for
Human Health Risk Assessment
U.S. Naval Activity Puerto Rico - DRMO
Building 2009 Area

AGVIQ CH2M HILL

EXHIBIT 2-4
Potentially Complete Exposure Pathways and Receptors
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Receptor	Media	Exposure Route and Point of exposure	Pathway Selected for Evaluation	Reason for Selection or Exclusion
Future				
On-Site Maintenance Worker	Surface Soil	Ingestion, dermal contact, and inhalation exposure to arsenic in site surface soils	Yes	A hypothetical future maintenance worker engaged in landscape maintenance, pest control, and utility repair activities is assumed to be exposed to contaminated surface soil.
	Concrete Dust	Ingestion and dermal contact exposure to arsenic and TRPH in site concrete dust	Yes	A hypothetical future maintenance worker is assumed to be exposed to contaminated concrete dust as a result of skin contact with dust followed by hand-to-mouth contact through smoking and/or eating.
On-Site Industrial Worker	Surface Soil	Ingestion, dermal contact, and inhalation exposure to arsenic in site surface soils	Yes	A hypothetical future industrial worker engaged in outdoor work activities is assumed to be exposed to contaminated surface soil.
	Concrete Dust	Ingestion and dermal contact exposure to arsenic and TRPH in site concrete dust	Yes	A hypothetical future industrial worker is assumed to be exposed to contaminated concrete dust as a result of skin contact with dust followed by hand-to-mouth contact through smoking and/or eating.
On-Site Construction/Utility Worker	Surface Soil	Ingestion, dermal contact, and inhalation exposure to arsenic in site surface soils	Yes	A hypothetical future construction/utility worker engaged in the maintenance of buried pipelines and utility repair activities is assumed to be exposed to contaminated surface soil.
	Concrete Dust	Ingestion and dermal contact exposure to arsenic and TRPH in site concrete dust	Yes	A hypothetical future construction worker is assumed to be exposed to contaminated concrete dust as a result of skin contact with dust followed by hand-to-mouth contact through smoking and/or eating.
Trespasser (adult, youth, and child)	Surface Soil	Ingestion, dermal contact, and inhalation exposure to arsenic in site surface soils	Yes	A hypothetical trespasser (adult, youth, or child) could pass through the site and be exposed to contaminated surface soil.
	Concrete Dust	Not applicable	No	A hypothetical trespasser (adult, youth, or child) is not expected to be exposed to concrete inside Building 2009.

EXHIBIT 2-5

Exposure Point Concentrations (EPCs)—Surface Soil

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Matrix	Units	Parameter Name	Number Analyzed	Number Detected	Arithmetic Mean Concentration	Minimum Detected Concentration	Maximum Detected Concentration	UCL 95	EPC	Statistic	Rationale
SS	MG/KG	**Arsenic**	50	47	4.50E+00	2.84E-01	2.98E+01	5.52E+00	5.52E+00	App. Gama	(3),(4)

Note:

Full statistics for data included in Appendix C.

ProUCL, Version 3.00.02 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA, 2004a). ProUCL, Version 3.00.02, EPA Technical Support Center for Monitoring and Site Characterization).

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data, H-Statistic (95% UCL-T); 95% Chebyshev (MVUE) UCL (95% Cheb); 99% Chebyshev (MVUE) UCL (99% Cheb); 95% Chebyshev (mean,std) UCL (95% Cheb-m); 97.5% Chebyshev (mean,std) UCL (97.5% Cheb-m); 99% Chebyshev (mean,std) UCL (99% Cheb-m); Mean of Log-transformed Data using the Minimum Variance Unbiased Estimate (MVUE) method (Mean-T), 95% modified-t UCL adjusted for skewness (95% Mod-t); 95% Student's-T test UCL (95% Stud-t); 95% Hall's Bootdtrap UCL (95% Hall); 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma).

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Shapiro-Wilk W Test indicates data fit both log-normal and normal distribution. Select distribution with higher W Test result.
(7) The maximum detected concentration was used as the UCL because the value recommended by ProUCL 3.0 was higher than the Max.
(8) The maximum detected concentration was used as the UCL because n<5.

mg/kg = Milligrams per kilogram

EXHIBIT 2-6

Exposure Point Concentrations (EPCs)—Concrete

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Matrix	Units	Parameter Name	Number Analyzed	Number Detected	Arithmetic Mean Concentration	Minimum Detected Concentration	Maximum Detected Concentration	UCL 95	EPC	Statistic	Rationale
CD	MG/KG	**Arsenic**	10	10	5.12E+00	7.60E-01	1.35E+01	7.50E+00	7.50E+00	95% UCL-N	(2)
CD	MG/KG	**TRPH**	10	10	1.68E+02	2.93E+01	3.27E+02	2.26E+02	2.26E+02	95% UCL-N	(2)

Note:

Full statistics for data included in Appendix C.

ProUCL, Version 3.00.02 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA, 2004). ProUCL, Version 3.00.02, EPA Technical Support Center for Monitoring and Site Characterization).

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data, H-Statistic (95% UCL-T); 95% Chebyshev (MVUE) UCL (95% Cheb); 99% Chebyshev (MVUE) UCL (99% Cheb); 95% Chebyshev (mean,std) UCL (95% Cheb-m); 97.5% Chebyshev (mean,std) UCL (97.5% Cheb-m); 99% Chebyshev (mean,std) UCL (99% Cheb-m); Mean of Log-transformed Data using the Minimum Variance Unbiased Estimate (MVUE) method (Mean-T), 95% modified-t UCL adjusted for skewness (95% Mod-t); 95% Student's-T test UCL (95% Stud-t); 95% Hall's Bootdtrap UCL (95% Hall); 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma).

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Shapiro-Wilk W Test indicates data fit both log-normal and normal distribution. Select distribution with higher W Test result.
(7) The maximum detected concentration was used as the UCL because the value recommended by ProUCL 3.0 was higher than the Max.
(8) The maximum detected concentration was used as the UCL because n<5.

mg/kg = Milligrams per kilogram

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
Ingestion	Maintenance Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 1991	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Utility Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	330	mg/day	EPA, 1991	
				EF	Exposure Frequency	25	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Industrial Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 1991	CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Trespasser	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 1991	CS x IR-S x EF x ED x Fi x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	52	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				FI	Fraction Ingested from Bldg 2009 area	0.5	Unit less	--	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
		Youth	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 1991	CS x IR-S x EF x ED x Fi x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	52	days/year	EPA, 1991	
				ED	Exposure Duration	10	years	EPA, 1991	
				FI	Fraction Ingested from Bldg 2009 area	0.5	Unit less	--	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	51	kg	EPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	EPA, 1989	
		Child	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	200	mg/day	EPA, 1991	CS x IR-S x EF x ED x Fi x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	52	days/year	EPA, 1991	
				ED	Exposure Duration	6	years	EPA, 1991	
				FI	Fraction Ingested from Bldg 2009 area	0.5	Unit less	--	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,195	days	EPA, 1989	
Dermal	Maintenance Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004b, (2)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004b, (3)	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004b	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
	Industrial Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004b	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004b	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004b	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Utility Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004b	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2004b	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004b	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	25	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Trespasser	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg		CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	5,700	cm^2	EPA, 2004b	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004b	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004b	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	52	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
		Youth	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg		CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	4,400	cm^2	EPA, 2004b	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2004b	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004b	

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	52	days/year	EPA, 1991	
				ED	Exposure Duration	10	years	EPA, 1991	
				BW	Body Weight	51	kg	EPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	EPA, 1989	
		Child	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg		CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,800	cm^2	EPA, 2004b	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2004b	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004b	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	52	days/year	EPA, 1991	
				ED	Exposure Duration	6	years	EPA, 1991	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,195	days	EPA, 1989	

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
Inhalation	Maintenance Worker	Adult	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CA x IN x EF x ED x 1/BW x 1/AT
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002a	
				PEF	Particulate Emission Factor	1.32E+09	m^3/kg	EPA, 2002a	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002a	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 1991	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Utility Worker	Adult	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002a	CA x IN x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.32E+09	m^3/kg	EPA, 2002a	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002a	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 1991	
				EF	Exposure Frequency	25	days/year		
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Trespasser	Adult	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002	CA x IN x ET x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.32E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	0.83	m^3/hr	EPA, 1991	
				ET	Exposure Time	4	hr		
				EF	Exposure Frequency	52	days/year		
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
		Youth	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002	CA x IN x ET x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.32E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	0.83	m^3/hr	EPA, 1991	
				ET	Exposure Time	4	hr		
				EF	Exposure Frequency	52	days/year		
				ED	Exposure Duration	10	years	EPA, 1991	
				BW	Body Weight	51	kg	EPA, 1997	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		Child	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002	CA x IN x ET x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.32E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	0.625	m^3/hr	EPA, 1991	
				ET	Exposure Time	4	hr		
				EF	Exposure Frequency	52	days/year		
				ED	Exposure Duration	6	years	EPA, 1991	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	2,195	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Industrial Worker	Adult	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CA x IN x EF x ED x 1/BW x 1/AT
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002	
				PEF	Particulate Emission Factor	1.32E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 1991	
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

EXHIBIT 2-7
Exposure Factors For Soils
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name

Notes:
(1) Conservative assumption based on potential maintenance activities (e.g., lawn mowing) at the site, 2 days per week for 26 weeks.
(2) Worker assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed surface area is the face, hands and forearms.
(3) SSAF based on maximum adherence factor for utility workers.
Sources:
EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
EPA, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.
EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.
EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005

EXHIBIT 2-8
Exposure Factors for Concrete Dust
U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Scenario Timeframe: Future
Medium: Concrete
Exposure Medium: Concrete Dust

		Value				
Parameter Name	**Parameter Code**	**Utility Worker**	**Maintenance Worker**	**Industrial Worker**	**Units**	**Rationale/Reference**
Exposed skin surface area*	SA	904	904	452	cm^2	Source: EPA, 2004b. One half the skin surface areas of hands.
Dust-to-skin adherence factor	AF	0.3	0.2	0.2	mg/cm^2	Source: EPA, 2004b
Fraction transferred from surface to skin	FTSS	0.5	0.5	0.5	unitless	Only partial amount of dust present on surface adheres to the skin – based on best professional judgment. (per EPA Region III Wipe Sample Assessment)
Fraction transferred from hands to mouth	FTSM	0.1	0.1	0.1	unitless	10% of dust on the palms is assumed to be ingested during routine activities. (per EPA Region III Wipe Sample Assessment)
Fraction of contaminant absorbed in GI tract	ABS_{GI}	0.95	0.95	0.95	unitless	Source: EPA, 2004b
Dermal absorption factor	ABS_d-Arsenic	0.03	0.03	0.03	unitless	Source: EPA, 2004b
Dermal absorption factor	ABS_d-TRPH**	0.13	0.13	0.13	unitless	Source: EPA, 2004b
Exposure frequency	EF	25	52	250	days/year	Source: EPA, 1991. Based on 5 days per week.
Exposure duration	ED	25	25	25	years	Source: EPA, 1991. Cited as 90th percentile of tenure with a single employer.
Body weight	BW	70	70	70	kg	Source: EPA, 1991. Average adult body weight.
Averaging time	AT	70 or 25	70 or 25	70 or 25	years	Source: EPA, 1989. 70-year averaging time used to calculate *lifetime average daily dose* (LADD) for cancer risk. 25-year averaging time (same as exposure duration) used to calculate *average daily dose* (ADD) for non-cancer effects.

Note: *- The SA is estimated assuming palm and fingers come into contact with dust on the concrete surface on a daily basis.
The skin surface of the hands is 904 cm^2; one-half of this skin surface (the palm and bottom surfaces of the fingers), or 452 cm^2 is assumed to come into contact with dust for an industrial worker.
** - TRPH absorption factors are based on the polycyclic aromatic hydrocarbon (PAH) ABS value.
EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.
GI = gastrointestinal tract

EXHIBIT 2-9

Cancer and Non-cancer Toxicity Factors

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

		Cancer		Noncancer						
Name	**Weight-of-Evidence Class**	**Oral SF kg-day/mg**	**Inhal SF kg-day/mg**	**Oral RfD mg/kg-day**	**Inhal RfD mg/kg-day**	**HI Target Organ**	**% Absorbed ABS_{GI} [1]**	**Oral to Dermal Adjustment Factor (DE)**	**Source(s)**	**Date (MM/DD/YY)**
Arsenic	A	1.5E+00	1.51E+01	3.0E-04	NA	Skin/vascular	95%	100%	IRIS	01/09/2007
TRPH	D	NA	NA	2.00E-01	NA	Liver [2]	100%	100%	TPHCWG	01/09/2007

Notes:

[1] Conversion of toxicity values from oral to dermal is eliminated if ABSGI is > 50%,
EPA, 2004b. Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual.
Part E Supplemental Guidance for Dermal Risk Assessment) Final, Section 4.2.

[2] HI target organ taken from Florida Department of Environmental Protection, FAC 62-777, Technical Report:
Development of Soil Cleanup Target Levels, Feb. 2005, Table C-7, MADEP Fraction - Aliphatics (C19 - C36).

HI = Hazard Index

IRIS = Integrated Risk Information System (EPA online database at: http://www.epa.gov/iris/subst/index.htm)

NA = Not Applicable or Not Available

TPHCWG = EPA Total Petroleum hydrocarbon Criteria Work Group (TPHCWG, 1997)

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

EXHIBIT 2-10
Risk Results Summary for DRMO Building 2009 Area
U.S. Naval Activity Puerto Rico

Receptor	Media	Exposure Route	Cancer Risk	Hazard Index
Future Maintenance Worker	Surface Soil	Ingestion	6.0E-07	0.004
		Inhalation	9.2E-10	NA
		Dermal Contact	1.2E-07	0.001
		Total	**7.2E-07**	**0.0045**
	Concrete Dust	Ingestion	7.0E-08	0.00044
		Dermal Contact	2.2E-08	0.00014
		Total	**9.2E-08**	**0.0006**
		Receptor Total	**8.1E-07**	**0.005**
Future Utility Worker	Surface Soil	Ingestion	9.5E-07	0.006
		Inhalation	4.4E-10	NA
		Dermal Contact	8.6E-08	0.001
		Total	**1.0E-06**	**0.006**
	Concrete Dust	Ingestion	5.1E-08	0.00031
		Dermal Contact	1.6E-08	0.00010
		Total	**6.7E-08**	**0.0004**
		Receptor Total	**1.1E-06**	**0.007**
Future Industrial Worker	Surface Soil	Ingestion	2.9E-06	0.018
		Inhalation	4.4E-09	NA
		Dermal Contact	5.7E-07	0.004
		Total	**3.5E-06**	**0.022**
	Concrete Dust	Ingestion	1.7E-07	0.001
		Dermal Contact	5.3E-08	0.0003
		Total	**2.2E-07**	**0.0014**
		Receptor Total	**3.7E-06**	**0.023**
Future Trespasser (youth)	Surface Soil	Ingestion	1.7E-07	0.003
		Inhalation	8.4E-11	NA
		Dermal Contact	1.3E-07	0.002
		Receptor Total	**3.0E-07**	**0.005**
Future Trespasser (adult)	Surface Soil	Ingestion	3.0E-07	0.002
		Inhalation	1.5E-10	NA
		Dermal Contact	2.1E-07	0.001
		Receptor Total	**5.1E-07**	**0.003**
Future Trespasser (child)	Surface Soil	Ingestion	6.7E-07	0.017
		Inhalation	1.3E-10	NA
		Dermal Contact	1.7E-07	0.004
		Receptor Total	**8.4E-07**	**0.022**

Note:
NA - Not applicable or Not Available

SECTION 3

Summary, Conclusions, and Recommendations

The future land use-related exposure conditions for the Building 2009 area were evaluated for a maintenance worker, industrial worker, utility/construction worker, and trespasser (child, youth, and adult) in accordance with the EPA-approved Site-Specific Risk Assessment Work Plan. The potential exposure to arsenic in surface soil and arsenic and TRPH in concrete floor dust inside Building 2009 did not present risks or HIs above acceptable limits. Therefore, no human exposure concern exists for Building 2009 and the immediate surrounding area because none of the receptor scenarios indicated an unacceptable risk from exposure to surface soil or concrete dust. The risk from exposure to concrete dust is further mitigated by the epoxy coating covering the concrete floor surface in Building 2009.

Therefore, it is recommended that a Closure Certification be submitted to the EPA and EQB indicating that the Building 2009 area has met the requirements of the EPA-approved RCRA Closure Plan for the facility, the requirements of Title 40 Code of Federal Regulations Parts 264.115 and 264 (Subparts G and I), and the requirements of paragraph 25 (Completion of Closure) of the Administrative Order on Consent between the Navy and EPA.

SECTION 4

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APPENDIX A

Analytical Data used in Human Health Risk Assessment

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009ASB1	NRS2009ASB10	NRS2009ASB11	NRS2009ASB2	NRS2009ASB3	NRS2009ASB4	NRS2009ASB5	NRS2009ASB5
	CollectDate	03/03/2005	03/04/2005	03/03/2005	03/04/2005	03/04/2005	03/04/2005	03/04/2005	03/04/2005
	SampleType	N	N	N	N	N	N	FD	N
	SampleID	NRS2009ASB1-R01	NRS2009ASB10-R01	NRS2009ASB11-R01	NRS2009ASB2-R01	NRS2009ASB3-R01	NRS2009ASB4-R01	NRS2009AFD1P-0205	NRS2009ASB5-R01
Parameter	**Units**								
Inorganics									
Arsenic	mg/Kg	2.59	5.28	1.9	4.41	1.05	3.24	3.4	4.02

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009ASB6	NRS2009ASB7	NRS2009ASB8	NRS2009ASB9	NRS2009BSS1	NRS2009BSS10	NRS2009BSS11	NRS2009BSS12	
	CollectDate	03/04/2005	03/04/2005	03/04/2005	03/04/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005	
	SampleType	N	N	N	N	N	N	N	N	
	SampleID	NRS2009ASB6-R01	NRS2009ASB7-R01	NRS2009ASB8-R01	NRS2009ASB9-R01	NRS2009BSS1-R01	NRS2009BSS10-R01	NRS2009BSS11-R01	NRS2009BSS12-R01	
Parameter	**Units**									
Inorganics										
Arsenic	mg/Kg	4.9	5.67	1.06	2.83	4.66	2.16	2.62	4.12	J

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009BSS13		NRS2009BSS14		NRS2009BSS15		NRS2009BSS15		NRS2009BSS16		NRS2009BSS17		NRS2009BSS18		NRS2009BSS2
	CollectDate	03/07/2005		03/07/2005		03/07/2005		03/07/2005		03/07/2005		03/07/2005		03/07/2005		03/07/2005
	SampleType	N		N		FD		N		N		N		N		N
	SampleID	NRS2009BSS13-R01		NRS2009BSS14-R01		NRS2009BFD1P-0205		NRS2009BSS15-R01		NRS2009BSS16-R01		NRS2009BSS17-R01		NRS2009BSS18-R01		NRS2009BSS2-R01
Parameter	**Units**															
Inorganics																
Arsenic	mg/Kg	3.7	J	4.77	J	8.18	J	7.31	J	7.96	J	6.65	J	3.58	J	5.48

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009BSS3	NRS2009BSS4	NRS2009BSS5	NRS2009BSS6	NRS2009BSS7	NRS2009BSS8	NRS2009BSS9	NRS2009SB1
	CollectDate	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/04/2005
	SampleType	N	N	N	N	N	N	N	N
	SampleID	NRS2009BSS3-R01	NRS2009BSS4-R01	NRS2009BSS5-R01	NRS2009BSS6-R01	NRS2009BSS7-R01	NRS2009BSS8-R01	NRS2009BSS9-R01	NRS2009SB1-R01
Parameter	**Units**								
Inorganics									
Arsenic	mg/Kg	4	12.9	3.32	3.3	2.29	1.87	2.38	0.764 J

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009SB10	NRS2009SB11	NRS2009SB12	NRS2009SB13	NRS2009SB13	NRS2009SB14	NRS2009SB2	NRS2009SB3
	CollectDate	03/02/2005	03/02/2005	03/02/2005	03/02/2005	03/02/2005	03/02/2005	03/04/2005	03/03/2005
	SampleType	N	N	N	FD	N	N	N	N
	SampleID	NRS2009SB10-R01	NRS2009SB11-R01	NRS2009SB12-R01	NRS2009FD4P-0205	NRS2009SB13-R01	NRS2009SB14-R01	NRS2009SB2-R01	NRS2009SB3-R01
Parameter	**Units**								
Inorganics									
Arsenic	mg/Kg	1.88	2.66	2.33	2.22	3.73	1.88	0.707 U	0.646 U

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009SB4	NRS2009SB5	NRS2009SB6	NRS2009SB7	NRS2009SB7	NRS2009SB8	NRS2009SB9	NRS2009SS1
	CollectDate	03/02/2005	03/03/2005	03/03/2005	03/03/2005	03/03/2005	03/02/2005	03/02/2005	03/07/2005
	SampleType	N	N	N	FD	N	N	N	N
	SampleID	NRS2009SB4-R01	NRS2009SB5-R01	NRS2009SB6-R01	NRS2009FD3P-0205	NRS2009SB7-R01	NRS2009SB8-R01	NRS2009SB9-R01	NRS2009SS1-R01
Parameter	**Units**								
Inorganics									
Arsenic	mg/Kg	3.82	2.15	4.42	6.01	7.74	1.77	1.6 J	2.64

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-1
DRMO Building 2009 Area Soil Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	NRS2009SS2	NRS2009SS3	NRS2009SS3	NRS2009SS4	NRS2009SS5	NRS2009SS6	NRS2009SS7
	CollectDate	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005	03/07/2005
	SampleType	N	FD	N	N	N	N	N
	SampleID	NRS2009SS2-R01	NRS2009FD2P-0205	NRS2009SS3-R01	NRS2009SS4-R01	NRS2009SS5-R01	NRS2009SS6-R01	NRS2009SS7-R01
Parameter	**Units**							
Inorganics								
Arsenic	mg/Kg	0.568 U	10.6	12.3	7.02	29.8	12.1	4.52

Notes:
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-2
DRMO Building 2009 Concrete Core Sample Results
U.S. Naval Activitiy Puerto Rico

		StationID	NRS2009CC1		NRS2009CC1		NRS2009CC10		NRS2009CC10		NRS2009CC2		NRS2009CC3		NRS2009CC4	
		Date Collected	03/03/2005		03/03/2005		03/03/2005		03/03/2005		03/03/2005		03/03/2005		03/03/2005	
		SampleType	N		FD		N		FD		N		N		N	
Parameter	**Units**	**SampleID**	**NRS2009CC1-R01**		**NRS2009FD8P-0205**		**NRS2009CC10-R01**		**NRS2009FD9P-0205**		**NRS2009CC2-R01**		**NRS2009CC3-R01**		**NRS2009CC4-R01**	
Inorganics																
Arsenic	mg/Kg		4.41E+00	=	1.98E+00	=	9.51E+00	=	1.05E+01	=	2.07E+00	=	1.35E+01	=	3.21E+00	=
Organics - TRPH																
Total Petroleum Hydrocarbons C10-C28 (DRO)	mg/Kg		1.02E+01	=	2.93E+01	=	6.90E+01	=	4.29E+01	=	1.85E+02	=	7.95E+01	=	1.30E+02	=

Notes:
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-2
DRMO Building 2009 Concrete Core Sample Results
U.S. Naval Activitiy Puerto Rico

		StationID	NRS2009CC5		NRS2009CC6		NRS2009CC7		NRS2009CC8		NRS2009CC9	
		Date Collected	03/03/2005		03/03/2005		03/03/2005		03/03/2005		03/03/2005	
		SampleType	N		N		N		N		N	
Parameter	**Units**	**SampleID**	NRS2009CC5-R01		NRS2009CC6-R01		NRS2009CC7-R01		NRS2009CC8-R01		NRS2009CC9-R01	
Inorganics												
Arsenic	mg/Kg		6.34E+00	=	6.10E+00	=	2.04E+00	=	2.22E+00	=	7.55E-01	J
Organics - TRPH												
Total Petroleum Hydrocarbons C10-C28 (DRO)	mg/Kg		2.18E+02	=	2.37E+02	=	3.27E+02	=	2.95E+02	=	1.08E+02	=

Notes:
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-3
DRMO Building 2009 Area Soil Background Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	**9BGSB01** [a]		**9BGSB01**		**9BGSB02** [a]		**9BGSB03** [a]		**9BGSB04** [a]		**9BGSB05** [a]		**NRS2009SS01**		**NRS2009SS02**		**NRS2009SS03**	
	CollectDate	06/26/1999		06/26/1999		06/26/1999		06/26/1999		06/26/1999		06/26/1999		06/07/2006		06/07/2006		06/07/2006	
	SampleType	N		FD		N		N		N		N		N		N		N	
	SampleID	9BGSS01		9BGSS01D		9BGSS02		9BGSS03		9BGSS04		9BGSS05		NRS2009SS01-B1		NRS2009SS02-B1		NRS2009SS03-B1	
Parameter	**Units**																		
Arsenic	MG/KG	2.2	J	0.8	J	2.5	J	2.3	J	2.1	J	0.21	J	2.28	J	2.2	J	2.77	UJ

Notes:

[a] Background sample results for 1999 collection date can be found in *Corrective Measures Study Investigation Report for SWMU 9* (Baker *Environmental, Inc., April 25, 2003).*

Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.

mg/Kg = milligrams per kilogram

J = Estimated concentration

U = Undetected. Not detected above method detection limit.

UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-3
DRMO Building 2009 Area Soil Background Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	**NRS2009SS04**		**NRS2009SS05**		**NRS2009SS06**		**NRS2009SS07**		**NRS2009SS07**		**NRS2009SS08**		**NRS2009SS09**	
	CollectDate	06/07/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006	
	SampleType	N		N		N		FD		N		N		N	
	SampleID	NRS2009SS04-B1		NRS2009SS05-B1		NRS2009SS06-B1		NRS2009FD03-B1		NRS2009SS07-B1		NRS2009SS08-B1		NRS2009SS09-B1	
Parameter	**Units**														
Arsenic	MG/KG	2.62	UJ	0.576	UJ	0.504	UJ	2.48	UJ	2.63	UJ	1.27	J	3.23	J

Notes:
[a] Background sample results for 1999 collection date can be found in *Corrective Measures Study Investigation Report for SWMU 9* (Baker *Environmental, Inc., April 25, 2003).*
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-3
DRMO Building 2009 Area Soil Background Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	**NRS2009SS10**		**NRS2009SS11**		**NRS2009SS12**		**NRS2009SS13**		**NRS2009SS14**		**NRS2009SS15**		**NRS2009SS16**	
	CollectDate	06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006	
	SampleType	N		N		N		N		N		N		N	
	SampleID	NRS2009SS10-B1		NRS2009SS11-B1		NRS2009SS12-B1		NRS2009SS13-B1		NRS2009SS14-B1		NRS2009SS15-B1		NRS2009SS16-B1	
Parameter	**Units**														
Arsenic	MG/KG	1.08	UJ	2	UJ	2.76	UJ	0.097	UJ	0.483	UJ	1.14	UJ	2.37	U

Notes:
[a] Background sample results for 1999 collection date can be found in *Corrective Measures Study Investigation Report for SWMU 9* (Baker *Environmental, Inc., April 25, 2003).*
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-3
DRMO Building 2009 Area Soil Background Sample Results
U.S. Naval Activitiy Puerto Rico

	StationID	**NRS2009SS17**		**NRS2009SS17**		**NRS2009SS18**		**NRS2009SS19**		**NRS2009SS20**		**NRS2009SS21**		**NRS2009SS21**	
	CollectDate	06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006		06/09/2006	
	SampleType	FD		N		N		N		N		FD		N	
	SampleID	NRS2009FD04-B1		NRS2009SS17-B1		NRS2009SS18-B1		NRS2009SS19-B1		NRS2009SS20-B1		NRS2009FD05-B1		NRS2009SS21-B1	
Parameter	**Units**														
Arsenic	MG/KG	5.7	U	4.94	U	5.44	U	5.71	U	1.18	U	3.17	U	3.3	U

Notes:
[a] Background sample results for 1999 collection date can be found in *Corrective Measures Study Investigation Report for SWMU 9* (Baker *Environmental, Inc., April 25, 2003).*
Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-3
DRMO Building 2009 Area Soil Background Sample Results
U.S. Naval Activitiy Puerto Rico

		StationID	**NRS2009SS22**		**NRS2009SS23**		**NRS2009SS24**	
		CollectDate	06/09/2006		06/09/2006		06/09/2006	
		SampleType	N		N		N	
		SampleID	NRS2009SS22-B1		NRS2009SS23-B1		NRS2009SS24-B1	
Parameter	**Units**							
Arsenic	MG/KG		3.33	=	1.2	U	0.104	U

Notes:

[a] Background sample results for 1999 collection date can be found in *Corrective Measures Study Investigation Report for SWMU 9* (Baker *Environmental, Inc., April 25, 2003).*

Field duplicates are included in this table for comparison purposes and are not included in the statistical analysis.

mg/Kg = milligrams per kilogram

J = Estimated concentration

U = Undetected. Not detected above method detection limit.

UJ = Undetected, Reporting Limit Estimated

EXHIBIT A-4
DRMO Building 2009 Concrete Core Background Sample Results
U.S. Naval Activitiy Puerto Rico

		StationID	NRS2009CCB1		NRS2009CCB2		NRS2009CCB3		NRS2009CCB4		NRS2009CCB5	
		Date Collected	02/22/2005		02/22/2005		02/22/2005		02/22/2005		02/22/2005	
		SampleType	N		N		N		N		N	
Parameter	**Units**	**SampleID**	**NRS2009CCB1K-R01**		**NRS2009CCB2K-R01**		**NRS2009CCB3K-R01**		**NRS2009CCB4K-R01**		**NRS2009CCB5K-R01**	
Inorganics												
Arsenic	mg/Kg		1.21E+00	U	3.53E+00	J	5.85E-01	U	4.85E+00	=	9.94E-01	U
Organics - TRPH												
Total Petroleum Hydrocarbons C10-C28 (DRO)	mg/Kg		1.02E+01	=	1.01E+01	=	2.09E+01	=	2.02E+01	=	1.99E+01	=

Notes:
mg/Kg = milligrams per kilogram
J = Estimated concentration
U = Undetected. Not detected above method detection limit.
UJ = Undetected, Reporting Limit Estimated

APPENDIX B

Concrete Dust Background Limit Calculations

EXHIBIT B-1

Concrete Core Sample Background Limit Calculations

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Matrix	Units	Parameter Name	Number Analyzed	Number Detected	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration [1]	STDEV	Background Limit [2]	Regulatory Criteria for Concrete Dust [3]
CD	mg/kg	Arsenic	5	2	5.85E-01 - 1.28E+00	3.53E+00	4.85E+00	1.96E+00	2.10E+00	6.85E+00	1.91E+00
CD	mg/kg	TRPH	5	5	0 - 0	1.01E+01	2.09E+01	1.63E+01	5.59E+00	2.93E+01	1.00E+02

Notes:

[1] For data sets containing nondetected values, mean concentration was calculated using ½ of the minimum detection limit value.

[2] Background Limit is the calculated Upper Tolerance Limit (UTL) for normally distributed data,

$$UTL_{1-\alpha}(x_{0.95}) = \bar{x} + sK_{1-\alpha,0.95}$$

[3] Regulatory criteria for soils were used a surrogate for concrete dust.

RBC values from the April 07, 2005 Region 3 Risk Based Concentrations for industrial soils.

TRPH value derived from Criterion from *Commonwealth Government of Puerto Rico, Office of the Governor,*

Environmental Quality Board, Water Quality Area (November 7, 1990, Amendments 2002)

[4] Rationale Code

Selection Reason:

Above Screening Levels (ASL)

ProUCL, Version 3.00.02 used to determine the mean concentration and standard deviation.

NA = Not Applicable or Not Available

mg/kg = milligrams per kilogram

CD = Concrete Dust (from concrete core samples)

EXHIBIT B-2

Concrete Core Background Limit Calculations

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Site:	NAPR DRMO - Building 2009 Area
Media:	concrete
Units:	mg/kg
Chemical:	arsenic
CASRN:	7440-38-2

STATISTICS	
N	5
Detects	2
FOD	40%
Mean of Detect	4.190
Min of Detect	3.5300
Max of Detect	4.85
Best Estimate of Mean (arithmetic)	2.0
Best Estimate of Mean (geometric)	1.1
Nondetects at 1/2 DL	YES

95% UPPER CONFIDENCE LIMITS FOR MEAN		
UCL95 Normal	4.0	
t-statistic	2.13	
UCL95 Lognormal	103.2	Exceeds Max Detect
H-statistic	6.00	
UCL95 Nonparametric	0	
UCL95 Bootstrap		

95% UPPER TOLERANCE INTERVAL	
UTL95 Normal	6.850218093
coverage	95%
UTL95 Lognormal	20.36029114
coverage	95%
UTL95 Nonparametric	4.85
coverage	83%

DISTRIBUTION TESTING	
Population is best described as:	LOGNORMAL
W_{normal}	0.805
W_{log}	0.868
$W_{\alpha = 0.05}$	0.762

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values.
The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If nondetection is >90%, it is generally impossible to caclulate UTL or UCL with any level of confidence.

EXHIBIT B-3

Concrete Core Background Limit Calculations

U.S. Naval Activity Puerto Rico - DRMO Building 2009 Area

Site:	NAPR DRMO - Building 2009 Area
Media:	concrete
Units:	mg/kg
Chemical:	Total Petroleum Hydrocarbons C10-C28 (DRO)
CASRN:	

STATISTICS		
N	5	
Detects	5	
FOD	100%	
Mean of Detect	16.260	
Min of Detect	10.1000	
Max of Detect	20.90	
Best Estimate of Mean (arithmetic)	20.0	
Best Estimate of Mean (geometric)	15.4	
Nondetects at 1/2 DL	YES	
95% UPPER CONFIDENCE LIMITS FOR MEAN		
UCL95 Normal	21.6	Exceeds Max Detect
t-statistic	2.13	
UCL95 Lognormal	26.2	Exceeds Max Detect
H-statistic	2.40	
UCL95 Nonparametric	0	
UCL95 Bootstrap		
95% UPPER TOLERANCE INTERVAL		
UTL95 Normal	29.314318	
coverage	95%	
UTL95 Lognormal	37.47742508	
coverage	95%	
UTL95 Nonparametric	20.90	
coverage	83%	
DISTRIBUTION TESTING		
Population is best described as:	NONPARAMETRIC	
W_{normal}	0.736	
W_{log}	0.724	
$W_{\alpha = 0.05}$	0.762	

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values.
The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If there is >90% nondetection, it is generally impossible to caclulate a UTL or UCL with any level of confidence.

EXHIBIT B-4
Site: NAPR DRMO - Building 2009 Area
Media: Concrete
Units: mg/kg

Chemical	CASRN	Samples	Detects	NonDetects	FOD	Min Detect	Max Detect	Avg Detect	Mean	Min nondetect	Max nondetect	W-Test	t-Statistic	UCL95 norm	H-statistic	UCL96 log	UCL95 nonparm	UCL95 bootstrap	UTL norm	UTL log	UTL nonparm
arsenic		5	2	3	40%	3.53	4.85	4.19	1.9549	0.2925	0.605	LOGNORMAL	2.132	3.953405	6.001	103.1572	0		6.850218	20.36029	4.85
TRPH		5	5	0	100%	10.1	20.9	16.26	16.26	0	0	NONPARAMETRIC	2.132	21.5894	2.402	26.15852	0	20.00391	29.31432	37.47743	20.9

APPENDIX C

EPA ProUCL Version 3.00.02 Statistical Output

EXHIBIT C-3
EPA ProUCL Version 3.00.02 Output
Summary Statistics - DRMO Building 2009 Area, Concrete
U.S. Naval Activitiy Puerto Rico

Variable name	Units	Number of Observations	Minimum	Maximum	Mean	Median	Sd	CV	Skewness	Variance
Arsenic	(mg/kg)	10	0.76	13.5	5.12	3.81	4.11	0.80	1.15	16.89
TRPH	(mg/kg)	10	29.3	327	167.78	157.5	100.48	0.60	0.27	10097.16

Sd = Standard deviation
CV = Coefficient of Variation

EXHIBIT C-4
EPA ProUCL Version 3.00.02 Output
UCL Calculation - DRMO Building 2009 Area, Concrete
U.S. Naval Activitiy Puerto Rico

Variable: Arsenic (mg/kg)

Raw Statistics	
Number of Valid Samples	10
Number of Unique Samples	10
Minimum	0.76
Maximum	13.5
Mean	5.115
Median	3.81
Standard Deviation	4.109313
Variance	16.88645
Coefficient of Variation	0.803385
Skewness	1.154979

Gamma Statistics	
k hat	1.761818
k star (bias corrected)	1.299939
Theta hat	2.903252
Theta star	3.9348
nu hat	35.23635
nu star	25.99878
Approx.Chi Square Value (.05)	15.3766
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	13.97457

Log-transformed Statistics	
Minimum of log data	-0.274437
Maximum of log data	2.60269
Mean of log data	1.322295
Standard Deviation of log data	0.86988
Variance of log data	0.756692

RECOMMENDATION
Data are normal (0.05)

Use Student's-t UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.875143
Shapiro-Wilk 5% Critical Value	0.842
Data are normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	**7.50**

Gamma Distribution Test	
A-D Test Statistic	0.246043
A-D 5% Critical Value	0.737319
K-S Test Statistic	0.159976
K-S 5% Critical Value	0.270434
Data follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	8.648451
Adjusted Gamma UCL	9.516126

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.967157
Shapiro-Wilk 5% Critical Value	0.842
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	12.48976
95% Chebyshev (MVUE) UCL	11.745
97.5% Chebyshev (MVUE) UCL	14.56736
99% Chebyshev (MVUE) UCL	20.11135

95% Non-parametric UCLs	
CLT UCL	7.252452
Adj-CLT UCL (Adjusted for skewness)	7.759587
Mod-t UCL (Adjusted for skewness)	7.576194
Jackknife UCL	7.497091
Standard Bootstrap UCL	7.132347
Bootstrap-t UCL	8.686487
Hall's Bootstrap UCL	10.01196
Percentile Bootstrap UCL	7.27
BCA Bootstrap UCL	7.489
95% Chebyshev (Mean, Sd) UCL	10.7793
97.5% Chebyshev (Mean, Sd) UCL	13.23024
99% Chebyshev (Mean, Sd) UCL	18.04465

EXHIBIT C-5
EPA ProUCL Version 3.00.02 Output
UCL Calculation - DRMO Building 2009 Area, Concrete
U.S. Naval Activitiy Puerto Rico

Variable: TRPH

Raw Statistics	
Number of Valid Samples	10
Number of Unique Samples	10
Minimum	29.3
Maximum	327
Mean	167.78
Median	157.5
Standard Deviation	100.4846
Variance	10097.16
Coefficient of Variation	0.598907
Skewness	0.27157

Gamma Statistics	
k hat	2.490925
k star (bias corrected)	1.810314
Theta hat	67.35651
Theta star	92.68006
nu hat	49.81849
nu star	36.20628
Approx.Chi Square Value (.05)	23.43254
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	21.66147

Log-transformed Statistics	
Minimum of log data	3.377588
Maximum of log data	5.78996
Mean of log data	4.908696
Standard Deviation of log data	0.756833
Variance of log data	0.572796

RECOMMENDATION
Data are normal (0.05)

Use Student's-t UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.955083
Shapiro-Wilk 5% Critical Value	0.842
Data are normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	**226.0291**

Gamma Distribution Test	
A-D Test Statistic	0.213622
A-D 5% Critical Value	0.733911
K-S Test Statistic	0.143535
K-S 5% Critical Value	0.269142
Data follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	259.2416
Adjusted Gamma UCL	280.4375

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.935887
Shapiro-Wilk 5% Critical Value	0.842
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	350.3558
95% Chebyshev (MVUE) UCL	362.4162
97.5% Chebyshev (MVUE) UCL	443.819
99% Chebyshev (MVUE) UCL	603.7192

95% Non-parametric UCLs	
CLT UCL	220.0469
Adj-CLT UCL (Adjusted for skewness)	222.9627
Mod-t UCL (Adjusted for skewness)	226.4839
Jackknife UCL	226.0291
Standard Bootstrap UCL	218.3993
Bootstrap-t UCL	228.5534
Hall's Bootstrap UCL	219.2684
Percentile Bootstrap UCL	218.18
BCA Bootstrap UCL	219.18
95% Chebyshev (Mean, Sd) UCL	306.2885
97.5% Chebyshev (Mean, Sd) UCL	366.2213
99% Chebyshev (Mean, Sd) UCL	483.9475

EXHIBIT C-1
EPA ProUCL Version 3.00.02 Output
Summary Statistics - DRMO Building 2009 Area, Surface Soil
U.S. Naval Activitiy Puerto Rico

Variable name		NumObs	Minimum	Maximum	Mean	Median	Sd	CV	Skewness	Variance
Arsenic	(mg/kg)	50	0.284	29.8	4.49949	3.45	4.656161	1.03482	3.641606	21.67984

EXHIBIT C-2
EPA ProUCL Version 3.00.02 Output
UCL Calculation - DRMO Building 2009 Area, Surface Soil
U.S. Naval Activitiy Puerto Rico

Variable: Arsenic (mg/kg)

Raw Statistics	
Number of Valid Samples	50
Number of Unique Samples	49
Minimum	0.284
Maximum	29.8
Mean	4.49949
Median	3.45
Standard Deviation	4.656161
Variance	21.67984
Coefficient of Variation	1.03482
Skewness	3.641606

Gamma Statistics	
k hat	1.538739
k star (bias corrected)	1.459748
Theta hat	2.924141
Theta star	3.082374
nu hat	153.8739
nu star	145.9748
Approx.Chi Square Value (.05)	119.0467
Adjusted Level of Significance	0.0452
Adjusted Chi Square Value	118.3261

Log-transformed Statistics	
Minimum of log data	-1.258781
Maximum of log data	3.394508
Mean of log data	1.145096
Standard Deviation of log data	0.895542
Variance of log data	0.801996

RECOMMENDATION
Assuming gamma distribution (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.664358
Shapiro-Wilk 5% Critical Value	0.947
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	5.603466

Gamma Distribution Test	
A-D Test Statistic	0.77427
A-D 5% Critical Value	0.766895
K-S Test Statistic	0.113054
K-S 5% Critical Value	0.127444
Data follow approximate gamma distibution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	**5.517265**
Adjusted Gamma UCL	5.550866

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.951482
Shapiro-Wilk 5% Critical Value	0.947
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	6.224066
95% Chebyshev (MVUE) UCL	7.578783
97.5% Chebyshev (MVUE) UCL	8.849615
99% Chebyshev (MVUE) UCL	11.34592

95% Non-parametric UCLs	
CLT UCL	5.582594
Adj-CLT UCL (Adjusted for skewness)	5.944947
Mod-t UCL (Adjusted for skewness)	5.659986
Jackknife UCL	5.603466
Standard Bootstrap UCL	5.565717
Bootstrap-t UCL	6.170398
Hall's Bootstrap UCL	10.60892
Percentile Bootstrap UCL	5.68938
BCA Bootstrap UCL	5.96362
95% Chebyshev (Mean, Sd) UCL	7.369741
97.5% Chebyshev (Mean, Sd) UCL	8.6117
99% Chebyshev (Mean, Sd) UCL	11.05129

APPENDIX D

Human Health Risk Calculations

DRMO Building 2009 Area Concrete Dust - Hypothetical Future Maintenance Worker Scenario
U.S. Naval Activity Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
IF=	$\frac{C_{dust} * D_{dermal} * FTSM * ABS_{GI} * EF * ED * EV * CF}{BW * AT * 365 \text{ days/year}}$				
C_{dust}	Concentration in Concrete Dust (mg/kg)	EPC		EPC	
D_{dermal} =	Deposited amount on the skin (mg)	90.4	a	90.4	a
FTSM =	Fraction transferred from hands to mouth (unitless)	0.1	b	0.1	b
ABS_{GI} =	Fraction of contaminant absorbed in GI tract (unitless)	0.95	c	0.95	c
EF =	Exposure Frequency (days/year)	52	d,e	52	d,e
ED =	Exposure Duration (years)	25	d,f	25	d,f
EV =	Event Frequency (events/day)	1		1	
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	d,g	70	d,g
AT =	Averaging Time (years)	70	h	25	h

Dermal:					
IF=	$\frac{C_{dust} * SA * AF * ABS_d * FTSS * EF * ED * EV * CF}{BW * AT * 365 \text{ days/year}}$				
C_{dust}	Concentration in Concrete Dust (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	904	i	904	i
AF =	Dust-Skin Adherence Factor (mg/cm^2)	0.2	c	0.2	c
ABS_d =	Dermal absorption factor (unitless)	Chemical Specific		Chemical Specific	
FTSS =	Fraction transferred from surface to skin (unitless)	0.5	j	0.5	j
EF =	Exposure Frequency (days/year)	52	d, e	52	d, e
ED =	Exposure Duration (years)	25	d, f	25	d, f
EV =	Event Frequency (events/day)	1		1	
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	d, g	70	d, g
AT =	Averaging Time (years)	70	h	25	h

References/Comments:

a = Calculated using the equation: D_{dermal} = SA * AF *FTSS, where SA = Surface area (904 cm^2), AF = Dust-Skin Adherence Factor (0.2 mg/cm^2) and FTSS = Fraction transferred from surface to skin (0.5).
b = 10% of dust on the palms is assumed to be ingested during routine activities (per EPA Region III Wipe Sample Assessment)
c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005
d = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
e = Based on 5 days per week.
f = Cited as 90th percentile of tenure with a single employer.
g = Average adult body weight.
h = EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Manual, Part A. OERR. EPA/540/01-89/002.
70-year averaging time used to calculate lifetime average daily dose (LADD) for cancer risk.
25-year averaging time (same as exposure duration) used to calculate average daily dose (ADD) for non-cancer effects.
i = Source: EPA, 2004. One half the skin surface areas of hands.
j = Only partial amount of dust present on surface adheres to the skin - based on best professional judgment (per EPA Region III Wipe Sample Asessment)

GI = gastrointestinal tract

Appendix D
DRMO Building 2009 Area Concrete Dust - Hypothetical Future Maintenance Worker Scenario
U.S. Naval Activity Puerto Rico

									Ingestion		Dermal	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04		7.50E+00	1.0	0.03	1.31E-07	0.0004	4.14E-08	0.00014
MG/KG	TRPH	D	2.00E-01	2.00E-01		2.26E+02	1.0	0.13	3.95E-06	0.00002	5.41E-06	0.00003
	Hazard Index									**0.0004**		**0.00014**
										Total HI=	0.0006	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

Appendix D
DRMO Building 2009 Area Concrete Dust - Hypothetical Future Maintenance Worker Scenario
U.S. Naval Activity Puerto Rico

									Ingestion		Dermal	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**VFind**	**EPC**	**ABSgi**	**ABS_d**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00		7.50E+00	1.0	0.03	4.68E-08	7.02E-08	1.48E-08	2.22E-08
MG/KG	TRPH	D				2.26E+02	1.0	0.13	1.41E-06		1.93E-06	
	Total Risk									**7.02E-08**		**2.22E-08**
											Total Risk =	**9.24E-08**

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Risk

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Maintenance Worker Scenario
U.S. Naval Activitiy Puerto Rico

		Carcinogenic (for optional use)	Noncarcinogenic
Ingestion:			
CDI =	**Cs * IR-S * EF * ED * CF / BW * AT**		
Cs =	Concentration in soil (mg/kg)	EPC	EPC
IR-S =	Ingestion Rate (mg/day)	100 a	100 a
EF =	Exposure Frequency (day/year)	52 b	52 b
ED =	Exposure Duration (year)	25 a	25 a
CF =	Conversion Factor (kg/mg)	1.00E-06	1.00E-06
BW =	Body Weight (kg)	70 a	70 a
AT =	Averaging Time (days)	25550 c	9125 c
Dermal:			
CDI =	**Cs * SA * SSAF * DABS * EF * ED * CF / BW * AT**		
Cs =	Concentration in soil (mg/kg)	EPC	EPC
SA =	Surface Area (cm^2)	3300 d,e	3300 d,e
SSAF =	Soil-Skin Adherence Factor (mg/cm^2)	0.2 d,f	0.2 d,f
DABS =	Absorption Factor (unitless)	(Chemical Specific) d	(Chemical Specific) d
EF =	Exposure Frequency (day/year)	52 b	52 b
ED =	Exposure Duration (year)	25 a	25 a
CF =	Conversion Factor (kg/mg)	1.00E-06	1.00E-06
BW =	Body Weight (kg)	70 a	70 a
AT =	Averaging Time (days)	25550 c	9125 c
Inhalation:			
CDI =	**Cs * (1/PEF + 1/VF) * IN * EF * ED / BW * AT**		
Cs =	Concentration in soil (mg/kg)	RME	RME
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09 g	1.32E+09 g
IN =	Inhalation Rate (m^3/day)	20 a	20 a
EF =	Exposure Frequency (day/year)	52 b	52 b
ED =	Exposure Duration (year)	25 a	25 a
BW =	Body Weight (kg)	70 a	70 a
AT =	Averaging Time (days)	25550 c	9125 c
VF =	Volatilization Factor (VOCs only)	(Chemical Specific) g	ific) g

References/Comments:

a = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Interim Final. OSWER Directive 9285.6-03.
b = Conservative assumption based on potential maintenance activities (e.g., lawn mowing) at the site, 2 days per week for 26 weeks.
c = EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
d = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Ass Final. EPA/540/R/99/005
e = Worker assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed surface area is the face, hands and forearms.
f = SSAF based on maximum adherence factor for utility workers.
g = EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Maintenance Worker Carcinogenic Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**SFi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00	1.51E+01		5.52E+00	1.00E+00	0.03	4.01E-07	6.02E-07	7.94E-08	1.19E-07	6.08E-11	9.18E-10
	Total Risk										**6.02E-07**		**1.19E-07**		**9.18E-10**
												Total Risk =		**7.22E-07**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Exposure

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Maintenance Worker Noncarcinogenic Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**RfDi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04			5.52E+00	1.00E+00	0.03	1.12E-06	0.004	2.22E-07	0.0007	1.70E-10	
	Hazard Index										**0.004**		**0.001**		
													Total HI=	**0.004**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

DRMO Building 2009 Area Concrete Dust - Hypothetical Future Utility Worker Scenario
U.S. Naval Activity Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
IF=	$\frac{C_{dust} * D_{dermal} * FTSM * ABS_{GI} * EF * ED * EV * CF}{BW * AT * 365 \text{ days/year}}$				
C_{dust}	Concentration in Concrete Dust (mg/kg)	EPC		EPC	
D_{dermal} =	Deposited amount on the skin (mg)	135.6	a	135.6	a
FTSM =	Fraction transferred from hands to mouth (unitless)	0.1	b	0.1	b
ABS_{GI} =	Fraction of contaminant absorbed in GI tract (unitless)	0.95	c	0.95	c
EF =	Exposure Frequency (days/year)	25	d,e	25	d,e
ED =	Exposure Duration (years)	25	d,f	25	d,f
EV =	Event Frequency (events/day)	1		1	
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	d,g	70	d,g
AT =	Averaging Time (years)	70	h	25	h

Dermal:					
IF=	$\frac{C_{dust} * SA * AF * ABS_d * FTSS * EF * ED * EV * CF}{BW * AT * 365 \text{ days/year}}$				
C_{dust}	Concentration in Concrete Dust (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	904	i	904	i
AF =	Dust-Skin Adherence Factor (mg/cm^2)	0.3	c	0.3	c
ABS_d =	Dermal absorption factor (unitless)	Chemical Specific	c	Chemical Specific	c
FTSS =	Fraction transferred from surface to skin (unitless)	0.5	j	0.5	j
EF =	Exposure Frequency (days/year)	25	d, e	25	d, e
ED =	Exposure Duration (years)	25	d, f	25	d, f
EV =	Event Frequency (events/day)	1		1	
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	d, g	70	d, g
AT =	Averaging Time (years)	70	h	25	h

References/Comments:

a = Calculated using the equation: D_{dermal} = SA * AF *FTSS, where SA = Surface area (904 cm^2), AF = Dust-Skin Adherence Factor (0.3 mg/cm^2) and FTSS = Fraction transferred from surface to skin (0.5).

b = 10% of dust on the palms is assumed to be ingested during routine activities (per EPA Region III Wipe Sample Assessment)

c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005

d = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

e = Based on 5 days per week.

f = Cited as 90th percentile of tenure with a single employer.

g = Average adult body weight.

h = EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Manual, Part A. OERR. EPA/540/01-89/002.
70-year averaging time used to calculate lifetime average daily dose (LADD) for cancer risk.
25-year averaging time (same as exposure duration) used to calculate average daily dose (ADD) for non-cancer effects.

i = Source: EPA, 2004. One half the skin surface areas of hands.

j = Only partial amount of dust present on surface adheres to the skin - based on best professional judgment (per EPA Region III Wipe Sample Asessment)

Appendix D
DRMO Building 2009 Area Concrete Dust - Hypothetical Future Utility Worker Scenario
U.S. Naval Activity Puerto Rico

									Ingestion		Dermal	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**VFind**	**EPC**	**ABSgi**	**ABS_d**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04		7.50E+00	100%	0.03	9.45E-08	0.0003	2.98E-08	0.0001
MG/KG	TRPH	D	2.00E-01	2.00E-01		2.26E+02	100%	0.13	2.85E-06	0.0000	3.90E-06	0.0000
	Hazard Index									**0.0003**		**0.000099**
										Total HI=	**0.0004**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

Appendix D
DRMO Building 2009 Area Concrete Dust - Hypothetical Future Utility Worker Scenario
U.S. Naval Activity Puerto Rico

									Ingestion		Dermal	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00		7.50E+00	100%	0.03	3.37E-08	5.06E-08	1.07E-08	1.60E-08
MG/KG	TRPH	D				2.26E+02	100%	0.13			1.39E-06	
	Total Risk									**5.06E-08**		**1.60E-08**
											Total Risk =	**6.66E-08**

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Risk

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Utility Worker Scenario
U.S. Naval Activity Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
CDI =	$\frac{Cs * IR\text{-}S * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
IR-S =	Ingestion Rate (mg/day)	330	a	330	a
EF =	Exposure Frequency (day/year)	25	a	25	a
ED =	Exposure Duration (year)	25	a	25	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
Dermal:					
CDI =	$\frac{Cs * SA * SSAF * ABS * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	3300	c,d	3300	c,d
SSAF =	Soil-Skin Adherence Factor (mg/cm^2)	0.3	c,e	0.3	c,e
DABS =	Absorption Factor (unitless)	(Chemical Specific)	c	(Chemical Specific)	c
EF =	Exposure Frequency (day/year)	25	a	25	a
ED =	Exposure Duration (year)	25	a	25	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
Inhalation:					
CDI =	$\frac{Cs * (1/PEF + 1/VF) * IN * EF * ED}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	RME		RME	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	f	1.32E+09	f
IN =	Inhalation Rate (m^3/day)	20	a	20	a
EF =	Exposure Frequency (day/year)	25	a	25	a
ED =	Exposure Duration (year)	25	a	25	a
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
VF =	Volatilization Factor (VOCs only)	(Chemical Specific)	f	;ific)	f

References/Comments:

a = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Interim Final. OSWER Directive 9285.6-03.

b = EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Ass Final. EPA/540/R/99/005

d = Worker assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed surface area is the face, hands and forearms.

e = SSAF based on maximum adherence factor for utility workers.

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Utility Worker Scenario

U.S. Naval Activity Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**SFi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00	1.51E+01		5.52E+00	1.00E+00	0.03	6.36E-07	9.54E-07	5.73E-08	8.59E-08	2.92E-11	4.41E-10
	Total Risk										**9.54E-07**		**8.59E-08**		**4.41E-10**
												Total Risk =		**1.04E-06**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Risk

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Utility Worker Scenario
U.S. Naval Activity Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**RfDi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04			5.52E+00	1.00E+00	0.03	1.78E-06	0.006	1.60E-07	0.0005	8.18E-11	
	Hazard Index										**0.006**		**0.001**		
													Total HI=	**0.006**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

DRMO Building 2009 Area Concrete Dust - Hypothetical Future Industrial Worker Scenario
U.S. Naval Activity Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
IF=	$\frac{C_{dust} * D_{dermal} * FTSM * ABS_{GI} * EF * ED * EV * CF}{BW * AT * 365 \text{ days/year}}$				
C_{dust}	Concentration in Concrete Dust (mg/kg)	EPC		EPC	
D_{dermal} =	Deposited amount on the skin (mg)	45.2	a	45.2	a
FTSM =	Fraction transferred from hands to mouth (unitless)	0.1	b	0.1	b
ABS_{GI} =	Fraction of contaminant absorbed in GI tract (unitless)	0.95	c	0.95	c
EF =	Exposure Frequency (days/year)	250	d,e	250	d,e
ED =	Exposure Duration (years)	25	d,f	25	d,f
EV =	Event Frequency (events/day)	1		1	
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	d,g	70	d,g
AT =	Averaging Time (years)	70	h	25	h

Dermal:					
IF=	$\frac{C_{dust} * SA * AF * ABS_d * FTSS * EF * ED * EV * CF}{BW * AT * 365 \text{ days/year}}$				
C_{dust}	Concentration in Concrete Dust (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	452	i	452	i
AF =	Dust-Skin Adherence Factor (mg/cm^2)	0.2	c	0.2	c
ABS_d =	Dermal absorption factor (unitless)	Chemical Specific	c	Chemical Specific	c
FTSS =	Fraction transferred from surface to skin (unitless)	0.5	j	0.5	j
EF =	Exposure Frequency (days/year)	250	d, e	250	d, e
ED =	Exposure Duration (years)	25	d, f	25	d, f
EV =	Event Frequency (events/day)	1		1	
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	d, g	70	d, g
AT =	Averaging Time (years)	70	h	25	h

References/Comments:

a = Calculated using the equation: D_{dermal} = SA * AF *FTSS, where SA = Surface area (452 cm^2), AF = Dust-Skin Adherence Factor (0.2 mg/cm^2) and FTSS = Fraction transferred from surface to skin (0.5).
b = 10% of dust on the palms is assumed to be ingested during routine activities (per EPA Region III Wipe Sample Assessment)
c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005
d = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
e = Based on 5 days per week.
f = Cited as 90th percentile of tenure with a single employer.
g = Average adult body weight.
h = EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Manual, Part A. OERR. EPA/540/01-89/002.
70-year averaging time used to calculate lifetime average daily dose (LADD) for cancer risk.
25-year averaging time (same as exposure duration) used to calculate average daily dose (ADD) for non-cancer effects.
i = Source: EPA, 2004. One half the skin surface areas of hands.
j = Only partial amount of dust present on surface adheres to the skin - based on best professional judgment (per EPA Region III Wipe Sample Asessment)

Appendix D
DRMO Building 2009 Area Concrete Dust - Hypothetical Future Industrial Worker Scenario
U.S. Naval Activity Puerto Rico

									Ingestion		Dermal	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04		7.50E+00	100%	0.03	3.15E-07	0.0010	9.95E-08	0.0003
MG/KG	TRPH	D	2.00E-01	2.00E-01		2.26E+02	100%	0.13	9.50E-06	0.0000	1.30E-05	0.0001
	Hazard Index									**0.0010**		**0.0003**
										Total HI=	0.0014	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

Appendix D
DRMO Building 2009 Area Concrete Dust - Hypothetical Future Industrial Worker Scenario
U.S. Naval Activity Puerto Rico

									Ingestion		Dermal	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**VFind**	**EPC**	**ABSgi**	**ABS_d**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00		7.50E+00	100%	0.03	1.12E-07	1.69E-07	3.55E-08	5.33E-08
MG/KG	TRPH	D				2.26E+02	100%	0.13	3.39E-06		4.64E-06	
	Total Risk									**1.69E-07**		**5.3E-08**
											Total Risk :	**2.2E-07**

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Risk

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Industrial Worker Scenario
U.S. Naval Activity Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
CDI =	$\frac{Cs * IR\text{-}S * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
IR-S =	Ingestion Rate (mg/day)	100	a	100	a
EF =	Exposure Frequency (day/year)	250	a	250	a
ED =	Exposure Duration (year)	25	a	25	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
Dermal:					
CDI =	$\frac{Cs * SA * SSAF * DABS * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	3300	c,d	3300	c,d
SSAF =	Soil-Skin Adherence Factor (mg/cm^2)	0.2	c,e	0.2	c,e
DABS =	Absorption Factor (unitless)	(Chemical Specific)	c	(Chemical Specific)	c
EF =	Exposure Frequency (day/year)	250	a	250	a
ED =	Exposure Duration (year)	25	a	25	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
Inhalation:					
CDI =	$\frac{Cs * (1/PEF + 1/VF) * IN * EF * ED}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	RME		RME	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	f	1.32E+09	f
IN =	Inhalation Rate (m^3/day)	20	a	20	a
EF =	Exposure Frequency (day/year)	250	a	250	a
ED =	Exposure Duration (year)	25	a	25	a
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
VF =	Volatilization Factor (VOCs only)	(Chemical Specific)	f	;ific)	f

References/Comments:

a = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Interim Final. OSWER Directive 9285.6-03.

b = EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Ass Final. EPA/540/R/99/005

d = Worker assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed surface area is the face, hands and forearms.

e = SSAF based on maximum adherence factor for utility workers.

f = EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Industrial Worker Scenario

U.S. Naval Activity Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**SFi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00	1.51E+01		5.52E+00	1.00E+00	0.03	1.93E-06	2.89E-06	3.82E-07	5.73E-07	2.92E-10	4.41E-09
	Total Risk										**2.89E-06**		**5.73E-07**		**4.41E-09**
												Total Risk =		**3.47E-06**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Risk

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Industrial Worker Scenario

U.S. Naval Activity Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**RfDi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04			5.52E+00	1.00E+00	0.03	5.40E-06	0.018	1.07E-06	0.0036	8.18E-10	
	Hazard Index										**0.018**		**0.004**		
													Total HI=	**0.022**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Adult Scenario
U.S. Naval Activitiy Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
CDI =	**Cs * IR-S * FI * EF * ED * CF / BW * AT**				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
IR-S =	Ingestion Rate (mg/day)	100	a	100	a
FI =	Fraction Ingested (unitless)	0.5		0.5	
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	25	a	25	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
Dermal:					
CDI =	**Cs * SA * SSAF * DABS * EF * ED * CF / BW * AT**				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	5700	c,	5700	c
SSAF =	Soil-Skin Adherence Factor (mg/cm^2)	0.2	c	0.2	c
DABS =	Absorption Factor (unitless)	(Chemical Specific)	c	(Chemical Specific)	c
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	25	a	25	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
Inhalation:					
CDI =	**Cs * (1/PEF + 1/VF) * IN * ET * EF * ED / BW * AT**				
Cs =	Concentration in soil (mg/kg)	RME		RME	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	d	1.32E+09	d
IN =	Inhalation Rate (m^3/hr)	0.83	a	0.83	a
ET =	Exposure Time (4 hours per 24-hour day)	4.000		4.000	
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	25	a	25	a
BW =	Body Weight (kg)	70	a	70	a
AT =	Averaging Time (days)	25550	b	9125	b
VF =	Volatilization Factor (VOCs only)	(Chemical Specific)	d	(Chemical Specific)	d

References/Comments:

a = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Interim Final. OSWER Directive 9285.6-03.
b = EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Ass Final. EPA/540/R/99/005
d = EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Adult Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**SFi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00	1.51E+01		5.52E+00	1.00E+00	0.03	2.01E-07	3.01E-07	1.37E-07	2.06E-07	1.01E-11	1.52E-10
	Total Risk										**3.01E-07**		**2.06E-07**		**1.52E-10**
												Total Risk =		**5.07E-07**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Exposure

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Adult Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**RfDi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04			5.52E+00	1.00E+00	0.03	5.61E-07	0.002	3.84E-07	0.0013	2.82E-11	
	Hazard Index										**0.002**		**0.001**		
													Total HI=	**0.003**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Child Scenario
U.S. Naval Activitiy Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
CDI =	$\frac{Cs * IR\text{-}S * FI * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
IR-S =	Ingestion Rate (mg/day)	200	a	200	a
FI =	Fraction Ingested (unitless)	0.5		0.5	
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	6	a	6	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	15	a	15	a
AT =	Averaging Time (days)	25550	b	2195	b
Dermal:					
CDI =	$\frac{Cs * SA * SSAF * DABS * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	2800	c	2800	c
SSAF =	Soil-Skin Adherence Factor (mg/cm^2)	0.3	c	0.3	c
DABS =	Absorption Factor (unitless)	(Chemical Specific)	c	(Chemical Specific)	c
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	6	a	6	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	15	a	15	a
AT =	Averaging Time (days)	25550	b	2195	b
Inhalation:					
CDI =	$\frac{Cs * (1/PEF + 1/VF) * IN * ET * EF * ED}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	RME		RME	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	d	1.32E+09	d
IN =	Inhalation Rate (m^3/hr)	0.625	a	0.625	a
ET =	Exposure Time (4 hours per 24-hour day)	4.000		4.000	
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	6	a	6	a
BW =	Body Weight (kg)	15	a	15	a
AT =	Averaging Time (days)	25550	b	2195	b
VF =	Volatilization Factor (VOCs only)	(Chemical Specific)	d	(Chemical Specific)	d

References/Comments:

a = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Interim Final. OSWER Directive 9285.6-03.
b = EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Ass Final. EPA/540/R/99/005
d = EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Child Carcinogenic Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**SFi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00	1.51E+01		5.52E+00	1.00E+00	0.03	4.49E-07	6.74E-07	1.13E-07	1.70E-07	8.51E-12	1.28E-10
	Total Risk										**6.74E-07**		**1.70E-07**		**1.28E-10**
												Total Risk =		**8.44E-07**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Exposure

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Child Noncarcinogenic Scenario
U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**RfDi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04			5.52E+00	1.00E+00	0.03	5.23E-06	0.017	1.32E-06	0.0044	9.90E-11	
	Hazard Index										**0.017**		**0.004**		
													Total HI=	**0.022**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Youth Scenario
U.S. Naval Activitiy Puerto Rico

		Carcinogenic (for optional use)		Noncarcinogenic	
Ingestion:					
CDI =	$\frac{Cs * IR\text{-}S * FI * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
IR-S =	Ingestion Rate (mg/day)	100	a	100	a
FI =	Fraction Ingested (unitless)	0.5		0.5	
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	10	a	10	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	51	e	51	e
AT =	Averaging Time (days)	25550	b	3650	b
Dermal:					
CDI =	$\frac{Cs * SA * SSAF * DABS * ET * EF * ED * CF}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	EPC		EPC	
SA =	Surface Area (cm^2)	4400	c	4400	c
SSAF =	Soil-Skin Adherence Factor (mg/cm^2)	0.3	c	0.3	c
DABS =	Absorption Factor (unitless)	(Chemical Specific)	c	(Chemical Specific)	c
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	10	a	10	a
CF =	Conversion Factor (kg/mg)	1.00E-06		1.00E-06	
BW =	Body Weight (kg)	51	e	51	e
AT =	Averaging Time (days)	25550	b	3650	b
Inhalation:					
CDI =	$\frac{Cs * (1/PEF + 1/VF) * IN * ET * EF * ED}{BW * AT}$				
Cs =	Concentration in soil (mg/kg)	RME		RME	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	d	1.32E+09	d
IN =	Inhalation Rate (m^3/hr)	0.83	a	0.83	a
ET =	Exposure Time (4 hours per 24-hour day)	4.000		4.000	
EF =	Exposure Frequency (day/year)	52	a	52	a
ED =	Exposure Duration (year)	10	a	10	a
BW =	Body Weight (kg)	51	e	51	e
AT =	Averaging Time (days)	25550	b	3650	b
VF =	Volatilization Factor (VOCs only)	(Chemical Specific)	d	(Chemical Specific)	d

References/Comments:

a = EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Interim Final. OSWER Directive 9285.6-03.
b = EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
c = EPA, 2004b: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Ass Final. EPA/540/R/99/005
d = EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Youth Carcinogenic Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**SFo**	**SFd**	**SFi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**ELCR**	**CDI**	**ELCR**	**CDI**	**ELCR**
MG/KG	Arsenic	A	1.50E+00	1.50E+00	1.51E+01		5.52E+00	1.00E+00	0.03	1.10E-07	1.65E-07	8.72E-08	1.31E-07	5.54E-12	8.36E-11
	Total Risk										**1.65E-07**		**1.31E-07**		**8.36E-11**
												Total Risk =		**2.96E-07**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; ELCR = Excess Lifetime Cancer Exposure

Appendix D - DRMO Building 2009 Area Surface Soil - Hypothetical Future Trespasser - Youth Noncarcinogenic Scenario

U.S. Naval Activitiy Puerto Rico

										Ingestion		Dermal		Inhalation	
Units	**Chemical**	**WOE**	**RfDo**	**RfDd**	**RfDi**	**VFind**	**EPC**	**ABSgi**	**ABS**	**CDI**	**HQ**	**CDI**	**HQ**	**CDI**	**HQ**
MG/KG	Arsenic	A	3.0E-04	3.00E-04			5.52E+00	1.00E+00	0.03	7.71E-07	0.003	6.10E-07	0.0020	3.88E-11	
	Hazard Index										**0.003**		**0.002**		
													Total HI=	**0.005**	

Notes: WOE = Weight of Evidence; CDI = Chronic Daily Intake; EPC = Exposure Point Concentration; HQ = Hazard Quotient; HI = Hazard Index