Engineering Evaluation/ Cost Analysis Report

Battery 129/NIKE SF-87C (Hawk Hill)
Marin Headlands, CA

DRAFT
August 30, 2021
Prepared by Terraphase Engineering Inc.

Signatories

Submitted By:		
CST Federal Government Lead on behalf of the CST	Signature	Date
Routed Through:		
Park Superintendent	Signature	Date
Regional Environmental Point-of-Contact	Signature	Date
Regional Director	Signature	Date
Ratified By:		
WASO Environmental Compliance and Cleanup Branch Chief	Signature	Date

Table of Contents

Signatories i

Table of Contents ii

List of Figures iii

List of In-Text Tables iii

List of Attached Tables iv

List of Appendices iv

List of Abbreviations and Acronyms v

Executive Summary viii

1. Introduction 1
- 1.1. National Park Service CERCLA Authority 1
- 1.2. EE/CA Purpose and Organizational Structure 2

2. Site Background and Conceptual Site Model 3
- 2.1. Site Description 3
- 2.2. Operational History 4
- 2.3. Historically and Culturally Significant Features 4
- 2.4. Geology and Hydrogeology 5
- 2.5. Site Surface Water 5
- 2.6. Local Climate 6
- 2.7. Sensitive Environments 6
- 2.8. Previous Investigations and Response Actions 8
- 2.9. Current/Future Land Uses 14

3. Risk Assessment 14
- 3.1. Baseline Human Health Risk Assessment 16
- 3.2. Ecological Risk Assessment 42
- 3.3. Development of Preliminary Risk-Based Removal Goals (PRGs) 55

4. Identification and Analysis of Applicable or Relevant and Appropriate Requirements 58
- 4.1. Chemical-Specific ARARs 60
- 4.2. Location-Specific ARARs 65
- 4.3. Action-Specific ARARs 75

5. Removal Action Objectives and Removal Goals 86
- 5.1. Identification of Removal Action Objectives 86
- 5.2. Response Action: Removal Action Goals Selection 86
- 5.3. Determination of Removal Action Scope 88

6. Identification of Removal Action Alternatives 89
- 6.1. Alternative 1: No Action 91

6.2. Alternative 2: Limited Soil Removal and Off-Site Disposal, Residential Use Restriction 91
6.3. Alternative 3: Excavation and Off-Site Disposal 94

7. Comparative Analysis of Removal Action Alternatives 98
7.1. Effectiveness 98
7.2. Implementability 101
7.3. Cost 102
7.4. Summary of the Alternatives Comparative Analysis 104

8. Recommended Removal Action Alternative 105

9. References 106

List of Figures

Figure 1-1: Site Location
Figure 2-1: Site Layout
Figure 2-2: Soil Sampling Locations
Figure 2-3: Scenarios of Potential Human Exposure
Figure 2-4: Scenarios of Potential Ecological Exposure
Figure 3-1: Locations with Potentially Unacceptable Risk – Human Health
Figure 3-2: Locations with Lead in Soil Above Residential Screening Level
Figure 3-3: Outcome of the Simple BERA for Terrestrial Plants and Soil Invertebrates
Figure 6-1: Alternative 2 Estimated Excavation Extents
Figure 6-2: Alternative 3 Estimated Excavation Extents

List of In-Text Tables

Text Table 2-1: Special Species List
Text Table 3-1: Refined Lead Exposure Concentrations by Area of Investigation
Text Table 3-2: Ecological Risk Assessment Summary by Receptor Category and Area of Investigation
Text Table 3-3: Human Health PRGs
Text Table 3-4: Ecological PRGs
Text Table 3-5: Summary of Overall Risk-based PRGs
Text Table 4-1: Chemical-Specific ARARs
Text Table 4-2: Location-Specific ARARs
Text Table 4-3: Action-Specific ARARs
Text Table 5-1: Background Threshold Values
Text Table 5-2: Remedial Goal Selection
Text Table 7-6: Comparison of Alternatives

List of Attached Tables

Table 2-1: Summary of Soil Analytical Results
Table 2-2: Background Soil Sampling Results and Statistics
Table 2-3: Scenarios for Potential Human Exposure
Table 3-1: Chemicals of Potential Concern
Table 3-2: High-End Exposure Factors
Table 3-3: Upper-Bound Background Soil Cumulative Cancer Risks and Noncancer HIs
Table 3-4: Upper-Bound Site-Related Cumulative Soil Cancer Risks and Noncancer HIs
Table 3-5: Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
Table 3-6: Upper-Bound Site-Related Sediment Cumulative Cancer Risks and Noncancer HIs
Table 3-7: Site-Related Sediment Single-Chemical Cancer Risk and Noncancer HQ
Table 3-8: Standing Water Screening Results
Table 3-9: Lead Soil Screening Summary
Table 3-10: Soil Ecological Screening and Baseline Summary
Table 3-11: Standing Water Ecological Summary (Amphibians)
Table 3-12: Sediment Ecological Screening Summary (Amphibians)
Table 3-13: Soil Samples Exceeding Terrestrial Plant and Soil Invertebrate Threshold Values
Table 3-14: Human Health and Ecological Preliminary Risk-Based Removal Goals (PRGs)
Table 6-1: Minimum Excavation and Confirmation Sample Quantities (Alternative 2)
Table 6-2: Minimum Excavation and Confirmation Sample Quantities (Alternative 3)

List of Appendices

Appendix A: Human Health Risk Assesssment Supporting Information
Appendix B: Ecological Risk Assessment Supporting Information
Appendix C: Detailed Cost Estimates

List of Abbreviations and Acronyms

ADD	average daily dose
AOI	Area of Investigation
ARAR	applicable or relevant and appropriate requirements
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
BAFs	bioaccumulation factors
BCY	bank cubic yards
BERA	baseline ecological risk assessment
bgs	below ground surface
BTVs	background threshold levels
CAA	Clean Air Act
CASRN	Chemical Abstracts Service Registry Number
CCB	Contaminants Cleanup Branch
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
CHF	Central Hazardous Materials Fund
CIP	Community Involvement Plan
CO-COMP	Casemate 1 Gun Pit
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
CWA	Clean Water Act
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DNOC	4,6-Dinitro-2-methylphenol
DRO	diesel range organics
DTSC	Department of Toxic Substances Control
ECM	Environmental Compliance Memorandum
EcoSSL	Ecological Soil Screening Level
ED	exposure duration
EE/CA	Engineering Evaluation/Cost Analysis
EF	exposure frequency
EPC	exposure point concentration
ERA	ecological risk
ESL	Environmental Screening Level
ESV	ecological screening value
ET	exposure time
FUDS	Formerly Used Defense Sites
GGNPC	Golden Gate National Parks Conservancy
GGNRA	Golden Gate National Recreation Area
GGRO	Golden Gate Raptor Observatory
HERD	Human and Ecological Risk Division

HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
ICs	institutional controls
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LOAEL	lowest observed adverse effect level
LOEC	lowest observable effect concentration
MCL	Maximum Contaminant Levels
MCLGs	Maximum Contaminant Level Goals
ug/m^3	micrograms per cubic meter
mg	milligrams
mg/kg	milligrams per kilograms
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	no observed adverse effect level
NOEC	no observable effect concentration
NPS	National Park Service
NTCRA	non-time-critical removal action
OSHA	Occupational Safety and Health
PA	Preliminary Assessment
PCBs	polychlorinated biphenyls
PDIST	petroleum distillate
PM_{10}	respirable soil particulates
PPRTV	Provisional Peer Reviewed Toxicity Values
PRG	preliminary removal goal
RAO	remedial action objective
RESNA	RESNA Industries, Inc.
RfC	reference concentration
RfD	reference dose
RGs	removal action goals
RME	reasonable maximum exposure
RRR	Records Research Report
RSL	Regional Screening Level
RWQCB	Regional Water Quality Control Board
S/S	solidification/stabilization
SFs	slope factors
SI	Site Inspection
Site	Hawk Hill
SLERA	screening-level ecological risk assessment
SMCLs	secondary maximum contaminant levels
SVOC	semi-volatile organic compound
TBC	to be considered
TCLP	Toxicity Characteristic Leachate Procedure
TDI	total dietary intake
Terraphase	Terraphase Engineering Inc.
TetraTech	TetraTech, Inc.
TN&A	TN & Associates, Inc.
TPH	total petroleum hydrocarbon

TRVs	toxicity reference values
UCL	upper confidence limit
URFs	unit risk factors
USACE	United States Army Corps of Engineers
USC	United States Code
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
WASO-ECCB	Washington Support Office-Environmental Compliance and Cleanup Branch
Weiss	Weiss Associates
WET	Waste Extraction Test

Executive Summary

This section highlights the key information contained in this Engineering Evaluation/Cost Analysis (EE/CA) Report. The following provides a brief site description, including investigation results and conceptual site model. A summary of the risk assessment, and of applicable or relevant and appropriate requirements (ARARs), is also provided along with the scope and objectives of the removal action. Finally, a summary of the removal action alternatives considered, and the recommended removal action is provided. More information on each topic included in the Executive Summary can be found in the corresponding section in the EE/CA Report.

ES 1. Introduction and Purpose

The Battery 129/NIKE SF-87C (Hawk Hill, the Site) is located within the Marin Headlands and the Golden Gate National Recreation Area (GGNRA). It is owned by the United States and operated/ managed by the National Park Service (NPS), with support from the Golden Gate National Parks Conservancy (GGNPC). The Site is being investigated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The NPS is the lead agency under CERCLA at the Site because the Site is under the jurisdiction, custody, or control of NPS. The GGNPC and NPS retained Terraphase Engineering Inc. (Terraphase) to prepare this EE/CA Report.

This EE/CA has been prepared pursuant to the authorities of Section 104(b) of CERCLA and Section 300.415 (b)(4)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan, commonly called the National Contingency Plan (NCP), which authorizes the NPS to conduct investigations and studies to characterize the nature and extent of contamination at the Site. It also authorizes the NPS to evaluate the need for a response action to any identified contamination in order to protect public health or welfare or the environment.

The EE/CA documents the release, nature, and extent of hazardous substances at the Site and provides a framework for evaluating removal action[1] alternatives. The EE/CA identifies removal action objectives (RAOs) and analyzes the effectiveness, implementability, and cost of removal action alternatives that may be used to satisfy the RAOs.

ES 2. Site Description, Investigation Results, and Conceptual Site Model

Hawk Hill is the highest peak in the Marin Headlands. The Marin Headlands receives approximately 750,000 visitors a year. In 2014, nearly 2,500 youth participated in programs at Hawk Hill. The Site provides a unique opportunity to learn about raptor migration and the history of World War II and the Cold War, with gun pits and casemates for visitors to see and explore. Visitors to Hawk Hill are rewarded

[1] Removal action is a general term for a response action; it does not indicate that material will be removed, though that is one possible action that may be taken.

with access to unique cultural and natural resources and an iconic backdrop of the Golden Gate Bridge, San Francisco, the Marin Headlands, and the California coast.

All NPS-managed lands are considered "sensitive environments", which is defined as "a terrestrial or aquatic resource, fragile natural setting, or other area with unique or highly-valued environmental or cultural features" (USEPA 1991a). The California red-legged frog (*Rana aurora draytonii*) and the mission blue butterfly (*Icaricia icarioides missionensis*) may be affected by a non-time critical removal action[2] and/or the Hawk Hill Visitor Improvement Project.[3] The mission blue butterfly is an important species to the area grasslands.[4] The butterfly depends on three species of lupine to lay its eggs: the preferred, and most common, silver lupine (*Lupinus albifrons*), the summer lupine (*Lupinus formosus*), and the varied lupine (*Lupinus variicolor*). The silver lupine occurs on and around Hawk Hill.

Hawk Hill is also known for its raptor migration in the fall, where as many as 19 different species of raptors may be seen.[5] According to the Golden Gate Raptor Observatory (GGRO) 2018 Season Summary (GGRO 2019), 24,323 raptors were sighted during the 16-week season in 2018 (August 13 through December 2).

The Site is located at Hawk Hill, or what has been referred to as Battery Construction 129, in the Control Area of the San Francisco Defense Area Site 87 (SF-87C). SF-87C was constructed on top of Battery Construction 129 in Fort Barry at Hawk Hill. In 1942, the United States Army Corps of Engineers (USACE) began construction on Battery 129, which consisted of a network of tunnels, casements, and a battery commander's station, that was intended to service two 16-inch guns. Battery 129 was never armed or deployed.

As a result of some of this construction and these operations, releases of hazardous substances, pollutants, or contaminants to the environment (i.e., surface and/or subsurface soil) may have occurred. Sources of these chemicals may have included former fuel oil and waste oil tanks, a former distribution transformer, and construction materials including paint from the historical on-site structures.

Based upon the results of historical environmental sampling conducted at the Site, chemicals of potential concern (COPC) which have been identified in soil include several metals (including arsenic and lead), PCBs[6], diesel range organics (DRO), and 4,6-Dinitro-2-methylphenol (DNOC).

[2] A non-time-critical removal action is being conducted at the Site based on NPS's determination that a planning period of six months or more is available prior to the start of removal activities at the Site because no immediate threat to public health or welfare or the environment is present at the Site. A non-time critical removal action is a general term for a response action that will evaluate information and potential alternatives for cleanup; it does not indicate that material will be removed, though that is one possible action that may be taken.
[3] Personal communication with wildlife specialists from the GGNPC.
[4] https://www.nps.gov/goga/learn/nature/hawk-hill.htm
[5] https://www.parksconservancy.org/parks/hawk-hill
[6] Specifically, Aroclor-1260.

The presence of metals (i.e., lead) and PCBs in surface soil may be related to the degradation of paint on select adjacent structures. With specific regards to PCBs, concentration ranging from non-detect to as high as 35 mg/kg have been identified in paint samples collected from various areas of the Site. This suggests that paint on some structures could be the source of elevated concentrations in surface soil[7]. With regards to DNOC, it has been used as an insecticide, fungicide and herbicide and has been commercially used in the United States for insect control and crop protection. As such, its presence may be associated with such historical activities at this Site. DRO has been identified in an area where a former diesel fuel underground storage tank (UST) was removed. Finally, the presence of arsenic in soil may be associated with naturally occurring concentrations or with limited historical use as an herbicide or insecticide by the Army.

ES 3. Risk Assessment Summary

Human health and ecological risk assessments were performed to evaluate whether there is the potential for unacceptable risk to people and/or plants and animals from exposure to site-related COPCs, and if so, to establish risk-based remediation goals. Both risk assessments follow standard USEPA and California guidance, as well as guidance developed by the NPS. The approach and outcome of the human health risk assessment and ecological risk assessment are summarized in the following subsections.

Human Health

With consideration for current and reasonably expected future land use, the human health risk assessment (HHRA) evaluated potential exposure of park employees, maintenance workers, construction workers, park visitors and out-of-bound visitors to site-related COPCs. Although residential land use is unlikely at the Site, it is not unreasonable. The HHRA included the evaluation of residential exposure because residential land use cannot be ruled out as a potential future use of portions of the Site.

The conclusions of the HHRA are as follows:

- For construction workers, no areas of the Site exhibited soil concentrations that would result in cumulative cancer risk or noncancer hazard index (HI) estimates above the risk management goals.

- For park workers, park residents, and maintenance workers, uncontrolled exposure to COPCs in soil at five areas of the Site could pose unacceptable risk that may warrant response action. Depending on the area, these potentially unacceptable risks were driven by one or more of the following chemicals: arsenic, DNOC and PCBs.

[7] While a former distribution transformer was formerly located on a concrete pad at Building S-781, sampling from this area did not identify elevated concentrations of PCBs.

- Nine areas of the Site also exhibited lead concentrations at levels that would warrant response action.

- For construction workers and maintenance workers, concentrations of COPCs in the sediment would not warrant response action.

- Finally, no chemicals were detected at concentrations in the standing water at levels that would warrant response actions to address potential human health risks.

Ecological

The ecological risk assessment evaluated terrestrial plants, soil invertebrates, birds and mammals, as well as the threatened California red-legged frog and endangered Mission blue butterfly.

For birds and mammals, the risk assessment included information on their home range and therefore potential exposure based on foraging or hunting within a given area. For the California red-legged frog, a review of the literature showed that it depends on a permanent water source, the presence of emergent vegetation, and a shrubby riparian zone for breeding and foraging. Also, based on the outcome of the SLERA, in the absence of conducting a more refined risk evaluation, and in light of current plans for site improvement, it has been determined that the gun pit will be cleaned out and renovated to enhance drainage and thereby eliminate any standing water the frog might use for spawning. .

The outcome of the ecological risk assessment is as follows:

- There are no unacceptable risks to birds and mammals from exposure to Site related COPCs.

- There are no unacceptable risks to soil invertebrates from exposure to Site related COPCs with the exception of zinc in one area.

- For terrestrial plants, unacceptable risks are identified from exposure to soil lead in five areas and soil zinc in one area. In all cases, potential risks are for samples from locations immediately adjacent to either a retaining wall or buildings.

ES 4. Identification and Analysis of Applicable or Relevant and Appropriate Requirements

Before the remedial action objectives and goals were developed, applicable or relevant and appropriate requirements (ARARs) for the Site were considered. ARARs include standards, requirements, criteria, or limitations under federal, or more stringent State environmental law (CERCLA Section 121 (d)(2)(A)). ARARs are typically categorized as chemical-specific, location-specific, or action-specific.

Examples of chemical-specific ARARs considered by NPS to be applicable or relevant and appropriate include the California Code of Regulations, which provides information on the establishment of cleanup goals, and the Federal Occupational Safety and Health Act, which regulates worker health and safety. For this Site, the 2009 California Department of Toxic Substances Control (DTSC) Arsenic Strategies Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals was considered in setting a site-specific soil removal goal for arsenic.

Examples of location-specific ARARs considered by NPS to be applicable or relevant and appropriate to the Site based on its location include the Organic Act which requires the NPS to manage national parks to protect its fundamental purpose, resources, and values, the Federal Endangered Species Act to conserve endangered species and/or critical habitat, the National Historical Preservation Act and Federal Archeological Preservation Act, and a Cooperative Agreement between NPS and GGNPC to implement shared goals for public engagement, resource protection, and visitor enjoyment.

Examples of action-specific ARARs considered by NPS to be applicable or relevant and appropriate include Resource Conservation and Recovery Act (RCRA) – Identification and Listing of Hazardous Waste, Clean Water Act (CWA) Stormwater Requirements requiring implementation of best management practices during construction, California Code of Regulations for general monitoring of areas at which waste has been discharged monitoring of remedial action, and the Clean Air Act (CAA) National Primary and Secondary Ambient Air Quality Standards for the protection of public health.

ES 5. Removal Action Objectives and Preliminary Removal Goals

Removal action objectives (RAOs) define what the removal action goals (RGs) are intended to accomplish. For this Site, the RAOs are as follows:

- Eliminate, or reduce to the extent practicable, levels of DNOC, PCBs (total), arsenic, and lead in soil at select areas where concentrations could pose unacceptable risk to human health via direct human contact.
- Eliminate, or reduce to the extent practicable, levels of lead and zinc in soil at select areas where concentrations could pose unacceptable risk to ecological receptors.
- Eliminate contaminant-related constraints on the full enjoyment and utilization of park resources consistent with NPS mandates.
- Attain all other federal and state ARARs.

RGs were established for this Site based on the ARAR-specific preliminary removal goals (PRGs) described above, preliminary risk-based PRGs, and background concentrations for naturally occurring COPCs.

ES 6. Identification of Removal Action Alternatives

The identified potential remedial technologies and process options were preliminarily screened according to their overall applicability (technical implementability) to soil, the chemicals of concern (COCs), and the site-specific conditions. The purpose of this screening effort was to evaluate the available technologies and process options and to eliminate those not applicable to the Site. The following remedial action alternatives were retained for further evaluation:

Alternative 1: No Action

Consistent with the NCP and CERCLA guidance, a "no action" alternative is considered as a baseline for comparison. Under this alternative, no remedial action, monitoring, or maintenance would be performed. This alternative would not include a mechanism to prevent future exposure to contaminants and would fail to achieve the RAOs for the Site. If no action is taken, lead, arsenic, PCBs, zinc, and DNOC in soil would continue to pose a potential unacceptable risk to human and ecological receptors.

Alternative 2: Limited Soil Removal and Off-Site Disposal, Residential Use Restriction

Alternative 2 would involve limited excavation and off-site disposal of shallow soil to address residual risk for the likely foreseeable future land users (park visitors, park workers, and ecological receptors) but would leave soil in place that poses an unacceptable risk to the future park resident via direct contact. This alternative would rely on a residential land use restriction (a limit on future land use preventing construction of housing) to address the remaining residual risks posed to the future park resident.

Alternative 3: Excavation and Off-Site Disposal

Alternative 3 would involve excavation and off-site disposal of shallow soil from areas where COCs have been detected above RGs. Under this alternative, additional land use restrictions are not anticipated to be required. This alternative would involve excavation of soil to remove soil above the RGs to the extent technically feasible. If the results of sidewall confirmation sampling indicated concentrations above RGs in soil adjacent to the habitat for the mission blue butterfly, excavation would not extend within the habitat area. This is because use of this land for residential or commercial purposes would violate the Endangered Species Act. Implementation of this alternative will not require additional institutional controls.

ES 7. Comparative Analysis of Removal Action Alternatives

Pursuant to the NCP, each alternative described above was analyzed using the following evaluation criteria: effectiveness, implementability, and cost. The effectiveness of each alternative was evaluated by each alternative's protectiveness of human health and the environment; attainment of ARARs; reduction

of toxicity, mobility, or volume through treatment; long-term effectiveness and permanence; and short-term effectiveness. The implementability criterion addressed the technical feasibility of implementing the response (including availability of services and materials), the administrative feasibility, and State and community acceptance. Projected costs were calculated using direct capital costs, indirect capital costs, and annual post-removal site control costs.

ES. 8 Recommended Removal Action Alternative

Alternative 3 is the recommended removal action alternative based on the results of the comparative analysis completed in Section 7, which determined that it is protective of both human health and the environment, complies with the ARARs, is most effective in both short- and long-term durations, is highly technically feasible, is highly administratively feasible, and anticipated to be accepted by both state and community stakeholders.

The final EE/CA is being made available to the public for 30 days to allow for comment on the EE/CA and the Administrative Record supporting this EE/CA. Following receipt and evaluation of public comments, NPS will prepare an Action Memorandum. The Action Memorandum, as the decision document selecting a non-time-critical removal action (NTCRA), summarizes the need for the removal action, identifies the selected action, provides the rationale for the action, and addresses significant comments received from the public, including those received from other jurisdictions (e.g., states, tribes, USEPA).

1. Introduction

The purpose of Section 1 is to describe the National Park Service (NPS) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority and the purpose of the Engineering Evaluation/Cost Analysis (EE/CA) Report.

This EE/CA Report has been prepared to evaluate the nature and extent of contamination at Hawk Hill (the Site; see Figure 1-1), evaluate removal alternatives, and provide the basis for recommending a non-time-critical removal action for the Site located at the Marin Headlands in the state of California. The Site, or Battery Construction 129, is located in the Control Area of the San Francisco Defense Area Site 87 (SF-87C). SF-87C was constructed on top of Battery Construction 129 on Fort Barry at Hawk Hill. In 1942, the United States Army Corps of Engineers (USACE) began construction on Battery 129, a casemated battery, which consisted of a network of tunnels, casements, and a battery commander's station, that was intended to service two 16-inch guns. Battery 129 was never armed or deployed. The Site provides a unique opportunity to learn about raptor migration, and the history of World War II and Cold War, with gun pits and casemates for visitors to explore. Visitors to Hawk Hill are rewarded with access to unique cultural and natural resources and an iconic backdrop of the Golden Gate Bridge, San Francisco, Marin Headlands, and the California coast.

1.1. National Park Service CERCLA Authority

The NPS is authorized under CERCLA, 42 United States Code (USC) Section 9601 et seq., to respond as the lead agency to a release or threatened release of hazardous substances, or a release or threatened release of any pollutant or contaminant that may present an imminent and substantial danger to public health or the environment, on NPS-managed land. Section 104(b) of CERCLA, 42 USC Section 9604(b), authorizes NPS to conduct investigations and other studies to characterize the nature and extent of a release or threat of release, determine if response is necessary to protect public health or welfare or the environment, and evaluate response alternatives. Section 104(a) of CERCLA, 42 USC Section 9604(a), authorizes NPS to select and implement a response action when NPS determines a response is necessary.

CERCLA's implementing regulations, codified in the National Oil and Hazardous Substances Pollution Contingency Plan, commonly called the National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, establishes the framework for responding to such releases and threatened releases. The NCP authorizes and describes two processes for responding to releases: (1) a removal action process and (2) a remedial action process (see NCP Sections 300.400 through 300.440). Based on preliminary investigations at the Site[8], NPS determined that site conditions warranted additional response to address the release or threatened release of hazardous substances and that a non-time-critical removal action is appropriate at the Site as

[8] In completing the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS) at Hawk Hill, the USACE did not investigate or address lead in soil associated with the releases from lead-based paint on structures. Lead is a CERCLA hazardous substance (USEPA 2020a). Because its potential release to the environment at this Site was not previously investigated or addressed during DERP FUDS, it has been investigated and evaluated as part of this EE/CA.

specified in 40 CFR Section 300.415(b). This determination was formalized in an EE/CA Approval Memorandum, signed on September 12, 2019, by the NPS Director of the Pacific West Region and included in the Administrative Record for the Site.

This EE/CA Report was generated in accordance with CERCLA Section 104(b) and the NCP, 40 CFR Section 300.415(b)(4)(i), the U.S. Environmental Protection Agency (USEPA) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA 1993a), and the U.S. Department of the Interior (USDOI) Environmental Compliance Memorandum (ECM) 16-3 (USDOI 2016).

1.2. EE/CA Purpose and Organizational Structure

This EE/CA Report is organized by the following topical headings, which also represent the overall objectives of the EE/CA:

- Characterize the nature and extent of contamination at the Site and conduct risk assessments (Sections 2 and 3)
- Identify applicable or relevant and appropriate requirements (ARARs) (Section 4)
- Develop RAOs and preliminary removal goals (PRGs) (Section 5)
- Identify and analyze potential removal action alternatives (Section 6)
- Conduct a comparative evaluation of the removal action alternatives (Section 7)
- Recommend a removal action alternative (Section 8)

1.2.1. Impact of NPS-Specific Requirements and Policies on EE/CA Development

The NPS has several requirements and policies that must be satisfied when undertaking a response to the release of hazardous substances, or pollutants or contaminants, on NPS-managed land (see NPS 2015), including the NPS Organic Act of 1916 (Organic Act) (54 USC Sections 100101et seq.; 36 CFR Chapter 1, Part 1), which requires that the NPS manages parks to conserve the scenery, natural and historic objects, and wildlife and provide for their enjoyment by such means as will leave them unimpaired for the enjoyment of future generations. In accordance with this mandate, NPS strives to clean up contaminated sites with long-term, comprehensive solutions that do not rely on post-removal site controls to the maximum extent practicable.

This EE/CA Report will be the basis for selecting what is intended to be a final, permanent response action to address human health risk, ecological risk, and ARARs at the Site. Consequently, in accordance with NPS policy this EE/CA Report includes a baseline human

health risk assessment (HHRA), a screening-level ecological risk assessment (SLERA), and a simple baseline ecological risk assessment (BERA).

1.2.2. Park-Specific Considerations during EE/CA Development

Park-specific considerations during the EE/CA development include the Organic Act which requires the NPS to manage national parks to protect its fundamental purpose, resources, and values, the Federal Endangered Species Act to conserve endangered species and/or critical habitat, the National Historical Preservation Act and Federal Archeological Preservation Act, and a Cooperative Agreement between NPS and GGNPC to implement shared goals for public engagement, resource protection, and visitor enjoyment. NPS's enabling legislation, general management plan or foundation document, current and future land use scenarios in the absence of contamination, and natural and cultural resource considerations have been identified and evaluated in assessing how to analyze what is required to satisfy the Organic Act's non-impairment ARAR at the Site. Specifically, the Site supports patches of silver lupine (*Lupinus albifrons*), the host plant for the endangered mission blue butterfly and the protection of this habitat was considered during the EE/CA development. Also, GGNPC and NPS wish to avoid land use restrictions which would limit potential future use of the Site (e.g., for residential purposes).

2. Site Background and Conceptual Site Model

The purpose of Section 2 is to provide information on the extent of contamination and the physical characteristics of the Site, and to present the conceptual site model (CSM) so that the location of contaminant sources and the fate and transport of contamination is understood.

This section includes a summary of relevant site features, operational history, historical sources and releases of contaminants, the specific hazardous substances, pollutants, or contaminants released at the Site, and other factors that could influence the migration of these chemicals such as hydrogeology, hydrology, climate, extent of chemicals in site media, and chemical transport pathways and behavior. All these elements makeup the CSM.

2.1. Site Description

Hawk Hill is the highest peak in the Marin Headlands. The Marin Headlands receives approximately 750,000 visitors a year. In 2014 nearly 2,500 youth participated in programs at Hawk Hill. The Site provides a unique opportunity to learn about raptor migration, and the history of World War II and Cold War, with gun pits and casemates for visitors to see and explore. Visitors to Hawk Hill are rewarded with access to unique cultural and natural resources and an iconic backdrop of the Golden Gate Bridge, San Francisco, the Marin Headlands, and the California coast.

2.2. Operational History

The Site is located at Hawk Hill, or what has been referred to as Battery Construction 129, in the Control Area of the San Francisco Defense Area Site 87 (SF-87C). SF-87C was constructed on top of Battery Construction 129 in Fort Barry at Hawk Hill. In 1942, the United States Army Corps of Engineers (USACE) began construction on Battery 129, which consisted of a network of tunnels, casements, and a battery commander's station, that was intended to service two 16-inch guns. Battery 129 was never armed or deployed. Figure 2-1 provides a general layout of the Site.

As a result of some of this construction and these operations, releases of hazardous substances, pollutants, or contaminants to the environment (i.e., surface and/or subsurface soil) may have occurred. Sources of these chemicals may have included former fuel oil and waste oil tanks, a former distribution transformer, and construction materials including paint from the historical on-site structures.

Finally, during the construction of and/or operation of the Site by the Army, the grade of the Site was modified via typical cut-and-fill construction. Differentiating between soil and fill material (locally sourced) is very difficult at this Site given the lack of construction documents or diagrams and the similarity of the natural soil and fill material in appearance, chemistry, and physical characteristics. In this EE/CA, "soil" is used in the general sense and refers to both natural soil and the fill material which was used on-site.

2.3. Historically and Culturally Significant Features

Hawk Hill is divided, vertically, between a relatively low point, where Conzelman Road arrives, and a high point, the highest along the ridges of the Marin Headlands. In addition to its historical military structures, it is also situated within a natural setting with incredible views of the ocean, the Golden Gate Bridge, and its surrounding landscape. Its military history represents two eras, specifically remnants of World War II and structures established during the Cold War period. Overall, the Site serves as a point from which the overall historical and cultural landscapes that surround the Golden Gate Bridge area can be interpreted and enjoyed (Roth and Hulbert 2008).

To enhance visitor safety, create accessible trails, and improve the overall resource that Hawk Hill provides, the GGNPC and the NPS are currently planning Phase 3 of the Hawk Hill Visitor Improvement Project. Phase 1 of the Improvement Project was completed in 2017, and Phase 2 of the Improvement Project is planned to be implemented in 2021. Phase 3 of the Improvement Project will involve the rehabilitation of the historic military structures, improvements to the sustainability and accessibility of trails, overlooks and seating, expanded educational opportunities through enhanced wayfinding and interpretive materials, and efforts to further protect natural and cultural resources.

2.4. Geology and Hydrogeology

2.4.1. Regional and Local Geology

The area of Hawk Hill is on the boundary of the North American and Pacific plates. This boundary is dominated by the San Andreas Fault, an active transform fault known to cause major earthquakes and rugged terrain. The Site is underlain by the Franciscan Complex. While the San Andreas Fault system is a relatively new geologic feature that extended through the San Francisco Bay area only six to ten million years ago, the Franciscan Complex rocks formed in a subduction zone and range from 80 to 200 million years old. The Franciscan Complex is dominated by highly fractured and disrupted blocks of rock, known as terranes. The divisions between the eight terranes are based on differences in rock types and ages and their metamorphic grade (i.e., degree to which their minerals have been altered by heat and pressure).

Hawk Hill is situated in the Marin Headlands Terrane of the Franciscan Complex. There are several smaller thrust faults within the Marin Headlands Terrane. The Marin Headlands Terrane is dominated by oceanic rocks including basaltic ocean crust, open-ocean chert deposits, and continental-derived sandstone. Fossils indicate that the chert[9] was deposited in the Early Jurassic to Late Cretaceous (100 to 200 million years ago) and the sandstone was deposited between 90 and 100 million years ago.

2.4.2. Hydrogeology

According to the California Department of Water Resources, the Site is not located within a groundwater basin.[10]

2.5. Site Surface Water

Hawk Hill is located within the Arroyo Corte Madera Del Presidio Frontal San Francisco Bay Estuary of the San Francisco Bay subregion of the San Francisco Bay Delta watershed.[11,12] It is approximately 900 feet above mean sea level (ft amsl) with steep declines in topography to the north and south. Surface water from the area is expected to follow topography and flow through riverine habitat (Rodeo Creek) towards the San Francisco Bay and Pacific Ocean, located approximately 0.4 mile south, or towards a stream located approximately 0.5 mile north. This stream flows west towards Rodeo Lagoon, which also discharges to the Pacific Ocean. No wetlands or floodplains are mapped within the site boundaries.[13]

[9] Radiolarian Ribbon chert contains microscopic fossils and represents a cultural and educational resource in the area (https://www.nps.gov/goga/learn/education/upload/Rock%20information%20cards%20TT_small.pdf).
[10] https://gis.water.ca.gov/app/bbat/
[11] https://www.epa.gov/sfbay-delta/about-watershed
[12] https://www.arcgis.com/apps/OnePane/basicviewer/
[13] https://msc.fema.gov/portal/

2.6. Local Climate

The local climate is a warm-summer Mediterranean type climate with mild and moderately wet winters and dry, cool summers.[14] The average annual precipitation is 20 inches. The warmest month is August with an average temperature of 64°F and the coldest month is January with an average temperature of 48°F.[15]

2.7. Sensitive Environments

All NPS-managed lands are considered "sensitive environments", which is defined as "a terrestrial or aquatic resource, fragile natural setting, or other area with unique or highly-valued environmental or cultural features" (USEPA 1991a).

Habitat at the Site is predominantly coastal prairie (coastal grassland) interspersed with areas of coastal scrub and small tree stands[16]. Historically, the grasslands were likely dominated by purple needlegrass (*Nasella pulchra*) with ephemeral non-grass species occupying the spaces between the tussocks. Coastal scrub is typically dominated by coyote brush (*Baccharis pilularis*), California sagebrush (*Artemisia californica*), bush lupine (*Lupinus arboreus*), and poison oak (*Toxicodendron diversilobum*). The Marin Headlands and Fort Baker also support patches of silver bush lupine (*Lupinus albifrons*), the host plant for the endangered mission blue butterfly (*Icaricia icaroides missionensis*) (May & Associates 2009).

According to the California Department of Fish and Wildlife (CDFW) there are several species within the San Francisco North and Point Bonita quadrangles that have either federal or state special status, as summarized below.[17]

[14] https://www.climate.gov/maps-data/primer/how-do-scientists-classify-different-types-climate
[15] https://www.ncdc.noaa.gov/cag/city/time-series/USW00023234/pcp/ann/9/1895-2020?base_prd=true&begbaseyear=1901&endbaseyear=2000
[16] California coastal prairies are considered Environmentally Sensitive Habitat Areas under the California Coastal Act
[17] https://apps.wildlife.ca.gov/bios/?tool=cnddbQuick

Text Table 2-1: Special Species List				
Species Type	**Common Name**	**Federal Status**	**State Status**	**Quadrangle**
Amphibians	California red-legged frog	Threatened	None	SF North, Point Bonita
Birds	California Ridgway's rail	Endangered	Endangered	SF North, Point Bonita
	Northern Spotted Owl	Threatened	Threatened	Point Bonita
Insects	Mission blue butterfly	Endangered	None	SF North, Point Bonita
	Bay checkerspot butterfly	Threatened	None	SF North
	Callippe silverspot butterfly	Endangered	None	SF North
Vascular	Beach layia	Endangered	Endangered	SF North, Point Bonita
	San Francisco lessingia	Endangered	Endangered	SF North
	White-rayed pentachaeta	Endangered	Endangered	SF North, Point Bonita
	Marsh Sandwort	Endangered	Endangered	SF North
	Franciscan manzanita	Endangered	None	SF North
	Presidio manzanita	Endangered	Endangered	SF North
	Marin western flax	Threatened	Threatened	SF North
	Presidio clarkia	Endangered	Endangered	SF North
Note: Given the location of the Site, marine and coastal species are not included.				

Of these listed species, the California red-legged frog (*Rana aurora draytonii*) and the mission blue butterfly may be affected by a non-time critical removal action and/or the Hawk Hill Visitor Improvement Project.[18] The mission blue butterfly is an important species to the area grasslands.[19] The butterfly depends on three species of lupine to lay its eggs: the preferred, and most common, silver lupine (*Lupinus albifrons*), the summer lupine (*Lupinus formosus*), and the varied lupine (*Lupinus varricolor*). The lupines grow scattered among fields of coastal prairie and scrub. While the butterfly can travel up to 50 meters between lupine patches, its movement is impaired by barriers such as roads, trails, and dense strands of trees. The GGNPC and the NPS completed habitat restoration activities in the winter of 2011 and 2012 that included the removal of non-native Monterey pine (*Pinus radiata*) and cypress trees (*Cupressus macrocarpa*) and the replanting of native vegetation. These activities helped the butterfly populations on either side of the ridge merge and follow the natural shifts in lupines across the landscape (Coast Ride Ecology 2018).[20]

Although it is unlikely that the Site provides suitable breeding and foraging habitat for the California red-legged frog (see Appendix B, Attachment 2), it has been observed in the remaining gun pit when it was filled with water.[21]

Lastly, it is noted that Hawk Hill is known for its raptor migration in the fall, where as many as 19 different species of raptors may be seen.[22] According to the Golden Gate Raptor Observatory (GGRO) 2018 Season Summary (GGRO 2019), 24,323 raptors were sighted during the 16-week season in 2018 (August 13 through December 2).

[18] Personal communication with wildlife specialists from the GGNPC
[19] https://www.nps.gov/goga/learn/nature/hawk-hill.htm
[20] Appendix B, Attachment 1 includes more details regarding the life cycle of the butterfly.
[21] Personal communication with wildlife specialist from the GGNPC.
[22] https://www.parksconservancy.org/parks/hawk-hill

2.8. Previous Investigations and Response Actions

Both the NPS and the USACE have conducted site characterization activities at this and adjacent Administrative Units. The USACE investigated the Site and nearby areas via a Records Research Report (RRR), which functions as the CERCLA Preliminary Assessment (PA) and then the Site Inspection (SI) was undertaken. Sites identified by the NPS are called 'Sites', and previously Administrative Units whereas USACE nomenclature is Area of Investigation (AOI). The following provides summaries of the characterization activities performed by both USACE and NPS at Hawk Hill. Data collected during these investigation activities is summarized in Table 2-1, while Figure 2-2 presents the sampling locations.

2.8.1. USACE Investigation Activities

The USACE investigation activities involved several AOIs. Summaries of the investigation activities completed in each AOI are provided in this section.

2.8.1.1. *Fuel Oil Storage Tank at Building S-785 (Fort Cronkhite AOI 4)*

According to the Fort Cronkhite SI (TetraTech 2009c), former building S-785 had been identified as a 275-gallon steel fuel oil storage tank on a map of the facility and building inventory. The Fort Cronkhite RRR (TetraTech 2009b) could not determine whether this tank was an aboveground storage tank (AST) or underground storage tank (UST).

In 2009, exploratory excavations to depths of up to 2 feet below ground surface (bgs) were performed by TetraTech, Inc. (TetraTech) on all four sides of the 8-foot by 9-foot concrete pad that remains at the site of Building S-785. One 2-inch diameter pipe was identified protruding from the eastern end of the concrete pad. TetraTech traced and excavated around this pipe and determined that it terminated at the end of the pad and appeared to be an electrical conduit. No evidence suggesting the presence of a UST, including vent or return lines, was identified and no visual evidence of contamination was observed. As such, no sampling was completed. Based upon these results, the Fort Cronkhite RRR and SI (TetraTech 2009c) recommended no further action for the area.

The location of this area is shown on Figure 2-1. The sampling locations and results in this area are shown on Figure 2-2 and Attached Table 2-1, respectively.

2.8.1.2. *5,000-Gallon Fuel Oil UST at Building S-789 (Fort Cronkhite AOI 5)*

A 5,000-gallon fuel oil UST (a/k/a UST 061 or Tank F-9) was located at the former Nike SF-87C. According to the Fort Cronkhite SI (TetraTech 2009c), this tank was removed by RESNA Industries, Inc. (RESNA) in 1992. Soil samples collected by RESNA between 12 and 15 feet bgs identified diesel range total petroleum hydrocarbon (TPH_{dro}) concentrations up to 1,600 mg/kg.

In 2003, TN & Associates, Inc. (TN&A) installed eight soil borings and collected soil samples between 9 and 29 feet bgs to further characterize the area. Elevated TPH_{dro} concentrations were identified between 10 and 20 feet bgs, with a maximum concentration of 4,100 mg/kg at 20 feet bgs. According to the Fort Cronkhite SI (TetraTech 2009c), the elevated concentrations of TPH_{dro} were only identified directly below the former UST location.

In 2009, TetraTech installed an additional soil boring in the vicinity of the former UST to assess whether elevated TPH_{dro} concentrations still existed. One soil sample was collected at 25 feet bgs. The reported TPH_{dro} concentration was 1,400 mg/kg. TetraTech proposed no further action.

NPS did not agree with the TetraTech/USACE conclusion that this area required no further investigation. Specifically, the NPS disagreed than an industrial land use scenario was appropriate given that the Site is a heavily visited recreation area. Furthermore, according to the Fort Cronkhite SI, the TPH_{dro} concentrations were compared to the San Francisco RWQCB ESL for Gross Contamination which at the time was 5,000 mg/kg. The current San Francisco RWQCB ESL for Gross Contamination is 2,300 mg/kg. Nevertheless, in correspondence dated March 13, 2012, the Department of Toxic Substances Control (DTSC) concurred with the findings of the Fort Cronkhite RRR and SI that no further investigation or remediation is needed. The NPS maintains that the USACE is responsible for conducting a proper risk assessment.

Overall, as shown on Attached Table 2-1, the reported TPH_{dro} concentrations were greater than USEPA's current Regional Screening Level (RSL) for residential exposure to soil for TPH (aliphatic medium) of 96 mg/kg. They were also greater than the current San Francisco Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential contact with soil of 260 mg/kg. Also, while ESVs for TPH have not been identified by the NPS Contaminants Cleanup Branch (CCB) for use in support of SLERAs at NPS sites (NPS 2018), the RWQCB Terrestrial Habitat Screening Level for TPH_{dro} is also 260 mg/kg.

The location of this area is shown on Figure 2-1. The sampling locations and results in this area are shown on Figure 2-2 and Attached Table 2-1, respectively.

2.8.1.3. *Former Distribution Transformer at Building S-781 (Fort Cronkhite AOI 13)*

According to the Fort Cronkhite SI (TetraTech 2009c), a distribution transformer was formerly located on a concrete pad at Building S-781. The transformer was removed at an unknown date. During the SI, no staining was observed on the concrete pad. TetraTech collected one wipe sample of the concrete pad surface and four surface soil samples adjacent to the pad. Each sample was analyzed for polychlorinated biphenyls (PCBs).

PCBs were not detected in the wipe sample and only Aroclor-1260 was detected in the surface soil samples. The maximum detected Aroclor-1260 soil concentration was 0.066 mg/kg which

is below the current USEPA RSL for residential soil exposure of 0.24 mg/kg and the NPS Screening Level Ecological Risk Assessment (SLERA) Chemicals of Potential Ecological Concern (COPEC) Selection Ecological Screening Value (ESV) of 0.88 mg/kg. This concentration is also below the current San Francisco RWQCB ESL for residential contact with soil of 0.23 mg/kg.

The location of this area is shown on Figure 2-1. The sampling locations and results in this area are shown on Figure 2-2 and Attached Table 2-1, respectively.

2.8.1.4. *Suspected Fuel and Waste Oil Tanks at Battery*

The construction plan for Battery 129 (dated 1942) depicted two fuel oil tanks along Conzelman Road. In addition, the 1943 Power Room Space Arrangement for Battery 129 depicted two additional 150-gallon fuel oil day tanks, one waste oil tank and three diesel generators inside the power room. The extent of construction at Battery 129 has not been determined, as the NPS typically only has access to USACE designs and plans, not as-built drawings. According to a draft version of the Fort Barry RRR (TetraTech 2009a), these features were either never installed, or if installed, were removed by the U.S. Army before the Site was transferred to the NPS.

The locations of these possible former tank locations and power room are shown on Figure 2-1. The sampling locations and results in this area are shown on Figure 2-2 and Attached Table 2-1, respectively.

2.8.1.5. *Other Historic Structures*

According to a 1943 site plan, two fuel tanks (Fuel Tank 1 and Fuel Tank 2), a septic tank with associated sludge disposal box, and drain lines were noted at the Site. The USACE and TetraTech completed a Trip Report dated March 27, 2014, to document inspection activities completed at two concrete vaults suspected of containing the above noted fuel tanks. The tanks were approximately 9 feet in diameter by 16 feet long (approximately 8,000 gallons). Both tanks were observed to be in good condition, empty and disconnected from the piping that entered the vaults. Rainwater was observed in each vault. According to the USACE, no signs of oil sheen or “odors of fuel” were detected and the USACE collected no samples. According to available records, the septic tank and associated features identified on the 1943 site plan have not been investigated.

2.8.2. National Park Service Investigation

The NPS identified the Site first via the PA developed by Kleinfelder and ASTS in March 2008 (Kleinfelder 2008). The conclusions of the PA concurred with the USACE RRR and SI which indicated that the Site required further investigation, though the USACE subsequently determined that no Department of Defense (DoD) action was warranted.

In addition to the AOIs identified by the USACE, the NPS conducted additional sampling to preliminarily assess soil and sediment quality in certain areas of the Site. Select building materials testing/sampling and biological assessments were also conducted. Summaries of these activities are provided in this section.

2.8.2.1. *Sediment at Casemate 1 Gun Pit*

On September 4, 2013, Treadwell and Rollo collected one four-point composite sample of sediment deposited within the Casemate 1 Gun Pit (CO-COMP). The sample was analyzed for TPH, pesticides and metals. Arsenic (4.0 mg/kg) was identified at a concentration greater than USEPA's current RSL for residential exposure to soil. Arsenic, lead (170 mg/kg) and vanadium (63 mg/kg) were also detected at concentrations above the current San Francisco RWQCB Tier 1 ESLs[23] of 0.067 mg/kg, 32 mg/kg, and 18 mg/kg, respectively. Pesticides were not detected above the laboratory reporting limits. In addition, the above referenced metals were also identified at concentrations exceeding the NPS SLERA COPEC Selection ESVs.

2.8.2.2. *Building Material and Additional Soil Characterization Activities*

Weiss Associates (Weiss) prepared a Hazardous Materials Assessment Report (March 2019a) and Site Management Plan (May 2019b) that summarized sampling and testing of building materials and some additional soil sampling that was performed in 2012, 2013, and 2018. Weiss' report and plan were prepared in anticipation of future earthwork and construction at the Site. Overall, Weiss noted:

1. The presence of asbestos in some materials used to construct on-site structures,
2. The presence of lead and PCBs in paint on select structures and elevated lead concentrations in soil adjacent to these structures,
3. Treated lumber with elevated metals concentrations (retaining structures near Casement 1 Gun Pit),
4. Elevated metals, PCBs, and herbicide concentrations in surface soil near a stormwater outfall (DO-1), and
5. Elevated metal concentrations in sediment inside the Casement 1 Gun Pit.

In 2020, Terraphase performed additional sampling for PCBs in soil adjacent to structures. Overall, 10 surface soil samples were collected and submitted for analysis. Concentrations in surface soil ranged from non-detect to 1.6 mg/kg. The overall average surface soil concentration was approximately 0.2 mg/kg. Only 1 location exhibited a surface soil concentration for PCBs (total) that was greater than 1 mg/kg (i.e., DO-1) which was collected near the stormwater outfall where detectable levels of PCBs were originally identified.

[23] https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/esl.html.

2.8.2.3. *Ecological Assessments*

Several biological assessments have been completed at the Marin Headlands as part of road and trail construction planning. Most importantly, as discussed in Section 2.8, the Site represents an important habitat for the mission blue butterfly, a species listed as endangered and protected under the Endangered Species Act of 1973. The butterfly requires certain host plants for survival, including the silver lupine (*Lupinus albifrons*), which is found throughout the Site. A non-native tree removal project was completed in 2012 to protect and expand mission blue butterfly habitat. The non-native tree removal had some impacts to the avian community composition and abundance.

2.8.3. Previous Cleanup Actions

To date there have been no actions to control or treat site-related contaminants from the previous environmental investigations.

2.8.4. Chemicals of Potential Concern (COPC)

As discussed in more detail in Section 3.1.1, based upon the results of historical environmental sampling conducted at the Site, chemicals of potential concern (COPC) which have been identified in soil include several metals (including arsenic and lead), PCBs[24], diesel range organics (DRO), and 4,6-Dinitro-2-methylphenol (DNOC).

The presence of metals (i.e., lead) and PCBs in surface soil may be related to the degradation of paint on select adjacent structures. With specific regards to PCBs, elevated concentrations as high as 110 mg/kg were identified in yellow building paint found on a concrete curb opposite Radar Pad 2, a concrete box near the Battery Commander Station, and a concrete box near Radar Pad 1 (Weiss 2019a) and as such are the likely source of elevated concentrations in surface soil[25]. With regards to DNOC, it has been used as an insecticide, fungicide and herbicide and has been commercially used in the United States for insect control and crop protection. As such, its presence may be associated with such historical activities at this Site. DRO has been identified in an area where a former diesel fuel UST was removed. Finally, the presence of arsenic in soil may be associated with naturally occurring concentrations or with limited historical use as an herbicide or insecticide by the Army.

Example of yellow building paint with PCBs (painted box near BCS)

[24] Specifically, Aroclor-1260.
[25] While a former distribution transformer was formerly located on a concrete pad at Building S-781, sampling from this area did not identify elevated concentrations of PCBs.

2.8.5. Chemical and Physical Properties of COPC

Section 3.1.2.4 presents the chemical and physical properties of the COPC which have been used to perform conservative fate and transport modeling in support of the EE/CA.

2.8.6. Naturally Occurring Metals Concentrations

This EE/CA has relied on studies performed to assess and quantify naturally occurring concentrations of metals in the area of the Site. These studies are discussed in Erler & Kalinowski, Inc.'s (2002) *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water*. This source detailed and tabulated the results of background soil sampling conducted in the area, including of chert/shale material consistent with the soil present at Hawk Hill.

Background soil sampling results have been used in this EE/CA for two purposes.

1. For the ecological risk assessment, background soil sampling results have been used to characterize the range of naturally occurring concentrations and assess whether the levels observed in soil at Hawk Hill are within this range (i.e., not site-related). More specifically, in determining whether a metal could be site-related, and not naturally occurring, maximum detected concentrations in soil in each AOI were compared to the background threshold levels (BTVs) calculated and presented on Table 6-4 of Erler & Kalinowski, Inc.'s (2002) report. Metals detected at concentrations below these BTVs were treated in this EE/CA as naturally occurring.

2. For the human health risk assessment, background soil sampling results have been used to estimate background risks from exposures to naturally occurring metals concentrations in soil, thereby allowing the risk assessment to quantify background exposure concentrations and distinguish site-related risks from risks associated with naturally occurring concentrations, per USEPA risk assessment guidance (USEPA 2002).

Attached Table 2-2 presents the background soil sampling results, exposure concentrations, and BTVs used for each metal.

2.8.7. Physical Site Characteristics Affecting Contaminant Migration

In general, COPC source areas are either vegetated or covered. Plant roots, leaf litter, and other surfacing materials also reduce the risks of soil migration via erosion or aeolian transport. Overall, the migration of COPCs in soil is not considered significant. Potentially complete pathways of exposure for human and ecological receptors are shown on Figures 2-3 and 2-4, respectively. Attached Table 2-3 also provides a tabulated summary of the scenarios for potential human exposure. The potential significance of exposure of human and ecological receptors to COPCs in soil at the Site are evaluated in Sections 3.1 and 3.2, respectively.

2.8.8. Site-Specific Contaminant Transport

As discussed in Section 2.8.4, COPCs identified in soil include several metals, PCBs, DRO and DNOC. The presence of metals and PCBs in surface soil may be related to the degradation of paint on select adjacent structures. A former fuel oil storage tank was also removed from the Site, which may be the source of DRO in soil in one area of the Site. DNOC has been used as an insecticide, fungicide and herbicide and has been commercially used in the United States for insect control and crop protection. As such, its presence may be associated with such historical activities at this Site.

Routes of COPC transport from these sources may include stormwater runoff[26] and leaching and infiltration[27]. COPCs may also have some potential to be present in outdoor air due to volatilization from soil or due to windblown emission of respirable particulates.

2.9. Current/Future Land Uses

Hawk Hill is operated as a recreational site, located within the Golden Gate National Recreation Area (GGNRA) in the Marin Headlands. Hawk Hill is accessible to the public where visitors come to learn about raptor migration, World War II and Cold War history, explore the gun pits and casemates, and participate in volunteer programs, environmental education programs, and military history tours.

Hawk Hill will continue to be operated as a recreational site open to visitors, with plans to renovate and improve accessibility to the public while keeping site resources unimpaired for the enjoyment of future generations. Currently, the GGNPC and the NPS are planning Phase 3 of the Hawk Hill Visitor Improvement Project, which will involve the rehabilitation of the historic military structures, including the SF-87C Target Tracking Radar Platforms, improve sustainability and accessibility of overlooks and seating, expand educational opportunities through enhanced wayfinding and interpretive materials, and protect natural and cultural resources.

3. Risk Assessment

Section 3 provides the details of the baseline human health (HHRA) and ecological risk (ERA) assessments performed to evaluate the risks that are attributable to releases of hazardous substances, pollutants, or contaminants at the Site. The results of these risk assessments are used to determine if potential risks are unacceptable and, if so, to establish remedial goals that must be satisfied by the recommended removal action. EE/CA guidance (USEPA 1993a) discusses the use of streamlined risk evaluations for an EE/CA when used for interim response actions. However, when the EE/CA is the basis for selecting a final response action, streamlined risk evaluations are not sufficient. Instead, an HHRA and

[26] Treadwell and Rollo (2012) identified concentrations of metals in the northern most drain outfall which may indicate contaminant transport through stormwater runoff, potentially related to the release of metals through flaking of paint from structures.

[27] TetraTech (2009c) identified levels of DRO in samples at 9 ft bgs in an area of a former fuel oil storage tank likely due to leaching.

a SLERA are developed for the Site (USDOI 2016). A BERA (or simple-BERA) may be required if the SLERA identifies the need to refine the ecological risk assessment with site-specific or receptor-specific information. In accordance with risk assessment guidance, a baseline risk assessment evaluates potential adverse effects caused by exposure of current/future receptors to site-related COPCs in environmental media in the absence of any actions to control or mitigate these exposures (i.e., under an assumption of no action).

Data evaluated in the following baseline HHRA and ERA included the results of historical environmental sampling conducted at the Site as described in Section 2.8. While these investigations included the sampling of building materials, the HHRA and ERA only evaluate the potential significance of COPCs in soil, as well as sediment and standing water in the gun pit of Casemate 1. The HHRA and ERA also included additional data for PCBs in soil samples collected from the Site by Terraphase in November 2020, and for arsenic in soil samples collected in February 2021.

The following procedures were used to prepare the sampling data to support quantitative risk assessment. These procedures, which are based upon USEPA guidance (USEPA 1989), are as follows:

- Chemical concentrations qualified as not detected (i.e., U or UJ-qualified) by the laboratory are evaluated as non-detects.

- Chemical concentrations qualified as being possibly associated with blank contamination (i.e., B-qualified) by the laboratory are conservatively included in the risk assessment.

- Concentrations qualified as estimated (i.e., J qualified data) by the laboratory are included for quantitative assessment.

- Concentrations in duplicate field samples are averaged to obtain a representative concentration for the sample. When a chemical was detected in only one sample of a duplicate pair, the average of the detected concentration and one-half the quantitation limit is used in further calculations.

- The concentrations of 1,3-dichloropropene (total) and xylenes (total) are the sums of the concentrations of the isomers that were detected and half the quantitation limits of the isomers that were not detected in the same sample but were detected in the same matrix at the Site. If no isomer was detected in a sample, the chemical is considered to be not detected in the sample.

- PCBs (total) are the measured concentrations for Aroclor-1260, which was the only Aroclor detected in samples at the Site.

- Composite soil samples that were collected from locations where discrete sampling was performed are not included in the quantitative risk assessment.

- Samples collected in AOI 05 (Former 5,000-gallon Fuel Oil UST) in 2003 recharacterized current COPC concentrations in the former location of a UST (TetraTech 2009c). Therefore, data collected previously in this AOI (1992-1993) are not included in the risk assessments. Also, the sampling performed in AOI 05 to characterize the area of the former UST was biased towards sampling depths expected to exhibit the most significant soil concentrations in the area (no shallower than 8 feet bgs). The depth of the former UST was no shallower than 3 feet bgs. As such, subsurface soil sampling results from AOI 5 are not included in the ERA due to a lack of a complete exposure pathway to ecological receptors.

- To distinguish background risks from site-related risks, concentrations of metals in soil at or below the site-specific background exposure concentrations[28], summarized on Attached Table 2-2 (and discussed in Section 2.8.6), are considered to pose background risks and zero site-related risks to human receptors. Metal concentrations in soil in excess of the site-specific background exposure concentrations are considered to pose potential site-related risks to human receptors.

3.1. Baseline Human Health Risk Assessment

This section discusses the methodology and results of the baseline HHRA. The HHRA evaluates potential human health risks that are attributable to releases of COPCs at the Site. The potential risks are characterized based upon the reasonable maximum exposure (RME), or a conservative estimate of the RME, under the current and reasonably expected future land uses at and around the Site. The methods used in the baseline HHRA are based upon USEPA and California EPA human health risk assessment guidance. The results of the HHRA have been used to identify where a release of hazardous chemicals from the Site may cause the RME to be significant enough to warrant response action.

The scope of the HHRA is summarized in the CSM discussed in Section 2, illustrated on Figure 2-3, outlined on Attached Table 2-3. The CSM includes a description of the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Site in terms of potentially exposed populations, the environmental media to which they could be exposed, and the potential routes of exposure. The scenarios for potential human exposure are future discussed in Section 3.1.2.1.

This HHRA is organized as follows:

- The selection of COPCs used in the HHRA is discussed in Section 3.1.1 – Selection of Chemicals of Potential Concern.

[28] The exposure concentrations for naturally occurring metals concentrations were calculated in accordance with USEPA guidance.

- The scenarios for potential human exposure are discussed in Section 3.1.2 – Exposure Assessment, which also discusses the estimation of exposure concentrations and chemical intakes for each exposure scenario.

- Toxicity values for the chemicals evaluated in the HHRA are summarized in Section 3.1.3 – Toxicity Assessment.

- The risk estimates associated with the potential exposures and their significance are discussed in Section 3.1.4 – Risk Characterization.

- Uncertainties associated with the risk estimates are discussed in Section 3.1.5 – Uncertainty.

Supporting information is provided in Appendix A.

3.1.1. Selection of Chemicals of Potential Concern

While risk assessment guidance (USEPA 1989) includes an optional step for shortening the list of chemicals included in quantitative risk assessments, in performing this HHRA, any chemical detected in soil, sediment or standing water at the Site was considered a COPC. This approach is more conservative and often more efficient than developing justification for using a shorter list of COPCs. Attached Table 3-1 lists the COPCs that were included in this HHRA.

3.1.2. Exposure Assessment

The potential exposures that are relevant under current and reasonably expected future land uses at and around the Site are discussed in this Section. These exposures are described in terms of potentially exposed populations and exposure pathways in Section 3.1.2.1.

The potential exposures via ingestion and dermal contact are quantified in terms of a dose as follows:

$$Dose = Concentration \times Intake$$

The dose for evaluating cancer risk is averaged over a lifetime and is called the lifetime average daily dose (LADD). For evaluating noncancer effects, the dose is averaged over the duration of exposure and is called the average daily dose (ADD). The concentration term in the dose equation refers to the average COPC concentration in an environmental medium to which a receptor is exposed over the exposure duration. The intake term refers to the intake rate of the affected environmental medium, which is a function of the magnitude, frequency, and duration of exposure. The exposure factors that are used to quantify the magnitude, frequency, and duration of potential exposures are discussed in Section 3.1.2.2. The methods for estimating the concentration term are discussed in Section 3.1.2.3.

Inhalation exposures are quantified in terms of an exposure concentration, which is an air concentration that is time-weighted over the duration of exposure. The exposure concentration for evaluating cancer risk is an average over a lifetime. For evaluating chronic and subchronic noncancer effects, the exposure concentration is an average over the duration of exposure. The methods for estimating air concentrations are discussed in Section 3.1.2.4.

In evaluating exposure to standing water in the Casemate 1 gun pit, concentrations were conservatively compared to drinking water screening levels. These drinking water screening levels are discussed in Section 3.1.2.5.

The environmental setting at and around the Site, including climate, geology, hydrogeology, land cover, surface water bodies, and groundwater use, is discussed in Section 2, and therefore is not repeated in this Section.

3.1.2.1. *Scenarios for Potential Human Exposure*

Under current and reasonably expected future land use, potentially exposed populations at and around the Site include park employees, maintenance workers, construction workers, park visitors, future park residents, and out-of-bound visitors. The receptors and their exposure scenarios apply to current and reasonably expected future land use as use conditions for the Site are not expected to change in the future. This HHRA considers potential construction worker exposures to be a near future exposure scenario given the planned upcoming improvement project for the Site.

Additionally, as previously stated in Section 1.2.1, the Organic Act requires that the NPS manage parks to conserve the scenery, natural and historic objects, and wildlife and provide for their enjoyment by such means as will leave them unimpaired for the enjoyment of future generations. NPS routinely interprets this unimpaired standard to mean unrestricted site use. Therefore, because residential land use is a potentially future use of the Site, this HHRA evaluates a park resident scenario.

The following provides a brief discussion of park workers, maintenance workers, construction workers, park visitors and out-of-bound visitors.

<u>Park Workers</u>

Park workers are assumed to include several different types of individuals who may be engaged in work activities at the Site. These include year-around staff, volunteers, scholars, or educational interpreters. This includes volunteers who support the GGRO by being on-site to count raptors during the fall migration from Hawk Hill. These individuals are present every day from August to mid-December. The GGRO also hosts weekend docent programs from September to October. Volunteer park workers may also be involved in activities that could include painting over

graffiti, picking up debris, or managing vegetation (e.g., planting, non-native invasive species removal).

Park workers could be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of COPCs in surface soil-derived vapor and/or particulates. While outside, park workers could also be exposed to COPCs in subsurface soil via inhalation if COPCs were to volatilize and migrate to the outdoor air.

Maintenance Workers

Maintenance workers are assumed to be individuals who perform occasional maintenance activities of limited size and duration at the Site (e.g., maintaining accessible trails and overlooks, seating and railings, rehabilitating historic structures, vegetation management, etc.). They are expected to be engaged in activities with more intensive soil contact (e.g., landscaping, excavation, removal or repair of trail tread, pavement, or concrete, etc.). If maintenance work were to be undertaken in or near the Casemate 1 gun pit, maintenance workers could also come into contact with the sediment and standing water within the gun pit. During such activities, maintenance workers could be exposed to COPCs in surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of soil-derived vapor and particulates. Workers could be exposed to COPCs in sediment via incidental ingestion and dermal contact. Potential routes of exposure to standing water would include incidental ingestion, dermal contact, and inhalation of vapor.

Construction Workers

In the near future, it is expected that significant portions of the Site could be subject to significant construction, renovation, and development. This would include the planned Phase 3 of the Hawk Hill Visitor Improvement Project. During such activities, construction workers are expected to be engaged in tasks that could include more intensive soil contact including excavation. If construction work were to be undertaken in or near the Casemate 1 gun pit, construction workers could also come into contact with the sediment and standing water within the gun pit. During such activities, construction workers could be exposed to COPCs in surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of soil-derived vapor and particulates. Workers could be exposed to COPCs in sediment via incidental ingestion and dermal contact. Potential routes of exposure to standing water would include incidental ingestion, dermal contact, and inhalation of vapor.

Recreators (Including Park Visitors and Birders)

Hawk Hill is a popular site all year around for one-time visitors and limited, but regular, park visitors. Peak tourism season for Hawk Hill runs from summer through the end of November. There are also several on-going public programs at Hawk Hill that may include school group

outings, environmental education programs for youth, nature club field trips, and military history tours.

During such activities, recreators could be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of soil-derived vapor and particulates. Potential routes of exposure to COPCs in surface soil would include incidental ingestion, dermal contact, and inhalation of vapor and particulates from soil. Recreators could also be exposed to COPCs in subsurface soil via inhalation if COPCs were to volatilize and migrate to the outdoor air.

Because their exposure would be less than that of a park worker, this risk assessment uses the risk estimates for park workers as a surrogate for recreators.

Out-of-Bound Visitors

Out-of-bound visitors are assumed to have some potential to be present at the Site and are assumed to be adult individuals engaged in unauthorized activities (e.g., trespass, vandalism, etc.). While exposures of out-of-bound visitors at the Site are generally expected to be limited in duration and extent, such individuals could be exposed to soil in unpaved or uncovered areas of the Site or sediment and standing water within the gun pit at Casemate 1.

Potential routes of exposure to COPCs in surface soil would include incidental ingestion, dermal contact, and inhalation of soil-derived vapor and particulates. Potential routes of exposure to COPCs in sediment would include incidental ingestion and dermal contact. Out-of-bound visitors could also be exposed to COPCs in subsurface soil via inhalation if COPCs were to volatilize and migrate to the outdoor air. Potential routes of exposure to standing water would include incidental ingestion, dermal contact, and inhalation of vapor.

Because their exposure would be less than that of a park worker, this risk assessment uses the soil risk estimates for park workers as a surrogate for out-of-bound visitors. Similarly, this risk assessment uses the sediment risk estimates for construction workers as a surrogate for out-of-bound visitors.

3.1.2.2. *Exposure Factors*

The exposure factors for evaluating the receptor specific exposure scenarios are summarized in Attached Table 3-2 and discussed below. In this HHRA, exposure parameters were based upon site-specific information provided by the GGNPC and the NPS, as available and appropriate. When unavailable, standard default exposure values recommended by CalEPA DTSC (2019a) and USEPA (1991a, 2014a) for estimating RME were used. When standard default values were not available, similarly conservative RME exposure parameters were determined based on professional judgment.

Additionally, when evaluating receptor specific exposure to sediment as discussed in Section 3.1.2.1, exposure factors for soil are applied to sediment. Exposure factors for standing-water exposure were not needed since the evaluation of surface water exposure was completed by comparing standing-water concentrations to drinking water screening levels.

Park Workers

In this HHRA, potential exposure of park workers to soil is conservatively evaluated using the standard default exposure factors (CalEPA DTSC 2019a, USEPA 1991a, 2014a) recommend for estimating RME[29]. According to USEPA, these standard default exposure factors are conservative assumptions about the magnitude, frequency, and duration of exposures, which, in combination, are intended to provide estimates of exposures that are higher than actual exposures to a large portion (90 to 99 percent) of a potentially exposed population. The exposure factors used for park workers are summarized below:

Soil Ingestion Rate

The soil ingestion rate of 50 milligrams (mg)/day is USEPA's standard default value for evaluating RME in commercial/industrial settings (USEPA 1991a).

Soil Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin surface area of 3,527 cm^2/day and the soil-to-skin adherence factor of 0.12 mg/cm^2 are USEPA recommended skin area and adherence factor for evaluating high-end contact with soil by workers in industrial settings (USEPA 2014a). The adsorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by the USEPA-recommended adsorption factors for absorption from soil (USEPA 2004a).

Body Weight

The body weight of 80 kg is the standard CalEPA DSTC (2019a) and USEPA (2014a) recommended body weight for assessing exposure to adults.

Exposure Time

[29] Although it is recognized that the use of the default exposure factors, rather than site-specific factors results, is an overestimation of RME risks at the Site, this approach streamlines the risk assessment. The assessment is also streamlined because the added conservatism in these risk estimates allow them to be used as conservative estimates for other receptors (e.g., recreators and out-of-bound visitors). In this HHRA, the risk estimates for park workers are used to evaluate potential exposures of recreators and out-of-bound visitors to vapors and particulates from on-site soil.

Park workers are assumed to be at the Site with the potential to inhale vapors and particulates from site-related sources for 8 hours/day, the CalEPA DTSC (2019a) and USEPA (2009, 2014a) recommended value for full time workers.

Exposure Frequency and Duration

The exposure frequency of 250 days/year is the CalEPA DTSC (2019a) and USEPA (1991a, 2014a) default value for evaluating RME in commercial/industrial settings. It is based on a 5-day work week and 50 weeks per year. The exposure duration of 25 years is the CalEPA DTSC (2019a) and USEPA (1991a, 2014a) standard value for estimating RME in commercial/industrial settings. It is the 95th percentile job tenure of workers in manufacturing. USEPA (1991a, 2014a) has recommended the use of these values for evaluating high-end routine worker exposures.

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989, 2014a; CalEPA DTSC 2019a).

Park Resident

Potential exposure of park residents to soil is conservatively evaluated using the standard default exposure factors (CalEPA DTSC 2019a, USEPA 1991a, 2014a) recommend for estimating RME. The exposure factors used for park residents are summarized below:

Soil Ingestion Rate

The soil ingestion rates of 200 and 100 mg/day are CalEPA DTSC's (2019a) and USEPA's (1991a, 2014a) standard default values for evaluating RME in residential settings by children and adults, respectively.

Soil Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin surface area of 2,373 and 6,032 cm^2/day and the soil-to-skin adherence factor of 0.2 and 0.07 mg/cm^2 are CalEPA DTSC's (2019a) and USEPA's (2014a) recommended values for evaluating RME with soil by children and adults, respectively.

Body Weight

The body weights of 15 and 80 kg for children and adults, respectively, are the standard CalEPA DSTC (2019a) and USEPA (2014a) recommended body weights for assessing exposure.

Exposure Time

Residents are assumed to be at home with the potential to inhale vapors and particulates from site-related sources for 24 hours/day, the CalEPA DTSC (2019a) and USEPA (2009, 2014a) recommended value for residents which is an upper-bound value.

Exposure Frequency and Duration

The exposure frequency of 350 days/year is the CalEPA DTSC (2019a) and USEPA (1991a, 2014a) default value for evaluating RME in residential settings. It is based on 7-days per week and 50 weeks per year. The exposure duration of 26 years is the CalEPA DTSC (2019a) and USEPA (2014a) standard value for estimating RME in residential settings. It is the 90th percentile for time spent at one residence.

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989, 2014a; CalEPA DTSC 2019a).

Construction Workers

The exposure factors used for evaluating potential exposure of construction workers to soil and sediment are summarized below:

Soil Ingestion Rate

The ingestion rate of 200 mg/day is the 90th percentile from the adult soil ingestion study published by Stanek et al. (1997). It is more appropriate than the 95th percentile (330 mg/day) from the same study, because in a study of only 10 adults, the 95th percentile is at or beyond the highest observed ingestion rate and, as such, has far more uncertainty than the 90th percentile. Using the 90th percentile is also consistent with USEPA guidance on selecting exposure factors for estimating the RME.

Soil Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin surface area of 3,527 cm^2/day and the soil-to-skin

adherence factor of 0.12 mg/cm^2 are the USEPA recommended skin area and adherence factor for evaluating high-end contact with soil by workers in industrial settings (USEPA 2014a). The adsorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by the USEPA-recommended adsorption factors for absorption from soil (USEPA 2004a).

Body Weight

The body weight of 80 kg is the standard CalEPA DSTC (2019a) and USEPA (2014a) recommended body weight for assessing exposure to adults.

Exposure Time

Construction workers are assumed to be at the Site with the potential to inhale vapors and particulates from site-related sources for 8 hours/day, the CalEPA DTSC (2019a) and USEPA (2009, 2014a) recommended value for full time workers.

Exposure Frequency and Duration

The exposure frequency of 250 days/year is based on professional judgment regarding the number of days of soil excavation or other high-intensity soil contact activities. This exposure frequency is expected to be conservative for the amount of time that workers are actually exposed to soil in excavations or during other high-intensity soil contact activities (as opposed to the total time for construction, which typically includes time not associated with high-intensity soil contact activities). It is based on a 5-day work week and 50 weeks per year.

The exposure duration of one year is based on professional judgment regarding the duration of site redevelopment activities.

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989, 2014a; CalEPA DTSC 2019a).

Maintenance Workers

The exposure factors used for evaluating potential exposure of maintenance workers to soil and sediment are the same as those used for construction workers except as follows:

Exposure Frequency and Duration

An exposure frequency of 52 days per year is used for workers performing occasional maintenance work that involves excavation into the soil based on conversations with NPS. Maintenance workers are estimated to be working at the Site one day per week.

An exposure duration of 10 years is used for maintenance worker exposure to soil. The exposure duration of 10 years is supported by the analysis of Burmaster (2000), using data from the Bureau of Labor Statistics through February 1996, which indicated that 95th and 90th percentile job tenure of workers in construction is approximately 12.48 years and 7.7 years, respectively. The duration of 10 years is longer than the length of time that workers typically work in an occupation (USEPA 2014a).

3.1.2.3. *Exposure Concentrations*

Soil risk estimates were calculated for each of the 100 soil sample locations[30]. This was done to facilitate the identification of areas with potentially unacceptable risks and help to support the development of remedial action objectives. To streamline risk calculations for each location, the highest detected concentration of each COPC from any depth at each soil sample location was used. This initial set of soil concentrations represent upper-bound estimates of the actual exposure concentrations. As such, the cumulative cancer and noncancer risk estimates calculated using these concentrations are considered upper-bound estimates.

If an upper-bound cumulative cancer or noncancer risk estimate for a soil sampling location exceeds the risk management goals (i.e., cumulative cancer risk greater than 1×10^{-6} and/or HI greater than 1), then more representative exposure concentrations were estimated where possible (i.e., adequate sampling data available).

In evaluating soil direct contact exposures, the refined exposure concentrations were estimated by calculating a 95 percent upper confidence limit (UCL) on the mean using the soil data from the other sampling locations within the same AOI. Refinements were only made for the COPCs that contributed most to the upper-bound cumulative risk estimates. For the remaining COPCs, the maximum concentrations were still used as exposure concentrations. The UCLs were conservatively calculated using the maximum detected concentrations from any depth at each sample location within an area. The UCL calculations were performed using ProUCL (Version 5.1.00), including the Kaplan-Meier method for datasets with non-detects. The recommended values from ProUCL were used for expediency, even though some of the recommended values are higher (more conservative) than those specified in EPA guidance[31]. The UCLs were then used

[30] This risk assessment conservatively assumes that the portion of the site represented by each soil boring location is a distinct exposure unit and calculates upper-bound cumulative cancer risk and HI estimates for each receptor's exposure to soil at each boring location ("location-by-location"). Because each of these hypothetical exposure units will be small relative to the amount of time that receptors are assumed to spend within that subarea, each hypothetical exposure unit represents the worst-case exposure unit encompassing each soil boring location.

[31] The recommended UCLs from ProUCL are not necessarily 95 percent UCLs but may represent up to 99 percent UCLs and may assume the data follow a distribution (e.g., normal or lognormal) that could provide more or less conservative estimates of the mean concentration than those specified for risk estimates in EPA guidance (EPA 1989b).

to estimate the cumulative cancer risk and HI for the exposure area. Where such refinements were made, the specific refinement for each case and rationale is discussed in Section 3.1.4.3. This approach (i.e., refining the exposure concentrations for only the COPCs contributing most to the cumulative risk) is efficient in that it avoids calculations (such as UCL calculations) that would not materially affect the cumulative cancer risk and/or HI estimates and is consistent with EPA guidance (EPA 1989b). This approach is also conservative, because it uses the maximum detected concentration, rather than 95 percent UCLs, for many COPCs.

The uncertainties associated with using such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 3.1.5.1.

Sediment risk estimates were calculated for one location, CO-COMP, based on a four-point composite sample from the Casemate 1 gun pit.

3.1.2.4. *Fate and Transport Models*

Vapor Emission from Exposed Soil

Vapor emissions from exposed soil are estimated using the Jury model (Jury et al. 1983), with USEPA (1996) default soil parameters, and based on depletion over time of soil initially contaminated, from the surface to a finite depth of 25 ft bgs (the depth of the deepest detected contaminant).

Dust Emission

For evaluating exposure of park workers, the emission of respirable soil particulates (PM_{10}) are calculated using the wind erosion model recommended by USEPA (1991b; 1996) with USEPA default soil parameters, and wind speed and anemometer height from the nearest weather station, which is located in San Francisco, California (NOAA 2019).

During maintenance activities, the PM_{10} level is set at 50 micrograms per cubic meter (ug/m^3). This PM_{10} level is based on a time-weighted average assuming maintenance workers spend 1/3 of their exposure period excavating into the subsurface and 2/3 of their exposure period conducting maintenance activities that do not involve excavation into the subsurface. In calculating the time-weighted average, the 24-hour average NAAQS for PM_{10} of 150 ug/m^3 is used as the PM_{10} concentration during excavations and a PM_{10} concentration of 1 ug/m^3 is used for the time during maintenance activities that do not involve excavation. The PM_{10} concentration during non-excavation maintenance activities is expected to be less than 1 ug/m^3, based on the wind erosion model recommended by USEPA (1991b; 1996) using site-specific wind speed from San Francisco, California (NOAA 2019).

During construction activities, the PM_{10} level is set at 50 ug/m^3, which is the former annual average NAAQS for PM_{10} since construction workers are assumed to be performing excavations

for a work year. It is conservatively assumed that the PM_{10} concentration would be at this limit, every day, for the entire period of construction worker exposure.

Air Dispersion

Annual average air concentrations are estimated using the empirical correlations presented in USEPA (2002) guidance, assuming a square source area, and correlation coefficients for the San Francisco, California meteorological area, which is the area nearest to the Site among the locations with available correlation coefficients. For soil exposures, the source area is conservatively based on 0.7 acres, the approximate total area of the AOIs.

3.1.2.5. *Standing Water Screening Evaluation*

To conservatively evaluate the potential significance of receptor exposure to COPCs in standing water in the Casemate 1 gun pit, concentrations in standing water were compared to drinking water screening levels that were based upon the following hierarchy:

1. California Maximum Contaminant Levels (MCLs) established under Title 22 of the California Code of Regulations (CCR).

2. Federal Maximum Contaminant Level Goals (MCLGs) established in accordance with the Safe Drinking Water Act.

3. USEPA's RSL for tap water ingestion exposure (at a target cancer risk level of $1x10^{-6}$ and noncancer hazard quotient (HQ) of 1).

3.1.3. Toxicity Assessment

A toxicity assessment identifies potential adverse health effects that are associated with exposure to chemicals and determines the dose response relationship between exposure and the occurrence of adverse effects. The toxicity values used in this risk assessment were compiled with consideration for the DTSC Regulation "*Toxicity Criteria for Human Health Risk Assessment*" (effective September 4, 2018) and USEPA's hierarchy of sources (USEPA 2003a).

For expediency, toxicity values for COPCs were obtained from the DTSC HERO HHRA Note 10 Toxicity Criteria (DTSC 2019b), where available. For COPCs not available in this source, toxicity values were compiled from the following hierarchy of sources

- USEPA's Integrated Risk Information System (IRIS)
- USEPA's Provisional Peer Reviewed Toxicity Values (PPRTV)
- Other Toxicity Values

Toxicity values are selected using this hierarchy to ensure the selection of up-to-date values and values appropriate for baseline risk assessments. When a toxicity value is not available from the

first two tiers of the hierarchy, other USEPA and non-USEPA sources of toxicity values (e.g., CalEPA OEHHA's toxicity criteria database, Agency for Toxic Substances and Disease Registry [ATSDR]) are used.

The toxicity values used in the risk assessment and their sources are summarized in Appendix A. The toxicity values used in this risk assessment are current as of October 2, 2020.

3.1.3.1. *Cancer Toxicity Values*

For chemicals that USEPA assessed prior to the 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005), USEPA considers chemicals belonging to the following cancer weight of evidence groups as human carcinogens:

- Group A - Known Human Carcinogen: Sufficient evidence of carcinogenicity in humans,
- Group B1 - Probable Human Carcinogen: Limited evidence of carcinogenicity in humans,
- Group B2 - Probable Human Carcinogen: Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans, and
- Group C - Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans.

For chemicals that USEPA assessed after the 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005), USEPA uses the following cancer weight of evidence groups:

- Carcinogenic to Humans
- Likely to be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential
- Inadequate Information to Assess Carcinogenic Potential

As shown in Appendix A, Table 1, many of the chemicals evaluated in this risk assessment are not designated as Group A or as being "Carcinogenic to Humans", which means USEPA acknowledges that there is either inadequate evidence or a lack of evidence that these chemicals cause cancer in humans. Therefore, evaluating these chemicals as human carcinogens in the risk assessment is highly conservative.

Cancer slope factors (SFs) and unit risk factors (URFs) for these constituents and their sources are shown in Appendix A, Table 1. The oral SFs and inhalation URFs represent 95% upper confidence bounds on the probability of getting cancer over a lifetime per unit dose. As recognized by USEPA, there is significant scientific evidence that some of the SFs and URFs may be overly conservative and may ignore the potential existence of threshold doses. Nonetheless, they are used here as conservative assessment tools. In addition, as recommended by USEPA (2005), ADAFs are used to adjust toxicity values for carcinogens with a mutagenic mode of action to assess potential exposures of adolescent out-of-bound visitors and recreators.

3.1.3.2. *Noncancer Toxicity Values*

Chemicals designated by USEPA as belonging to the cancer weight-of-evidence Group D (Not Classifiable as to Human Carcinogenicity) are considered noncarcinogens. Chemicals not designated as belonging to any cancer group are also treated as noncarcinogens. Chronic and subchronic reference doses (RfDs) and inhalation reference concentrations (RfCs) and their sources are shown in Appendix A, Table 1.

The oral RfDs and inhalation RfCs represent conservative estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects. These RfDs and RfCs typically incorporate several safety factors to account for uncertainties in their derivation, which in combination often result in overall uncertainty factors of 1,000 or more.

3.1.3.3. *Extrapolation of Toxicity Values*

The sources of toxicity values listed above do not provide dermal toxicity values for any of the chemicals evaluated. Therefore, oral toxicity values (i.e., oral SFs and RfDs) are used as dermal toxicity values in this risk assessment. Adjustments to the oral toxicity values, where appropriate, are made in this route-to-route extrapolation following USEPA guidance (USEPA 2004a).

The USEPA sources of toxicity values listed above do not provide inhalation toxicity values (URFs and RfCs) for all of the chemicals. Other than those chemicals for which CalEPA DTSC decided to perform route-to-route extrapolation from oral toxicity values, route-to-route extrapolation from oral toxicity values was not performed to obtain inhalation toxicity values for chemicals consistent with USEPA guidance on performing inhalation risk assessments (USEPA 2009).

Uncertainties introduced by using extrapolated toxicity values are discussed in Section 3.2.4.

3.1.3.4. *Lead*

Potential exposure of receptors to lead in soil is evaluated separately from the assessment for other constituents because USEPA (2003b) and CalEPA DTSC (2020) evaluate the significance of lead exposures using blood lead level as an index of exposure, rather than in terms of cancer risk or noncancer HQ. The screening level used to assess exposure to soil is discussed below.

Exposures of human receptors to lead in soil during outdoor activities is evaluated in this HHRA using CalEPA DTSC's residential screening level of 80 mg/kg (DTSC 2020)[32]. A residential screening level is used in this risk assessment to conservatively identify concentrations of lead in soil that may warrant consideration for remedial action under a future residential use scenario.

[32] CalEPA DTSC's residential screening level represents a lead concentration in soil that will result in a 90th percentile estimate of a 1 ug/dl increase in blood lead in a child or the fetus of a pregnant woman. Therefore, this value is adequately protective of children and women of child-bearing ages.

For comparison, the concentrations of lead identified in soil area also compared to USEPA's default residential screening level of 400 mg/kg (USEPA 2020b) and CalEPA DTSC's commercial/industrial screening level of 320 mg/kg (DTSC 2020).

3.1.4. Risk Characterization

The health significance of the potential exposures described in Section 3.1.2.1 is discussed in the following subsections. Section 3.1.4.1 describes the methods for estimating cancer risks and noncancer HIs. Section 3.1.4.3 discusses the risk estimates and the significance of the potential exposures for each receptor population/exposure scenario.

3.1.4.1. *Cancer and Noncancer Risks*

The cancer risk associated with potential exposure to a carcinogenic chemical via ingestion and dermal contact is calculated by multiplying an estimate of the LADD for a particular exposure scenario by the cancer SF for the chemical as follows:

$$Risk = LADD \cdot SF$$

For the inhalation route, the cancer risk is calculated using the chemical concentration in air (C_{air}) and the inhalation URF, as follows:

$$Risk = URF \cdot C_{air} \cdot \frac{ET \cdot EF \cdot ED}{AT_c}$$

Where ET is exposure time, EF is exposure frequency, ED is exposure duration, and AT_c is the averaging time for carcinogens.

The noncancer HQ associated with potential exposure via incidental ingestion and dermal contact is calculated by dividing an estimate of the ADD by the RfD for the chemical as follows:

$$Risk = \frac{ADD}{RfD}$$

For the inhalation route, the HQ is calculated using C_{air} and the RfC, as follows:

$$Risk = \frac{C_{air}}{RfC} \cdot \frac{ET \cdot EF \cdot ED}{AT_{nc}}$$

In this risk assessment, unit cancer risks and unit HQs were calculated for a unit chemical concentration (C_{unit}). C_{unit} is 1 mg/kg for soil or sediment. Because risk estimates scale directly with the chemical concentration (except for cancer risk estimates at very high doses), these unit risks and unit HQs can be calculated once and used to calculate cancer and noncancer risk estimates efficiently for a large number of locations by multiplying the chemical concentrations

for each location by the unit risks and unit HQs. The unit risks and unit HQs for all routes of exposure (incidental ingestion, dermal contact, vapor inhalation, and/or particulate inhalation) for a given receptor to chemicals in soil or sediment are conservatively summed to produce a single unit risk and unit HQ for each chemical. The cancer risk and noncancer HQ for a particular chemical i at a particular location is calculated as follows:

$$Risk_i = \frac{C_i \cdot UnitRisk_i}{C_{unit}}$$

$$HQ_i = \frac{C_i \cdot UnitHQ_i}{C_{unit}}$$

The media-specific cumulative cancer risk and noncancer HI from exposure to the combination of COPCs are estimated following USEPA (1989) guidance, as follows:

$$Cumulative\ Risk = \sum_i Risk_i$$

$$Hazard\ Index = \sum_i HQ_i$$

Where $Risk_i$ is the estimated cancer risk for the ith chemical and HQ_i is the HQ for the ith chemical. This approach may result in estimates of media-specific cumulative cancer risk and HI that are more conservative than necessary. For example, different COPCs may cause different and unrelated noncancer health effects, so summing the HQs for their individual effects would overestimate the significance of their combined effects. Nonetheless, this approach is used here as a conservative assessment tool.

As discussed in Section 3.1.2.3, the site-related soil risk estimates were conservatively calculated using maximum detected concentrations for each soil sample location and detected concentrations for the sediment sample location to streamline the identification of areas with potentially significant risks and the COPCs that drive the risk estimates, even though such concentrations are likely to overestimate the RME.

3.1.4.2. *Risk Management Goals*

Media-specific cumulative cancer risks and HIs are compared to a cumulative cancer risk of $1x10^{-6}$ and noncancer HI of 1, respectively, to help determine whether remedial action is warranted for a particular media at a particular area of the Site. These risk management goals are consistent with those used by NPS and CalEPA DTSC for remedial action decision-making (22 CCR §69022; CalEPA DTSC 2015, 2016).

3.1.4.3. *Risk Characterization for Potentially Exposed Populations*

Background Soil Risks

For each receptor, estimates of cumulative cancer risk and noncancer HI associated with exposure to background concentrations of metals in soil were calculated and are shown on Attached Table 3-3. The background cancer and noncancer risk estimates on Attached Table 3-3 were calculated using the exposure factors discussed in Section 3.1.2.2 and toxicity values discussed in Section 3.1.3. As indicated on Attached Table 3-4, the background cumulative cancer risk for the three receptors ranges from $5x10^{-7}$ (for construction workers) to $3x10^{-5}$ (for park residents). The background HIs among the receptors range from 0.05 (for construction workers) to 3 (for park residents). For park residents and park workers, the cumulative cancer risks of $3x10^{-5}$ and $4x10^{-6}$, respectively, and for park residents, the cumulative HQ of 3 are driven by arsenic.

As noted above, the total soil risk estimates for each receptor population can be assumed to include these background risks; the soil and sediment risk estimates discussed in the rest of Section 3.1.4.3 can be considered site-related and in excess of these background risks.

Park Workers

Potential exposure of park workers to COPCs in surface soil at each location could occur via incidental ingestion and dermal contact, and via the inhalation of COPCs in vapor and/or particulates emitted from surface soil. Park workers could also be exposed to COPCs in subsurface soil via inhalation if they were to volatilize and migrate to the outdoor air.

Potential exposure was evaluated using upper-bound estimates of RME cumulative cancer risk and HIs to streamline the risk assessment. These estimates are conservative upper-bound estimates because the site-related RME risks for a location would be lower if they were calculated using concentrations representative of the average concentrations to which receptors would be exposed at the area.

The upper-bound estimates of site-related cumulative cancer risk and noncancer HI for potential exposure of park workers are presented on Attached Table 3-4. Figure 3-1 presents the locations of the soil sampling locations and identifies those with risk or HI estimates that are in excess of the risk management goals. As shown on Attached Table 3-4 and Figure 3-1, three soil sampling locations, SS-2-1, SS-18-2 and SS-18-12, exhibited a cancer risk greater than the risk management goal of $1x10^{-6}$ (i.e., $1x10^{-5}$, $3x10^{-6}$ and $2x10^{-6}$, respectively). As shown on Attached Table 3-5, the potentially unacceptable cumulative cancer risk estimate at SS-2-1 is predominately driven by the detected concentrations of arsenic and PCBs (total). The potentially unacceptable cumulative cancer risk estimates at SS-18-2 and SS-18-12 are entirely driven by the detected concentrations of arsenic.

Therefore, potential exposure of park workers to arsenic and PCBs (total) in surface soil in the area of SS-2-1 and to arsenic in surface soil in the areas of SS-18-2 and SS-18-12 result in conservative estimates of cumulative cancer risk that would warrant consideration for response action.

Park Residents

While residential land use is unlikely at the Site, it is not unreasonable to consider that new housing may be constructed at or in the vicinity of the Site. The Park has been actively looking at housing options for employees, including the potential to build new housing in the Park. There is already housing in the Marin Headlands near Hawk Hill and it is not unreasonable to consider future residential use of portions of the Site. This HHRA evaluates a park resident scenario to account for unrestricted site use since residential use cannot be ruled out as a potential exposure scenario.

Potential exposure was evaluated using upper-bound estimates of RME cumulative cancer risk and HIs to streamline the risk assessment. These estimates are conservative upper-bound estimates because the site-related RME risks for a location would be lower if they were calculated using concentrations representative of the average concentrations to which receptors would be exposed at the area.

The upper-bound estimates of site-related cumulative cancer risk and noncancer HI for potential exposure of park residents are presented on Attached Table 3-4. Figure 3-1 presents the locations of the soil sampling locations and identifies those with risk or HI estimates that are in excess of the risk management goals. As shown on Attached Table 3-4 and Figure 3-1, 20 soil sampling locations, F9-SB05, SS-12-1, SS-12-2, SS-17-1, SS-17-2, SS-16-2, SS-18-1, SS-18-2, SS-18-2-B2, SS-18-3, SS-18-4, SS-18-6, SS-18-12, SS-9-2, SS-8A-5, DO-1, SS-2-1, SS-2-3, SS-2-4 and SS-2-5, exhibited a cancer risk or noncancer HI greater than the risk management goal of $1x10^{-6}$. As shown on Attached Table 3-5, these potentially unacceptable cumulative cancer risk and noncancer HI estimates are predominately driven by the detected concentrations of arsenic, DNOC, DRO and PCBs (total).

The upper-bound site-related noncancer HI risk estimate for F9-SB05 of 4 is predominately driven by the detected concentration of DRO and, as such, was refined by using a conservative estimate of the average concentrations for DRO in AOI 05. A 95 percent UCL on the mean was conservatively calculated for DRO by using the maximum concentration from any depth at each soil sample location in AOI 05, as shown in Figure 3-1.

Using a conservative estimate of the mean concentration for DRO in AOI 05 (1600 mg/kg) reduces the noncancer HI estimate to 1, equal to the risk management goal. Therefore, potential exposure of maintenance workers to DRO in soil in AOI-05 would not result in an unacceptable noncancer risk.

Additionally, arsenic is predominately a risk driver for locations in AOI 24 (i.e., DO-1, SS-2-1, SS-2-3, SS-2-4 and SS-2-5), and, as such, was refined by using a conservative estimate of the average concentrations for arsenic in AOI 24. A 95 percent UCL on the mean was conservatively calculated for arsenic by using the maximum concentration from any depth at each soil sample location in AOI 24, as shown in Figure 3-1.

However, using a conservative estimate of the mean concentration for arsenic in AOI 24 (3.6 mg/kg) did not reduce the cancer risk estimates to below the risk management goal.

Therefore, potential exposure of park residents to arsenic, DNOC and PCBs (total) in surface soil in the area of these locations (i.e. SS-12-1, SS-12-2, SS-17-1, SS-17-2, SS-16-2, SS-18-1, SS-18-2, SS-18-2-B2, SS-18-3, SS-18-4, SS-18-6, SS-18-12, SS-9-2, SS-8A-5, DO-1, SS-2-1, SS-2-3, SS-2-4 and SS-2-5) result in conservative estimates of cumulative cancer risk and noncancer HI that would warrant consideration for response action.

Maintenance Workers

Soil

Maintenance workers could be exposed to COPCs in soil during occasional subsurface maintenance activities. Potential routes of exposure to COPCs in surface and subsurface soil during such activities would include incidental ingestion, dermal contact, and inhalation of COPCs in vapor and/or particulates emitted from soil.

Potential exposures were evaluated using upper-bound estimates of RME cumulative cancer risk and HIs to streamline the risk assessment. These estimates are conservative upper-bound estimates because the site-related RME risks for a location would be lower if they were calculated using concentrations representative of the average concentrations to which receptors would be exposed at the area.

The upper-bound estimates of site-related cumulative cancer risk and noncancer HI for potential exposure of maintenance workers to soil are presented on Attached Table 3-4. Figure 3-1 presents the locations of each soil sampling location and identifies those with risk or HI estimates that are in excess of the risk management goals. As shown on Attached Table 3-4 and Figure 3-1, only one location, SS-2-1, exhibited a cancer risk greater than the risk management goal of $1x10^{-6}$ (i.e., $2\ x10^{-6}$). As shown on Attached Table 3-5, the potentially unacceptable cumulative cancer risk estimate is predominately driven by the detected concentrations of arsenic and PCBs (total).

Therefore, potential exposure of maintenance workers to arsenic and PCBs (total) in surface soil the area of SS-2-1 results in a conservative estimate of cumulative cancer risk that would warrant consideration for response action.

Sediment

Maintenance workers could be exposed to COPCs in sediment during occasional maintenance activities if performed in or near the Casemate 1 gun pit. Potential routes of exposure to COPCs in sediment during such activities would include incidental ingestion, dermal contact, and inhalation of COPCs in vapor emitted from sediment.

The estimates of site-related cumulative cancer risk and noncancer HI for potential exposure of maintenance workers to sediment are presented on Attached Table 3-6. Figure 3-1 presents the location of the sediment sampling location, CO-COMP, and identifies whether risk or HI estimates are in excess of the risk management goals. As shown on Attached Table 3-6 and Figure 3-1, neither the cumulative cancer risk nor the cumulative HI exceeded the risk management goals of $1x10^{-6}$ and 1, respectively. Attached Table 3-7 presents the cancer risks and HQs for each chemical detected at sediment sampling location, CO-COMP.

Therefore, potential exposure of maintenance workers to sediment in the Casemate 1 gun pit would not warrant consideration for response action.

Construction Workers

Soil

Construction workers could be exposed to COPCs in soil during site redevelopment or construction activities. Potential routes of exposure to COPCs in surface and subsurface soil during such activities would include incidental ingestion, dermal contact, and inhalation of vapor and particulates from soil.

Potential exposures were evaluated using upper-bound estimates of RME cumulative cancer risk and HIs to streamline the risk assessment. These estimates are conservative upper-bound estimates because the site-related RME risks for a location would be lower if they were calculated using concentrations representative of the average concentrations to which receptors would be exposed at the area.

The upper-bound estimates of site-related cumulative cancer risk and noncancer HI for potential exposure of construction workers are presented on Attached Table 3-4. Figure 3-1 presents the locations of each soil sampling location and identifies those with risk or HI estimates that are in excess of the risk management goals. As shown on Attached Table 3-4 and Figure 3-1, only one soil sampling location, F9-SB05, exhibited a noncancer HI estimate greater than the risk management goal of 1 (i.e., 3). As shown on Attached Table 3-5, the potentially unacceptable cumulative noncancer HI estimate is predominately driven by the maximum detected concentration of DRO. As such, this upper-bound site-related noncancer HI risk estimate was refined by using a conservative estimate of the average concentrations for DRO in AOI 05. A 95

percent UCL on the mean was conservatively calculated for DRO by using the maximum concentration from any depth at each soil sample location in AOI 05, as shown in Figure 3-1.

Using a conservative estimate of the mean concentration for DRO in AOI 05 (1600 mg/kg) reduces the noncancer HI estimate to 1, equal to the risk management goal. Therefore, potential exposure of maintenance workers to DRO in soil in AOI-05 would not result in an unacceptable noncancer risk.

Sediment

Construction workers could be exposed to COPCs in sediment during site redevelopment or construction activities if performed in or near the Casemate 1 gun pit. Potential routes of exposure to COPCs in sediment during such activities would include incidental ingestion, dermal contact, and inhalation of COPCs in vapor emitted from sediment.

The estimates of site-related cumulative cancer risk and noncancer HI for potential exposure of construction workers to sediment are presented on Attached Table 3-6. Figure 3-1 presents the location of the sediment sampling location, CO-COMP, and identifies whether risk or HI estimates are in excess of the risk management goals. As shown on Attached Table 3-6 and Figure 3-1, neither the cumulative cancer risk nor the cumulative HI exceeded the risk management goals of $1x10^{-6}$ and 1, respectively. Attached Table 3-7 presents the cancer risks and HQs for each chemical detected at sediment sampling location, CO-COMP.

Therefore, potential exposure of construction workers to sediment in the Casemate 1 gun pit would not warrant consideration for response action.

3.1.4.4. *Standing Water Screening Evaluation*

As discussed in Section 3.1.2.5, concentrations in standing water were compared to the drinking water screening levels. As shown on Attached Table 3-8, no chemicals were detected at concentrations greater than these conservative screening levels. Therefore, potential exposure of receptors to standing water in the Casemate 1 gun pit would not warrant consideration for response action.

3.1.4.5. *Lead*

Potential exposure of human receptors to lead in soil at the Site was conservatively evaluated using CalEPA DTSC's residential screening level of 80 mg/kg as discussed in Section 3.1.3.4. As presented on Attached Table 3-9 and as shown on Figure 3-2, 41 locations exhibited lead in surface soil at concentrations greater than this screening level. Overall, 10 AOIs exhibited at least one soil sampling location with a concentration of lead that is greater than this screening level (i.e., AOIs 14, 16, 18, 19, 20, 21, 22, 23, 24 and 25).

Per CalEPA DTSC guidance (2020), refined lead exposure concentrations (i.e., UCLs on the mean) were calculated for each of these 10 AOIs where adequate soil sampling had been performed. These refined lead exposure concentrations are summarized below. As shown, nine of the 10 AOIs exhibited refined lead exposure concentrations that are greater than CalEPA DTSC's residential screening level. These AOIs are identified below and illustrated on Figure 3-2.

Text Table 3-1: Refined Lead Exposure Concentrations by Area of Investigation

AOI	Name	Refined Exposure Concentration	Ratio of Conc to Screening Level
AOI 14	Casemate 1	**240 mg/kg**	**3.0**
AOI 16	Casemate 2	71 mg/kg	0.9
AOI 18	Radar Pad 1	**780 mg/kg**	**10**
AOI 19	Radar Platform	**560 mg/kg**	**7.0**
AOI 20	Battery Commander Station	**1900 mg/kg**	**24**
AOI 21	East Retaining Wall	**296 mg/kg**	**3.7**
AOI 22	Radar Pad 2	**92 mg/kg**	**1.2**
AOI 23	NW Retaining Wall	**1,029 mg/kg**	**13**
AOI 24	Drainage Outlet 1	**197 mg/kg**	**2.5**
AOI 25	Radar Pad 3	**170 mg/kg**	**2.1**

Note: Bolded refined exposure concentrations exceed CalEPA DTSC's residential screening level.

Based upon these results, these areas would warrant consideration for response action.

3.1.5. Uncertainty Assessment

3.1.5.1. *Exposure Concentrations*

Most exposure concentrations in this risk assessment are based upon the highest concentrations of COPCs detected in soil at each location, and refinements to the exposure concentrations (e.g., UCLs) are calculated only when an upper-bound estimate of the RME media-specific cumulative cancer risk or noncancer HI exceeds risk management goals. This streamlines the risk assessment by avoiding the calculation of refinements (e.g., UCLs) that would not materially affect risk assessment conclusions, the need for response action, or would require additional sampling/characterization to facilitate such refinements to be made. However, this approach inflates the cumulative cancer risk and noncancer HI estimates because these estimates are entirely based on maximum detected concentrations. The use of maximum detected concentrations for all COPCs introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure. The inflation of these risk and HI estimates makes them closer to (or puts them in excess of) the risk management goals more than they would be if refinements such as UCLs were used for all COPCs.

Most exposure concentrations that are based on mathematical modeling of chemical transfer from soil to air are conservative for the same reasons discussed above, since the model estimates are based on the use of maximum detected concentrations in soil. In addition, some model estimates are conservative because they do not account for the reduction of chemical concentration or mass in the soil as chemical transfer from these media. Even for models that account for reduction of mass in the soil (e.g., Jury model), risk calculations for ingestion and dermal contact with soil

assume soil concentrations remain constant, which is consistent with USEPA and CalEPA DTSC practice but contradicts the mass conservation principle. As a result, risk estimates that are based on the sum of risk estimates from soil and soil vapor/particulates are more conservative than necessary for RME estimates. These includes almost all of the risk estimates discussed in Section 3.1.4.3.

As a result, with consideration for these factors, the risk estimates presented are generally more conservative than necessary for RME estimates.

Soil samples at the Site were analyzed for PCBs at only five locations. Four locations were analyzed around an area that previously contained a transformer. The fifth location was at an outfall and exhibited a detected concentration of Aroclor-1260 of 15 mg/kg. The presence of PCBs in this sample may be due to stormwater transport of PCBs in soil due to degradation of PCB-containing building materials (e.g., paint).

3.1.5.2. *Exposure Factors*

As discussed in Section 3.1.2.2, most of the exposure factors used in the risk assessment are high-end (i.e., 90th to 95th percentile) estimates of the magnitude, frequency, and duration of potential exposures. When several such high-end factors are multiplied, the resulting estimates of dose will be higher than the 90th percentile of the distribution of exposures in the potentially exposed population and could be higher than the exposure to the maximally exposed individual, particularly when such exposure factors are combined with exposure concentrations that are based on maximum detected concentrations (as discussed above).

3.1.5.3. *Extrapolation of Toxicity Values*

A few of the inhalation toxicity values used in the risk assessment are based upon route-to-route extrapolation as determined by CalEPA. The use of route-to-route extrapolation may overestimate risks as the hazard may be misrepresented when toxicity data from one route of exposure are substituted for another route without consideration of the pharmacokinetic differences between the routes. As a result, the risk estimates may be higher than is necessary to be protective.

3.1.5.4. *Risk Characterization*

The summation of cancer risks and HQs for multiple COPCs is based upon USEPA guidance (1989) to assume dose additivity, which means that chemicals in a mixture are assumed to have no synergistic or antagonistic interactions and each chemical has the same mode of action and elicits the same health effects. In general, this approach can introduce significant uncertainty. However, the majority of the cumulative risk and HI estimates in this risk assessment are dominated by contributions from no more than a few COPCs, so that the cumulative risk and HI estimates are nearly the same as those for a few key COPCs.

3.1.6. Summary and Conclusions

This baseline HHRA has been prepared for Hawk Hill, located in the Marin Headlands in California. The HHRA has been completed to evaluate potential human health risks that are attributable to releases of COPCs at the Site. The results are used to determine if potential risks are potentially unacceptable and, if so, to establish remedial goals that must be satisfied by the recommended removal action.

The potential risks are characterized based upon the RME under current and reasonably expected future land use at and around the Site. The Site is currently operated as a recreational and research area, located within the GGNRA in the Marin Headlands and is expected to continue as such in the future. While residential land use of the Site is not likely, it cannot be ruled out in the future. As a result, this HHRA includes the evaluation of park resident exposure to account for unrestricted site use. Sources of COPCs are either generally vegetated or covered. Plant roots, leaf litter, and other surfacing materials also may reduce the risks of soil migration via erosion or aeolian transport, which can help reduce the potential for receptors to come into contact with contaminated soil. Based upon the results of historical environmental sampling conducted at the Site, COPCs identified in soil include several metals, PCBs, DRO, and DNOC.

In addition to accounting for unrestricted use of the Site, the HHRA evaluated the following potentially exposed populations at and around the Site:

- Park Workers
- Park Residents
- Maintenance Workers
- Construction Workers
- Recreators (Including Park Visitors and Birders)
- Out-of-Bound Visitors

The scope of the HHRA calculations for these receptors[33] is summarized by the scenarios for potential human exposure as shown on Attached Table 2-3 and on Figure 2-3. This table and figure describe the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Site in terms of potential exposure populations, environmental media to which they could be exposed, and their potential routes of exposure.

Overall, uncontrolled exposures of park workers, park residents and maintenance workers to soil in five AOIs may pose unacceptable risks. Uncontrolled exposures of human receptors to lead in soil in nine AOIs may pose unacceptable risks. Response action in these areas may be warranted.

[33] In this HHRA, the risk estimates for park workers are conservatively used to evaluate potential exposures of recreators and out-of-bound visitors.

The results of the HHRA are further summarized below, including the identification of the areas where conservative estimates of risk would warrant consideration for response action.

Park Worker

As presented on Figure 3-1, the following areas have soil concentrations that could result in cumulative cancer risk or noncancer HI estimates above the risk management goals of $1x10^{-6}$ and 1, respectively, when considering park worker exposure to COPCs in soil:

- AOI 24 (Drainage Outlet 1): soil sampling location SS-2-1 (cumulative cancer risk of $1x10^{-5}$, driven by PCBs (total) and arsenic)

- AOI 16 (Casemate 2): soil sampling locations SS-18-2 (cumulative cancer risk of $3x10^{-6}$, driven by arsenic) and SS-18-12 (cumulative cancer risk of $2x10^{-6}$, driven by arsenic)

Park Residents

As presented on Figure 3-1, the following areas have soil concentrations that could result in cumulative cancer risk or noncancer HI estimates above the risk management goals of $1x10^{-6}$ and 1, respectively, when considering park resident exposure to COPCs in soil:

- AOI 15 (East Trail): soil sampling locations SS-12-1 (cumulative cancer risk of $8x10^{-6}$, driven by arsenic), SS-12-2 (cumulative cancer risk of $7x10^{-6}$, driven by arsenic), SS-17-1 (cumulative cancer risk of $3x10^{-6}$, driven by arsenic) and SS-17-2 (cumulative cancer risk of $5x10^{-6}$, driven by arsenic)

- AOI 16 (Casemate 2): soil sampling locations SS-16-2 (cumulative cancer risk of $8x10^{-6}$, driven by arsenic), SS-18-1 (cumulative cancer risk of $7x10^{-6}$, driven by arsenic), SS-18-2 (cumulative cancer risk of $2x10^{-5}$ and cumulative HI of 2, driven by arsenic), SS-18-2-B2 (cumulative cancer risk of $5x10^{-6}$, driven by arsenic), SS-18-3 (cumulative cancer risk of $6x10^{-6}$, driven by arsenic), SS-18-4 (cumulative cancer risk of $5x10^{-6}$, driven by arsenic), SS-18-6 (cumulative cancer risk of $4x10^{-6}$, driven by arsenic) and SS-18-12 (cumulative cancer risk of $1x10^{-5}$, driven by arsenic)

- AOI 17 (South Tunnel SE Portal): soil sampling location SS-9-2 (cumulative cancer risk of $2x10^{-6}$, driven by arsenic)

- AOI 23 (NW Retaining Wall): soil sampling location SS-8A-5 (cumulative cancer risk of $7x10^{-6}$, driven by arsenic)

- AOI 24 (Drainage Outlet 1): soil sampling locations DO-1 (cumulative cancer risk of $9x10^{-6}$, driven by PCBs (total) and arsenic), SS-2-1 (cumulative cancer risk of $7x10^{-5}$ and

cumulative HI of 8, driven by DNOC, PCBs (total) and arsenic), SS-2-3 (cumulative cancer risk of $4x10^{-6}$, driven by arsenic), SS-2-4 (cumulative cancer risk of $4x10^{-6}$, driven by arsenic) and SS-2-5 (cumulative cancer risk of $7x10^{-6}$, driven by arsenic)

Maintenance Worker

Soil

As presented on Figure 3-1, the following area has soil COPC concentrations that could result in cumulative cancer risk or noncancer HI estimates above the risk management goals when considering maintenance worker exposure to COPCs in soil:

- AOI 24 (Drainage Outlet 1): soil sampling location SS-2-1 (cumulative cancer risk of $2x10^{-6}$, driven by PCBs (total) and arsenic)

Sediment

COPC concentrations in sediment of the Casemate 1 gun pit would not result in cumulative cancer risk or noncancer HI estimates above the risk management goals when considering maintenance worker exposure to sediment.

Construction Worker

Soil

There are no areas of the Site with soil COPC concentrations that would result in cumulative cancer risk or noncancer HI estimates above the risk management goals when considering construction worker exposure to soil.

Sediment

COPC concentrations in sediment of the Casemate 1 gun pit would not result in cumulative cancer risk or noncancer HI estimates above the risk management goals when considering construction worker exposure to sediment.

Standing Water

As presented on Attached Table 3-8, no chemicals were detected at concentrations in standing water that were greater than the drinking water screening levels. Therefore, potential exposure of receptors to standing water in the Casemate 1 gun pit would not warrant consideration for response action.

Lead

Potential exposure of human receptors to lead in soil at the Site was conservatively evaluated using CalEPA DTSC's residential screening level of 80 mg/kg. Nine AOIs, including AOIs 14 (Casemate 1), 18 (Radar Pad 1), 19 (Radar Platform), 20 (Battery Commander Station), 21 (East Retaining Wall), 22 (Radar Pad 2), 23 (NW Retaining Wall), 24 (Drainage Outlet 1) and 25 (Radar Pad 3), have lead exposure concentrations greater than CalEPA DTSC's screening level. Response action in these areas may be warranted.

3.2. Ecological Risk Assessment

This section discusses the methods used and results of the ERA. The ERA evaluates potential risks to ecological receptors from the release of contaminants at the Site. The ERA includes a SLERA and a simple BERA. The goal of the SLERA is to eliminate insignificant hazards while identifying chemicals whose concentrations are sufficiently high to potentially pose unacceptable risks to ecological receptors. Thus, selected ecological exposure and ecotoxicity reference values and assumptions are consistently biased toward overestimating risk. This ensures that chemicals and exposure pathways that might pose potential ecological risk are studied further.

The SLERA consists of two steps: identification of chemicals of potential ecological concern (COPECs) followed by a refined SLERA. In the first step, COPECs are identified by comparing maximum exposure concentrations to the lowest ESVs. In the second step, HQs are calculated comparing the maximum COPEC concentration to receptor-specific ESVs. If the second step indicates that any COPECs pose potentially unacceptable risk, the COPEC-receptor pathway is evaluated further in a simple BERA. For example, for birds and mammals, exposure is refined by using food chain modeling and toxicity reference values that are more receptor-specific and reflect less uncertainty than those used in deriving ESVs.

The methods used in the ecological risk assessment are based on USEPA (1997a) and NPS (2018) guidance. This ERA is organized as follows:

- The problem formulation which establishes the breadth and focus of the ERA is discussed in Section 3.2.1 – Problem Formulation
- The SLERA is discussed in Section 3.2.2 – Screening Level Ecological Risk Assessment
- The simple BERA is discussed in Section 3.2.3 – Baseline Ecological Risk Assessment
- Uncertainties associated with the ERA are discussed in Section 3.2.4 – Uncertainty

3.2.1. Problem Formulation

Problem formulation establishes the breadth and focus of the ecological risk assessment and includes a description of the ecological setting, development of a preliminary ecological pathway-receptor model, and selection of preliminary of assessment endpoints and measures of effect.

3.2.1.1. *Ecological Setting*

As described in Section 2.8, the habitat is predominantly coastal grassland interspersed with areas of scrub and small tree stands. The Site also supports patches of silver lupine which is the host plant for the endangered mission blue butterfly (May & Associates 2006). Despite its historical use as a military defense site and the presence of a parking lot on Conzelman Road, the Site is anticipated to provide habitat for a variety of terrestrial birds and mammals as well as invertebrates. Many bird species have been observed at the Site during avian surveys conducted as part of the Hawk Hill habitat restoration efforts (Dettling and Humple 2015). Following tree removal, 17 species were observed in the summer of 2014 and 15 species in the winter of 2014 and 2015. These included the California quail (*Callipepla californica*), western scrub-jay (*Aphelcoma californica*), Bewick's wren (*Thryomanes bewickii*), hermit thrush (*Catharus guttatus*), American robin (*Turdus migratorius*), and song sparrow (*Melospiza melodia*). The Site is also known for its raptor migration in the fall, where as many as 19 different species of raptors may be seen.[34] According to the GGRO 2018 Season Summary (GGRO 2019), 24,323 raptors were sighted during the 16-week season in 2018 (August 13 through December 2). The Site is also likely used by a variety of terrestrial mammals such as brush rabbit (*Sylvilagus bachmani*), deer mouse (*Peromyscus maniculatus*), coyote (*Canis latrans*), and gray fox (*Urocycon cinereoargenteus*)[35]. In addition to the mission blue butterfly, the other federally listed species present at the Site is the California red-legged frog.

3.2.1.2. *Ecological Receptor Pathway Model*

The ecological receptor pathway model presents the connection between the contaminant sources and the ecological receptors at the site via exposure pathways (see Figure 2-4). Depending on the routes of exposure, the exposure pathways are described as either potentially complete or not complete. COPC have been detected in surface soil in a number of AOIs at the Site (see Section 2.9.4) which may represent complete exposure pathways to the terrestrial plants and soil invertebrates as well as birds, and mammals that use the Site. Chemicals were also detected in a sample collected from the standing water and sediment that had accumulated in the remaining gun pit which could represent a potential exposure pathway for the California red legged frog during spawning and its tadpole life stage in the spring.

As it is not possible to evaluate potential risk to all the plants and animals at a site, selection is based on those that are ecologically significant, of high societal value, and/or represent broad

[34] https://www.parksconservancy.org/parks/hawk-hill
[35] https://www.nps.gov/goga/learn/nature/mammals.htm

categories that a site can support. Species are also selected to represent different trophic levels (e.g., primary producers, primary consumers, secondary consumers, or tertiary consumers), and for the birds and mammals, a range of representative feeding guilds (e.g., herbivorous, carnivorous, or omnivorous). Lastly, representative species are typically selected from those for which there is readily available information on their habitat requirements, diet, and home range. Based on a discussion of the ecological setting, the following receptors were selected for quantitative evaluation:

- Terrestrial plant community
- Soil invertebrate community
- Omnivorous bird: American robin (*Turdus migratorius*)
- Carnivorous bird: Red-tailed hawk (*Buteo jamaicensis*)
- Omnivorous mammal: Deer mouse (*Peromyscus maniculatus*)
- Carnivorous mammal: Red fox (*Vulpes vulpes*)
- Amphibians: California red-legged frog (*Rana aurora draytonii*)

The American robin is selected as a representative medium sized bird that can be found throughout most of the United States in a wide range of habitats. The American robin is omnivorous, foraging on the ground in open areas and low vegetation, as well as above ground in shrubs and the lower branches of trees. The diet primarily consists of invertebrates before and during breeding, and fruit for the remainder of the years. Nests are typically constructed from vegetation and mud in the crotches of trees or shrubs. During the breeding season, foraging is typically confined to an established territory, but in less productive areas, may extend further afield. Home ranges vary from 0.12 to 0.84 hectares.

The red-tailed hawk is selected as a representative carnivorous bird since it is frequently observed flying over the Site per reports from the GGRO. The red-tailed hawk can be found in a variety of habitats ranging from woodlands and wetlands to prairies and deserts. Its diet primarily consists of small mammals which it prefers to hunt for from elevated perches in trees near the edge of a woodland habitat. If trees are scarce, it will use rock pinnacles or man-made structures as perches. The hawk is territorial throughout the year, but breeding territories need to include trees or other similar sites for nesting and perching. Home ranges can vary widely from a few hundred hectares to over 1,500 hectares.

The deer mouse is selected as a representative small mammal as it can live in a wide range of dry-land habitats including deserts, coastal scrub and prairie, grasslands, tundra, rocky habitats, and woodlands. The deer mouse is an omnivorous and opportunistic forager with a diet primarily consisting of green vegetation, roots, fruit, seeds, fungi, and arthropods. Nesting sites can be in trees up to 8 meters from the ground, but also on the ground among tree roots and under rocks. The home range of the females includes its nesting and foraging areas while for males, the home range is often larger and overlaps the home range of several females. Overall, these home ranges are small ranging from 0.094 to 0.128 hectares.

The red fox is selected as representative of a carnivorous mammal such as the coyote or the gray fox which inhabit prairie, open woodland, and boulder strewn areas and have been observed by NPS staff at the Site. Coyotes have similar feeding habits to the red fox, primarily feeding on small mammals and birds; both will scavenge on carcasses when available. The gray fox also feeds on small mammals, but will also eat birds, eggs, and fruit depending on availability. While the red fox visits all parts of its territory, most activity occurs within favored hunting areas and closer to its den. Overall, home ranges typically fall within 57 to 170 hectares.

Given the threatened status of the California red legged frog, it is selected as the amphibian for evaluation because it has been observed in standing water that has collected in the remaining gun pit on the Site following a rainfall event. However, because the breeding and foraging requirements of the frog depend on a permanent water source, the presence of emergent vegetation, and a shrubby riparian zone, the Site is unsuitable habitat for large numbers of the frog (see Appendix B, Attachment 2). If present in the gun pit, the adult frogs will be exposed during spawning while the tadpoles will be exposed via gill respiration and grazing on algae before metamorphosing into juveniles and leaving the gun pit.

The terrestrial plants and soil invertebrates are potentially exposed to soil contaminants by direct contact, while the birds and mammals are potentially exposed indirectly via their diet. The tadpoles of the California red legged frog are potentially exposed to contaminants in the standing water and sediment of the remaining gun pit by direct contact as well as indirectly via their diet. These receptors and potential exposure pathways are summarized in the preliminary receptor exposure pathway model shown in Figure 2-4.

The mission blue butterfly is evaluated qualitatively in this EC/CA because the loss of habitat for the native lupines on which the female butterfly depends to lay their eggs, likely represents the most important stressor to the success of the butterfly. As discussed in Appendix B, Attachment 1, habitat for the mission blue butterfly at the Site is threatened by non-native, invasive plants such as jubata grass (*Cortaderia jubata*), and hemlock (*Conium maculatum*) that often reproduce rapidly and outcompete the native lupines. Other plants such as the blackwood acacia (*Acacia melanoxylon*) and Monterey cypress reduce and fragment the mission blue butterfly habitat. At Hawk Hill, this habitat is further impacted by recreational use (presence of unofficial trails) and fragmented by roads as well as official trails and hiking routes. Recognizing the importance of the mission blue butterfly, the NPS has been leading habitat restoration projects throughout the GGNRA since the late 1980s. These restoration projects are continuing as are surveys of the adult butterflies on the Marin Headlands (Coast Ride Ecology 2018). A review of the terrestrial plant ESVs described in Appendix B, Attachment 1, shows that if metal uptake does occur, translocation to the leaves, shoots, and flowers is often limited. Because the critical stage in the life cycle of the mission blue butterfly is the larval consumption of the leaves, shoots, and flowers of the lupine plants, it is unlikely that the concentrations of metals in the soil of Hawk Hill will adversely affect the success of the mission blue butterfly at the Site.

3.2.1.3. *Assessment Endpoints and Measures of Effect*

USEPA (1997a) describes assessment endpoints as "*explicit expressions of environmental values to be protected, operationally defined as an ecological entity and its attributes*." For this Site, that means its ability to support a community of functioning terrestrial plants and terrestrial animals. For terrestrial plants, the assessment endpoints are plant growth, yield, or germination. For all other receptors, the assessment endpoints are survival, growth, or reproduction.

A measure of effect is a measurable ecological characteristic that is used to evaluate a particular assessment endpoint. In the EC/CA process, the measures of effect used to identify the COPECs and used in the refined SLERA are medium-specific ESVs that are concentration based (NPS 2018). For plants and invertebrates, the identification of COPECs is based on the lowest plant or soil invertebrate ESV, and for birds and mammals, the identification of COPECs is based on the lowest bird or mammal ESV[36]. In the refined SLERA, ESVs for plants, invertebrates, birds, and mammals are selected based on a hierarchy described in the NPS protocol. One exception to this is for birds and exposure to lead in soil for which the screening values are based on those from Sample et al. (2019). Sample and coworkers recognized that for lead, the soil screening value derived according to USEPA's EcoSSL guidelines (and adopted by NPS 2018 for use in the refined screening step), result in a value that is within the background concentrations of lead in soils for over 90 percent of the United States; that is, it is too stringent. These authors re-evaluated the data in the EcoSSL for lead (USEPA 2005b) and derived revised EcoSSLs based on effect levels rather than NOAELs and LOAELs.

For amphibians, the identification of COPECs and the refined screening of the standing water in the gun pit uses the amphibian-based surface water ESVs from the NPS protocol. In the absence of ESVs for sediment, the NPS protocol suggests that NOAELs and LOAELs from a Naval Facilities Engineering Report on ecological risks to amphibians can be used (NAVFAC (2009). Note, because the California red legged frog is a threatened species, this evaluation will be based on NOAELs only.

3.2.2. Screening-Level Ecological Risk Assessment

As a first step in the SLERA for the soil exposure pathway, COPECs are identified by comparing the maximum concentrations of contaminants in surface soil samples from each AOI to the corresponding lowest soil-based ESV from the NPS protocol (NPS 2018) for either plants or invertebrates, and for birds or mammals. For the exposure of birds to lead, maximum soil lead concentrations from each AOI are compared to the lowest revised EcoSSL derived by Sample et al (2019) (i.e., for the American woodcock based on the ED_{10} or the dose resulting in a 10 percent reduction in egg production, and assuming 100 percent bioavailability). For the California red legged frog, standing water COPECs are identified by comparing contaminant concentrations for the one sample collected from the gun pit to chronic surface water ESVs for amphibians from the NPS protocol. In the absence of sediment ESVs for amphibians, the NPS protocol indicates that

[36] For birds and mammals, soil ESVs are back calculated from dose-based toxicity reference values.

all chemicals should be identified as COPECs and evaluated further. For the metals, this step also includes a comparison of the maximum concentration to background concentrations in soil and sediment (i.e., the BTVs described in Section 2.9.6). Metals detected at concentrations that are consistent with the BTVs are considered to be naturally occurring and are not evaluated further in this ERA.

The outcome of this first step is presented on Attached Table 3-10 for soil (see NPS SLERA COPEC Selection), Attached Table 3-11 for standing water and Attached Table 3-12 for sediment. In summary, the identified COPECs consist of:

- At least one metal in AOI 14 through 25, as well as in the standing water and sediment of the gun pit.
- PCBs in AOI 13 and AOI 24 (note that, although the maximum PCBs (total) concentration in soil from AOI 13 does not exceed the screening level ESV, PCBs are carried forward for this AOI given their bioaccumulative properties[37]).
- DNOC is retained as a COPEC since there is no ESV available (note, this chemical was detected in one sample collected from AOI 24).

3.2.3. Refined Screening Level Ecological Risk Assessment

In the refined SLERA, HQs for the COPECs are calculated by dividing the exposure point concentration (EPC) by a refined SLERA ESV for the applicable receptor category (i.e., terrestrial plant, soil invertebrate, bird, mammal, or amphibian).

$$HQ = {}^{EPC}/_{ESV}$$

For this Site, the EPCs are based on the maximum soil contaminant concentration in each of the AOIs, and the contaminant concentrations measured in the one standing water and one sediment sample from the gun pit. The EPCs are compared to the lowest ESV for a particular receptor category. For birds, HQs for lead are calculated using the EcoSSL for American Woodcock based on the ED20 threshold from Sample et al. (2019). For the California red legged frog, standing water HQs are calculated using the NPS protocol surface water amphibian refined screening ESVs based on chronic exposure. Sediment based HQs for the frog are calculated using the NOECs from NAVFAC (2009), where it is noted, there are only values for copper and lead.

The SLERA is designed to minimize the chances of eliminating a COPEC from further consideration when it may pose an actual ecological risk. Thus, the resulting risk calculation is expected to be an overestimate of actual risk and should not be used to derive response action

[37] Of the Aroclors measured in soil, only Aroclor-1260 was detected. Thus, the screening value used in Step 1 is a threshold value for Aroclor-1260 for birds and mammals (LANL 2017).

cleanup levels (USEPA 1997a). If the HQ is < 1, harmful effects are not likely, and the exposure pathway can be eliminated from further evaluation. If the HQ is ≥ 1, that contaminant is a COPEC, and the exposure pathway will be further evaluated in a simple BERA.

The results of the refined SLERA are also summarized in Attached Table 3-10 for soil (see NPS Refined SLERA), Attached Table 3-11 for standing water and Attached Table 3-12 for sediment, and are as follows:

- The HQs for lead are ≥ 1 in more of the AOIs than for the other contaminants evaluated. These consist of AOI 14, AOI 16, and AOI 18 through 25. For terrestrial plants, the HQs for lead range from 2 to 16 in AOI 14 and AOI 20, respectively; for birds, the HQs range from 1.0 to 21 in AOI 22 and AOI 20; and for mammals, the HQs range from 1.6 to 34 in AOI 22 and AOI 20, respectively. For soil invertebrates, the HQ for lead is above 1 only in AOI 20 with an HQ = 1.1. For amphibians, HQs for lead are ≥ 1 in the standing water sample and the sediment sample.

- In AOI 15, HQs are ≥ 1 for selenium and vanadium for terrestrial plants, and above 1 for birds from exposure to vanadium.

- In AOI 16, HQs are ≥ 1 for six metals: antimony, chromium, lead, selenium, vanadium, and zinc. For five of these metals, HQs are ≥ 1 for terrestrial plants, three are ≥ 1 for birds and mammals, and two are ≥ 1 for soil invertebrates. HQs are ≥ 1 for zinc for all four receptor categories in AOI 16.

- In AOI 17, selenium is the only COPEC with HQ ≥ 1, and only for terrestrial plants and mammals.

- In AOI 23, HQs are ≥ 1 for chromium, lead, selenium, and vanadium with terrestrial plants exhibiting HQs ≥ 1 for all four metals.

- In AOI 24, more of the metals exhibit HQs ≥ 1 than for the other AOIs evaluated. These metals consist of antimony, barium, cadmium, chromium, lead, selenium, vanadium, and zinc. Six of these metals are identified as COPECs for terrestrial plants, while antimony is only identified as a COPEC for mammals. Zinc is identified as a COPEC for all four receptor categories.

- PCBs are carried through to the BERA in AOI 24 based on exposure to birds and mammals, and DNOC is carried through due to the lack of an ESV.

- PCBs are also carried through to the BERA in AOI 13 even though the HQs are < 1 given the bioaccumulative properties for this class of contaminants.

Overall, HQs are ≥ 1 for all five receptor categories, but with terrestrial plants exhibiting more exceedances than soil invertebrates, birds, or mammals. Lead is identified as a COPEC in 10 of the 12 AOIs where lead was analyzed, as well as in the standing water and sediment of the gun pit, and more COPECs are identified in AOI 24 (the drainage outlet) than all other AOIs evaluated. For AOI 24, the COPECs include metals and PCBs based on HQs ≥ 1, and DNOC due to the lack of an ESV.

3.2.4. Baseline Ecological Risk Assessment

In the simple BERA, COPECs with receptor-specific HQs ≥ 1 as determined in the refined SLERA undergo further assessment. For birds and mammals, exposure to the COPECs from dietary intake is compared to dose-based toxicity reference values (TRVs) reported in the scientific literature. This evaluation is conducted for the American robin, the red-tailed hawk, the deer mouse, and the red fox. For plants and invertebrates, soil COPEC concentrations are compared to concentration-based threshold values reported in the scientific literature. The exposure assessment and toxicity assessment for these are summarized in the following sections. While HQs are ≥ 1 for amphibians based on the one standing water sample and one sediment sample from the remaining gun pit, the California red legged frog was not evaluated further in the refined BERA for several reasons. First, based on the outcome of the SLERA, in the absence of conducting a more refined risk evaluation, and in light of current plans for site improvement, it has been determined that the gun pit will be cleaned out and renovated to enhance drainage and thereby eliminate any standing water the frog might use for spawning. Second, because the habitat requirements for the California red-legged frog are a shrubby riparian zone with a permanent source of water and emergent vegetation, it is concluded that the Site does not have suitable habitat for the frog (see Appendix B, Attachment 2).

3.2.4.1. *Exposure Assessment*

For plants and invertebrates, exposure is assessed using the individual soil sample COPEC concentration for each AOI to be evaluated.

For birds and mammals, exposure is assessed by calculating a total dietary intake (TDI). TDIs are calculated as a function of an EPC, food ingestion rate, dietary composition, body weight and an area use factor (AUF) for each AOI using the following general equation:

$$TDI = AUF \cdot \left(\frac{(IR_{ss} \cdot C_{ss}) + (IR_f \cdot C_f)}{BW}\right)$$

Where:

TDI	= Total daily intake via ingestion of chemical in diet (mg/kg-day)
AUF	= Area Use Factor (unitless; similar to the fractional intake described above)
IR_{ss}	= Ingestion rate (kg fresh weight of surface soil/individual/day)
C_{ss}	= Chemical concentration in surface soil (mg/kg surface soil)
IR_f	= Ingestion rate of food (kg fresh weight of food/individual/day)

C_f = Chemical concentration in food (mg/kg fresh weight food)
BW = Body weight (kg)

The chemical concentration in the different food items (C_f) is calculated as follows:

$$C_f = \sum\left[\left(F_{tp} \cdot C_{tp}\right) + \left(F_{ti} \cdot C_{ti}\right) + \left(F_{pm} \cdot C_{pm}\right)\right]$$

Where:

F_{tp} = Fraction of the diet composed of terrestrial plants (unitless) (literature)
C_{tp} = Chemical concentration in terrestrial plants (mg/kg fresh weight, calculated)
F_{ti} = Fraction of the diet composed of terrestrial invertebrates (unitless)
C_{ti} = Chemical concentration in terrestrial invertebrates (mg/kg fresh weight, calculated)
F_{pm} = Fraction of the diet composed of prey mammals (unitless)
C_{pm} = Chemical concentration in prey mammals (mg/kg fresh weight, calculated)

Dietary dose for soil is estimated by multiplying the concentration of the chemical in the soil by the soil ingestion rate. The dietary dose for food is a function of the chemical concentration in each food item, the fraction of the food item in the diet, and the food ingestion rate. The concentration of chemicals in food and prey items (plants, invertebrates, small mammals) are estimated using COPEC concentrations in site media and literature-derived bioaccumulation factors (BAFs) (Appendix B, Table 1). If a receptor does not consume a given prey item, the fraction of the diet for that item is 0. The dietary dose for food is further refined by taking into account the fraction of a chemical that is absorbed by the receptor. Receptor specific AUFs are calculated for each AOI as the area of the AOI divided by the home range of the bird or mammal (Appendix B, Table 2). Home ranges are a measure of the area within which a particular bird or mammal will typically hunt or forage for food. AUFs that are less than 1 indicate that only a fraction of the receptor's TDI is from a particular AOI. The receptor parameters (such as dietary composition, body weight, intake rates, and home ranges) are consistent with USEPA guidance and scientific literature. Species-specific exposure parameters for birds and mammals included in the food web model are summarized in Appendix B, Table 3. The calculated TDI values, including the concentration estimates for each dietary item by AOI, are provided in Appendix B, Tables 4a-4m.

3.2.4.2. *Toxicity Assessment*

In the SLERA, risk estimates are based on the lowest ESV across multiple NPS-approved toxicity value sources. However, in the BERA, risk estimates are revised using more species-specific concentrations and/or dose-based toxicity values in a manner that is consistent with USEPA risk assessment guidance.

For birds and mammals, dose-based TRVs are calculated as the geometric mean of the selected no observed adverse effect level (NOAEL) and lowest observed adverse effect level (LOAEL).

For the most part, NOAELs and LOAELs for this EC/CA are from sources used by the NPS protocol such as USEPA's Ecological Soil Screening Level (EcoSSL) documents, Sample et al., (1996), or the Los Alamos National Lab (LANL) ECORISK database (LANL 2017). For birds, the effect threshold selected for lead is from Sample et al. (2019) and is based on an ED20 for egg production in the chicken. The TRVs, their sources, and rationale for selection, are presented in Appendix B, Table 5. For TRVs from the EcoSSL documents, the rationale used by the authors to select the NOAELs is also used for this EC/CA to select the LOAELs. For PCBs, the TRVs are based on Aroclor-1260 from LANL (2017) as this was the only Aroclor detected in the soil samples from the Site. In addition, the TRVs selected for chromium are based on chromium III, as this is the form of chromium expected to be present in the paint used on the concrete structures that has subsequently flaked off and is now in the soil surrounding the buildings.[38]

For plants and invertebrates, concentration-based thresholds are mostly calculated as the geometric mean of the selected NOEC and LOEC from the LANL ECORISK database (Appendix B, Table 6). For chromium, steps 1 and 2 of the SLERA used terrestrial plant and soil invertebrate ESVs based on chromium VI. However, since it is assumed that total chromium measured in soil is chromium III, it is not possible to quantitatively evaluate the potential risks to plants and invertebrates in the simple BERA. This uncertainty is addressed further in Section 3.2.5.

3.2.4.3. *Risk Characterization*

The risk characterization brings together the outcome of the exposure assessment and toxicity assessment. For this EC/CA, the risk characterization is based on a calculation of HQs for each COPEC-receptor pair by AOI. For terrestrial plants and soil invertebrates, HQs are calculated by comparing the EPC (in this case, individual soil sample COPEC concentration) to a threshold concentration as follows:

$$HQ = {}^{EPC}/_{Threshold}$$

For birds and mammals, HQs are calculated by comparing the TDIs and the TRVs as follows:

$$HQ = {}^{TDI}/_{TRV}$$

The outcome of this step, by receptor, is presented in Attached Table 3-10 (see Simple-BERA Refinements) with supporting details in Appendix B. For terrestrial plants and soil invertebrates,

[38] The assumption is that paint used on the concrete would not have contained chromium VI since corrosion protection was not of concern. However, given the extent of removal action being considered associated with other impacts associated with the degradation of paint and its impact on adjacent surface soil (e.g., lead), this unknown is not likely to have an impact on the removal action decision.

Table 6 in Appendix B presents the outcome of this step on a sample-by-sample basis in each AOI.

As shown in Attached Table 3-10, for birds and mammals, by evaluating exposure through dietary intake and accounting for area use, HQs are < 1 for all receptor-COPEC pairs in all AOIs with the exception of the estimated HQ = 2 for the deer mouse's exposure to antimony in soil in AOI 16 (see Section 3.2.5 for a discussion on the uncertainty with this outcome for the deer mouse).

For soil invertebrates, HQs are < 1 in all AOIs with the exception of zinc in AOI 24 (HQ = 5).

For terrestrial plants, HQs are > 1 for lead in AOIs 18, 19, 20, 21, and 23. They are also >1 for barium, vanadium, and zinc in AOI 24. For these metals, with the exception of zinc, all HQs are < 7. The HQ for zinc is 11. For barium and vanadium, given the uncertainty with respect to the selected thresholds, it is unlikely that these COPECs pose unacceptable risk to terrestrial plants at the Site (see Section 3.2.5). As shown in Figure 3-3, the distribution of threshold exceedances for terrestrial plants and soil invertebrates is confined to the following areas:

- AOI 20 (the Battery Commander Station)
- AOI 1 (Radar Pad 1)
- AOI 19 (Radar Platform)
- AOI 21 (East Retaining Wall)
- AOI 23 (NW Retaining Wall)
- AOI 24 (Drainage Outlet-1)

These exceedances are primarily due to lead and zinc which is plausible given the historical use of the Site and the expectation that the presence of these chemicals in soil is due to degrading paint on the structures.

3.2.5. Uncertainty

A summary of the uncertainties inherent to each component of the ecological risk assessment process and how they may affect the quantitative risk estimates and conclusions of the risk analysis is provided here. These uncertainties are associated with the exposure assessment and toxicity assessment as described below.

3.2.5.1. *Exposure Assessment*

Sample collection focused on characterizing locations where elevated contaminant concentrations were anticipated. Consequently, exposure concentrations are conservative and likely result in an overestimation of risk. This overestimation of risk is particularly true for birds and mammals for which exposures were estimated using maximum contaminant concentrations within an AOI rather than an estimate that reflects the spatial distribution of contaminant concentrations to which these receptors are exposed.

The small number of samples collected in some of the AOIs does not allow for the screening step to account for the frequency of detection. If the frequency of detection is < 5 percent, risk assessment guidance indicates that those COPC can be eliminated from further evaluation (USEPA 2018). This approach is conservative and likely results in the evaluation of exposure to COPCs that may otherwise have been eliminated had additional sampling been performed. Also, the soil concentrations used for each receptor's exposure estimate were equal to the maximum detected concentrations in each AOI and therefore exposures estimated would be conservative.

For the deer mouse with an HQ = 2 from exposure to antimony, it is noted that this is based on a maximum antimony soil concentration from AOI 16 which likely overestimates the potential hazard.

3.2.5.2. *Toxicity Assessment*

For terrestrial plants, there is uncertainty with the threshold values used for barium and vanadium due to a lack of toxicity data.

For barium, the plant threshold value calculated as the geometric mean of the NOEC and LOEC reported in the LANL ECORISK database fell below the refined SLERA ESV of 500 mg/kg from ORNL. Therefore, for the simple BERA, the value of 500 mg/kg was selected as the threshold concentration. Because this value is based on one soil exposure study of shoot growth in barley, the authors (Efroymson et al. 1997), have low confidence in its use. In addition, it is not known whether the barium in soil at the Site is in a soluble form such as barium chloride, or an insoluble form such as barium sulfate with low bioavailability. As a result, the potential risks to plants from exposure to barium in soils is uncertain, but likely to be low based on the magnitude of the HQ.

For vanadium, the threshold value used in the simple BERA is based on the geometric mean of a NOEC and LOEC from a single chronic study on the effect of vanadium in soil to the reproduction/development of collard (LANL 2017). It is noted that the NOEC of 60 mg/kg from this study was not selected by NPS (2018) as an ESV for identification of COPECs or as the refined SLERA ESV. Rather, the NPS selected a value of 2 mg/kg for both ESVs, even though confidence in the value is reported to be low (Efroymson et al., 1997). These authors reported that after uptake, most vanadium remains in the root system in an insoluble form with calcium. As a result, the potential risk to plants from exposure to vanadium in soils at the Site is uncertain, but likely to be low based on the magnitude of the HQ.

For DNOC, there are no ESVs in the NPS protocol, and there are no readily available threshold values in the literature. As a consequence, potential risks to ecological receptors from exposure to DNOC is uncertain.

For chromium, steps 1 and 2 of the SLERA used terrestrial plant and soil invertebrate ESVs based on chromium VI even though it is assumed that total chromium measured in soil at the Site is chromium III. Potential risks were not evaluated in the simple BERA due to the lack of

available threshold values for chromium with terrestrial plants and soil invertebrates (and is the reason plant and invertebrate-based EcoSSLs could not be derived for chromium – USEPA 2008a). However, since the simple BERA found that chromium does not pose unacceptable risk to birds or mammals, it is unlikely that chromium will pose unacceptable risk to the terrestrial plants and soil invertebrates at the Site.

For the deer mouse, the antimony NOAEL and LOAEL are based on a study for which antimony exposure was administered via drinking water (USEPA 2005c). The resulting Eco-SSL for mammals reported by USEPA (2005c) is 0.27 mg/kg, below the BTV of 3.0 mg/kg. In other studies, cited by USEPA (2005b) for which exposure was administered in the food or via gavage, NOAELs and LOAELs reported are higher (less stringent). Given this, and the finding that for all other receptor's HQs are < 1 from exposure to antimony, it is unlikely that antimony poses unacceptable risk to ecological receptors at the Site.

3.2.6. Summary and Conclusions

The ecological risk assessment evaluated potential risks to terrestrial plants, soil invertebrates, birds and mammals from exposure to contaminants in the surface soil at the Site. The bird and mammal species selected for evaluation represent the range of food web trophic levels and feeding guilds of those that are likely to use the Site. The ecological risk assessment consisted of a SLERA and a simple BERA.

The SLERA identified a number of COPECs with HQs > 1 in AOIs 13 through 25 for one or more of the receptor categories based on maximum soil contaminant concentrations and conservative ecological screening values. In the simple BERA, the COPEC-receptor pairs were further evaluated by refining the exposure assumptions and using less conservative, but protective, toxicity threshold values. By doing so, all HQs are < 1 for all bird and mammal - COPEC pairs in all AOIs with the exception of the estimated HQ for the deer mouse's exposure to antimony in soil in AOI 16. For the deer mouse, estimated exposure via dietary intake was based on a maximum antimony concentration in the AOI, which along with the uncertainty for the antimony TRV and the lack of potential risk estimated for other receptors, indicates that it is unlikely antimony poses unacceptable ecological risk at the Site. HQs are also < 1 in all AOIs for soil invertebrates with the exception of zinc in AOI 24. For terrestrial plants, HQs are > 1 for lead in AOIs 18, 19, 20, 21, and 23, and HQs are >1 for barium, vanadium, and zinc in AOI 24. As discussed in Section 3.2.5, it is unlikely that barium and vanadium pose unacceptable risk given the uncertainty with their threshold values.

An overall summary of the ecological risk assessment is presented in the table below.

Text Table 3-2: Ecological Risk Assessment Summary by Receptor Category and Area of Investigation	
AOI	**Simple BERA Refined Hazard Quotients[1]**

	Terrestrial Plants	Invertebrates	American Robin	Red-tailed Hawk[2]	Deer Mouse	Red Fox[3]
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15	-	-	-	-	-	-
16	-	-	-	-	-	-
17	-	-	-	-	-	-
18	Lead HQ ≤ 3	-	-	-	-	-
19	Lead HQ ≤ 2	-	-	-	-	-
20	Lead HQ ≤ 7	-		-	-	-
21	Lead HQ ≤ 3	-	-	-	-	-
22	-	-	-	-	-	-
23	Lead HQ ≤ 5	-	-	-	-	-
24	Zinc HQ ≤ 11	Zinc HQ ≤ 5	-	-	-	-
25	-	-	-	-	-	-

Notes
AOI = Area of Investigation
BERA = Baseline Ecological Risk Assessment
HQ = Hazard quotient
"-" = Indicates all HQs are less than or equal to 1 or the COPEC is unlikely to pose unacceptable risk
1 = Hazard quotients presented are based on maximum COPEC concentration within an AOI
2 = All HQs for the Red-tailed hawk < $2x10^{-5}$
3 = All HQs for the Red fox < $3x10^{-4}$

As shown in Figure 3-3 and Table 3-13, for those AOIs with retaining walls (AOI 21 and 23), HQs are > 1 for those samples collected immediately adjacent to the retaining wall. Furthermore, for AOI 18 (Radar Pad 1) and AOI 19 (Radar Platform), HQs are > 1 at only two locations in close proximity to the building structures.

3.3. Development of Preliminary Risk-Based Removal Goals (PRGs)

The purpose of this section is to identify risk-based PRGs. PRGs generally establish the concentrations of contaminants for each exposure medium that will not present unacceptable risk to human health or ecological receptors based on site-specific conditions.

3.3.1. Selection of Human Health Risk-Based Preliminary Removal Goals

Risk-based concentrations were derived for human receptors that could be potentially exposed to chemicals of concern (COCs) in soil. COCs are the chemicals which contribute significantly to unacceptable cumulative cancer risks or noncancer HIs estimates above the risk management goals of $1x10^{-6}$ and 1, respectively. The COCs identified for each receptor exposure scenario are summarized below:

Park Workers:

- Arsenic
- PCBs (total)

Park Residents:

- Arsenic
- DNOC
- PCBs (total)

Maintenance Workers:

- Arsenic
- PCBs (total)

The risk-based concentrations for each of these exposure scenarios have been derived at a target cancer risk of $1x10^{-6}$ and noncancer HQ of 1. They've been developed using the same exposure assumptions and fate and transport models as used to characterize risk in the baseline HHRA. The minimum of the cancer-based and noncancer-based calculations for each chemical is used for each receptor exposure scenario.

Potential exposure of human receptors to lead in soil at the Site was evaluated separately using CalEPA DTSC's residential and commercial/industrial screening levels (DTSC 2020). A conservative soil concentration for residential soil exposure to lead of 80 mg/kg will be used as the PRG for park residents. A conservative soil concentration of 320 mg/kg will be used as the PRG for park workers and maintenance workers.

The calculated human health risk-based concentrations are presented on Attached Table 3-14. The human health PRGs are the lowest of the values calculated for park residents, park workers and maintenance workers, presented below.

Text Table 3-3: Summary of Human Health PRGs

COC	Human Health-Based PRG	Basis, Receptor Exposure Scenario
DNOC	16 mg/kg	Park Resident, Soil Contact
PCBs (total)	0.23 mg/kg	
Arsenic	0.11 mg/kg	
Lead	80 mg/kg	

3.3.2. Selection of Ecological Risk-Based Preliminary Removal Goals

Risk-based PRGs were derived for ecological receptors that could be exposed to chemicals of ecological concern (COECs). COECs are the chemicals that resulted in an estimated HQ greater than 1. Based on the ERA, these ecological receptors consist of terrestrial plants and soil invertebrates. The COECs identified for each receptor are summarized below:

Terrestrial Plants:

- Lead
- Zinc

Soil Invertebrates:

- Zinc

For terrestrial plants and soil invertebrates, the risk-based PRGs are equal to the geometric mean of the chemical specific no observable effect concentration (NOEC) and lowest observable effect concentration (LOEC) for ecological soil screening levels presented in the LANL (2017) EcoRisk Database for generic plants and earthworms, respectively. The resulting preliminary removal goals for these receptors are presented on Attached Table 3-14.

The ecological-based PRGs are the lowest of the values calculated for plant and invertebrate receptors, presented below.

Text Table 3-4: Ecological PRGs

CEC	Ecological-Based PRG	Basis, Receptor Exposure Scenario
Lead	260 mg/kg	Terrestrial Plants
Zinc	360 mg/kg	

3.3.3. Selection of Overall Risk-Based Preliminary Removal Goals

Overall, the risk-based PRGs are based upon site-specific risk-based human health soil concentrations for relevant scenarios of potential human exposure, and risk-based ecological soil concentrations derived with consideration for the terrestrial ecological receptors present at the Site. The Overall risk-based PRGs are summarized below.

Text Table 3-5: Summary of Overall Risk-Based PRGs

COC/CEC	Overall PRG	Basis, Receptor Exposure Scenario
DNOC	16 mg/kg	Park Resident, Soil Contact
PCBs (total)	0.23 mg/kg	
Arsenic	0.11 mg/kg	
Lead	80 mg/kg	
Zinc	360 mg/kg	Terrestrial Plants

4. Identification and Analysis of Applicable or Relevant and Appropriate Requirements

The purpose of Section 4 is to identify Applicable or Relevant and Appropriate Requirements (ARARs) for the Site. ARARs include standards, requirements, criteria, or limitations under federal, or more stringent State, environmental law (CERCLA Section 121 (d)(2)(A)). To be adopted as an ARAR at an NPS CERCLA site, NPS must determine that the requirement is either "applicable" to conditions at the Site or, if not applicable, that it is both "relevant" and "appropriate" based on Site conditions. Applicable requirements are defined by NCP Section 300.5 as those requirements "that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" (40 C.F.R. §300.5). That is, they are laws and regulations that would be enforceable at a particular site even if a CERCLA response action was not occurring. Relevant and appropriate requirements are defined as those requirements "that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their uses are well suited to the particular site." In addition to being applicable or relevant and appropriate, ARARs must be substantive, rather than administrative, and promulgated. For this project, the NPS solicited input from the State and California EPA DTSC provided their requested ARARs in the timely manner. Their requested ARARs have been incorporated into this EE/CA.

It is necessary to identify ARARs prior to evaluating and selecting a cleanup action since circumstances may arise where non-time-critical removal action is expected to be the first and final action at the site and therefore, the selected removal action must satisfy all adopted ARARs (USDOI 2016).

ARARs are classified into the three following categories:

> Chemical-specific ARARs that address specific hazardous substances and are typically health or risk-based numerical values that cleanups must achieve.
>
> Location-specific ARARs that place restrictions on the concentration of hazardous substances or the conduct of activities solely because the response actions occur in the specific location. Location-specific ARARs often focus on protecting resources in a specific area. Therefore, NPS-specific ARARs generally fall within this category.
>
> Action-specific ARARs that are typically technology or activity-based requirements or limitations on actions taken with respect to specific hazardous substances.

Other factors "to be considered" (TBCs) are non-promulgated criteria, advisories, guidance, and proposed standards issued by federal or state governments. TBCs are not enforceable and a response action is not required to attain TBCs, but TBCs may be appropriate in shaping or guiding the development or implementation of a response action in certain circumstances, for example, where ARARs do not provide sufficient direction.

Pursuant to its delegated CERCLA lead agency authority, NPS has identified ARARs and TBCs for the Hawk Hill EE/CA. The results of the ARARs analysis, including state ARARs, are summarized in Text Tables 4.1, 4.2, and 4.3.

4.1. Chemical-Specific ARARs

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. As noted in the table below, a site-specific cleanup goal for arsenic in soil has been calculated in accordance with the California DTSC (2009) Arsenic Strategies Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals. This ARAR-specific PRG is reflected in the selection of RGs as discussed in Section 5.2.

Text Table 4.1 Chemical-Specific ARARs: Hawk Hill

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate or TBC?	Comment
ARARs				
California Code of Regulations	22 CCR §68400.5, 69020, 69021, and 69022	Criteria for establishing cleanup goals.	Applicable	
Federal Occupational Safety and Health (OSHA) Act; Worker Protection Standards	29 USC §§ 651 et seq., 29 CFR Part 1910	Regulates worker health and safety.	Applicable	
Federal Ambient Water Quality Criteria	Clean Water Act 33 USC Section 1314, 40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and humans.	Relevant and Appropriate	Applicable except where California standards are more stringent
RCRA – Maximum Constituent Concentrations in Groundwater	40 CFR §264.94	Specifies standards for 14 hazardous constituents as a part of RCRA ground water protection standards.	Relevant and Appropriate	

Text Table 4.1 Chemical-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Federal Safe Drinking Water Act (SDWA); National Primary and Secondary Drinking Water Standards	40 CFR Parts 141 and 143	Establishes health-based enforceable standards for public water systems, i.e., maximum contaminant levels (MCLs), including potential requirements for contaminant levels in groundwater, and aesthetic-based secondary maximum contaminant levels (SMCLs).	Relevant and Appropriate	
SDWA - Maximum Contaminant Level Goals	40 CFR Part 141	Establishes non-enforceable drinking water goals (MCLGs) set at levels that cause no known or anticipated adverse health effects with an adequate margin of safety without consideration of available treatment technology or cost.	Relevant and Appropriate	
Federal Clean Water Act (CWA); Toxic Pollutant Effluent Standards	40 CFR Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants.	Relevant and Appropriate	
CWA – Surface Water Quality Standards and Criteria and Water Quality Management	40 CFR Parts 130 and 131	Establishes surface water quality standards and criteria based on toxicity to aquatic organisms and human health.	Relevant and Appropriate	

Text Table 4.1 Chemical-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Federal Clean Air Act (CAA); National Primary and Secondary Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Establishes air quality standards protective of public health.	Relevant and Appropriate	
PCB Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions	40 CFR Part 761	Establishes requirements for use, marketing, distribution in commerce, cleanup, disposal, storage, transportation, marking and labeling of PCBs.	Relevant and Appropriate	
CAA - National Emission Standards for Hazardous Air Pollutants	40 CFR §50.6 and Part 61, Subpart K	Imposes management requirements for hazardous emissions, toxic pollutants and particulate matter in the air.	Relevant and Appropriate	
California Toxics Rules	65 Federal Register 31681, b 40 Code of Federal Regulations (CFR), Part 131	Establishes numeric aquatic life criteria for 23 priority toxic pollutants and numeric human health criteria for 57 priority toxic pollutants.	Relevant and Appropriate	

Text Table 4.1 Chemical-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
TBC				
California DTSC Arsenic Strategies Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals	January 2009	Guidance which provides the DTSC Human and Ecological Risk Division (HERD)'s suggested approach for determining arsenic cleanup goals for remediation of sites.	TBC	Per Appendix A, using methodologies presented in this guidance results in an arsenic cleanup goal of 4.7 mg/kg.
NPS Protocol for the Selection and Use of Ecological Screening Values	November 2018	Provides ecological screening values that can be used in support of SLERAs and, in particular, to identify chemicals of potential ecological concern (COPECs).	TBC	
USEPA, Regional Screening Levels (RSLs)	November 2020 or most recent version	Identifies generic screening levels for chemicals in soil, groundwater, air, and the soil-to-groundwater pathway. RSLs are used to screen chemicals at CERCLA sites and promote national consistency in the adoption of risk-based screening criteria.	TBC	

Text Table 4.1 Chemical-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
USEPA Ecological Soil Screening Levels (ESSLs)	USEPA OSWER, Directive 92857-55 (2003)	ESSLs are a set of risk-based ecological soil screening levels for many of the soil contaminants that are frequently of ecological concern for plants and animals.	TBC	
CalEPA DTSC Human and Ecological Risk Office (HERO) Modified Screening Levels	June 2020 or most recent version	Modified screening levels based upon USEPA RSLs for use in the human health risk assessment process at hazardous waste sites and permitted facilities.	TBC	
San Francisco Bay Regional Water Quality Control Board Environmental Screening Levels (ESLs)	January 2019 or most recent version	Provides conservative, risk-based screening values for assessing human and environmental health impacts in soil, groundwater, soil gas, and surface water that can be directly compared to environmental data collected at a site.	TBC	
San Francisco Bay Regional Water Quality Control Board Fact Sheet – PCBs TMDLs	March 2017	Provides guidance on the management of PCBs in soil and building materials at cleanup and spill sites.	TBC	

4.2. Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because the response actions occur in special locations. The following ARARs are applicable to the Site based on its location.

Text Table 4.2 Location-Specific ARARs: Hawk Hill

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Applicable or Relevant and Appropriate or TBC?	Comment
ARARs				
The Organic Act	National Park Service Organic Act, 54 USC Section 100101, et seq., General Authorities Act, as amended, 16 USC Section 1a-1	Requires NPS to manage national parks in such manner as to protect a park's fundamental purpose, resources, and values to leave them unimpaired for the enjoyment of future generations.	Applicable	
Restrictions on Solid Waste Disposal Sites in National Parks	Federal statue 54 USC 100903, 36 CRF Part 6: Solid Waste Disposal Sites in Units of the National Park System	Prohibits operation of any solid waste disposal site that was not in operation on September 1, 1984, except for sites used only for disposal of wastes generated within the park unit, so long as such site will not degrade any natural or cultural resources of the park unit. Regulations implementing 54 USCE 100903 are codified at 36 CFR Part 6. 36 CFR §6.4 specifies 12 conditions that must be met before a new solid waste disposal site may be authorized in a National Park, including the condition that there will be no disposal at the site of solid waste containing hazardous waste, polychlorinated biphenyls (PCBs), or radioactive materials.	Applicable	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Federal Endangered Species Act	50 CFR Parts 200 and 402	Requires action to conserve endangered species and/or critical habitats upon which endangered species depend.	Applicable	
Migratory Bird Treaty Act	16 USC §8703; 50 CFR §§10.2-10.13	Imposes requirements on activities that may involve the "taking" or death of certain protected migratory bird species.	Applicable	
California Endangered Species Act (CESA) (1970)	Fish and Game Code Sections 2050-2116	States that all native species of fish, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved.	Applicable	
Restrictions of Public Use and Recreation Activities	36 CFR Part 2: Resource Protection, Public Use, and Recreation, 36 CFR Part 7: Special Regulations, Areas of the National Park System	NPS 36 CFR Part 2 regulations prohibit specific public use and recreational activities in national parks to protect park resources. NPS 36 CFR Part 7 regulations are park-specific public use and recreational rules.	Relevant and Appropriate	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
National Park Area Nuisance Regulation	26 CFR Part 5: Commercial and Private Operations, 36 CFR §5.13	NPS 36 CFR Part 5 regulations regulate commercial use of national parks and the resources therein (e.g., commercial notices, advertisements, photography, business operations). 36 CFR §5.13 prohibits the creation or maintenance of a nuisance upon federal or private lands within a park area.	Relevant and Appropriate	
Authority of the Secretary of the United States Department of Interior	Executive Order 12580, 42 U.S.C. §9604, 42 U.S.C. §9606, 42 U.S.C. §9607, 42 U.S.C. §9622 USDOI Department Manual, Part 207, Chapter 7	Per Executive Order 12580, as amended, the President has delegated authority to the Secretary of the US DOI to conduct certain actions under CERCLA, including investigations and response activities abatement actions cost recovery and entering into agreements with potentially responsible parties to perform work with respect to remedial actions for releases or threatened releases not on the NPL and removal actions other than emergencies, when the release or threat of release of hazardous substances is on land or facilities under NPS jurisdiction, custody, or control. The Secretary of the Interior has re-delegated the authorities described above to the NPS.	Relevant and Appropriate	
National Historic Preservation Act and Federal Archeological Preservation Act	16 USC §§469 and 470, 40 CFR 6.301	Provides for the preservation of historical or archeological data that might otherwise be irreparably lost or destroyed.	Relevant and Appropriate	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
TBC				
2014 General Management Plan	Final General Management Plan/Environmental Impact Statement Vol. I and II	Provides a basic management philosophy for a park and framework for future decision making.	TBC	
NPS Policies for Restoration of Natural Systems	2006 NPS MP §4.1.5	States that the NPS will reestablish natural functions and processes in parks unless otherwise directed by Congress. Landscapes disturbed by natural phenomena will be allowed to recover naturally unless manipulation is necessary to protect other park resources, developments, or employee and public safety.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
NPS Policies for Managing Wildlife and Plant Resources	2006 NPS MP §4.4.1	Provides that the NPS will maintain as parts of the natural ecosystem of parks all plants and animals native to park ecosystems by preserving and restoring native plant and animal populations and habitats and minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them.	TBC	
NPS Policies for Managing Species of Special Concern	2006 NPS MP §4.4.2.3	Provides that the NPS will survey for, protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act. Additionally, the NPS will inventory other native species that are of specific management concern to the parks and will manage them to maintain their natural distribution and abundance.	TBC	
NPS Policies Concerning Surface Water and Ground Water Quality	2006 NPS MP §4.6.3	States that NPS will take all necessary actions to maintain or restore the quality of surface waters and groundwaters within the parks consistent with the Clean Water Act and all other applicable federal, state, and local laws and regulations.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
NPS Policies for Importation of Soil During Site Restoration	2006 NPS MP §4.8.2.4	Allows import of off-site soil or soil amendments to restore damaged sites. The off-site soil will normally be salvaged soil unless the use of pristine site soil can be achieved without causing any overall ecosystem impairment. Prior to using any off-site materials, parks must develop a prescription and select the materials needed to restore the physical, chemical, and biological characteristics of the original native soils without introducing any exotic species.	TBC	
NPS Policies for Managing Cultural Resources	2006 NPS MP §5f	Addresses research on cultural resources and traditional associated peoples; planning to ensure that management processes integrate information about cultural resources for setting priorities and decision making; and the preservation, protection, and the making available for public understanding of cultural resources.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
NPS Policies Concerning Revegetation and Landscaping	2006 NPS MP §9.1.3.2	Requires that, to the maximum extent possible, plantings selected for revegetation will consist of species that are native to the park, and that low water use practices should be employed. This provision also addresses use of fertilizers and other soil amendments.	TBC	
NPS Policies Concerning Waste Management and Contaminant Issues	2006 NPS MP §9.1.6.1-9.1.6.2	Section 9.1.6.1 (Waste Management) states that all disposal of solid waste on lands and waters within the boundaries of a park system unit must comply with regulations of 26 CFR Part 6 (see above) and that the NPS will remove landfill operations and associated impacts from parks where feasible. Section 9.1.6.2 (NPS Response to Contaminants) states that the NPS will make every reasonable effort to prevent or minimize the release of contaminants on or that will affect NPS lands or resources and will take all necessary actions to control or minimize such releases when they occur.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
NPS Policies Concerning Climate Change	NPS Policy Memorandum (PM) 15-01, "Addressing Climate Change and Natural Hazards" (Jan. 20, 2015) and accompanying Level 3 Handbook PM 12-02, "Applying NPS Management Policies in the Context of Climate Change" (March 6, 2012) PM 14-02, "Climate Change and Stewardship of Cultural Resources" 2006 NPS MP §9.1.1.5	NPS Policy Memorandum (PM) 15-01 and its accompanying Handbook provide guidance on the design of facilities in national parks to incorporate impacts of climate change and natural hazards. PM 15-01 specifically references NPS MP Section 9.1.1.5, which directs NPS to strive to site facilities where they will not be damaged or destroyed by natural physical processes and discusses siting considerations in areas where dynamic natural processes cannot be avoided.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
NPS Employee Guidance for Managing Cultural Resources	NPS DO #28: Cultural Resource Management NPS-28: Cultural Resource Management Guideline	DO #28 provides that the NPS will protect and manage cultural resources in its custody through effective research, planning, and stewardship and in accordance with the policies and principles contained in the NPS Management Policies. Additionally, it requires that the NPS comply with the Secretary of the Interior's Standards and Guidelines for Archeology, and Historic Preservation. NPS-28: Cultural Resource Management Guideline addresses park cultural resource management programs, compliance with Section 106 of the National Historic Preservation Act, and issues related to archaeological resources, cultural landscapes, structures, museum objects, and ethnographic resources.		
NPS Employee Guidance for Managing Wilderness	NPS DO #41: Wilderness Stewardship Reference Manual (RM)-41	DO #41 and the related RM-41 offer comprehensive guidance to NPS employees responsible for managing, conserving, and protecting wilderness character and resources found in park units.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
NPS Employee Guidance for Managing Natural Resources	NPS Reference Manual (RM) #77	Offers comprehensive guidance to NPS employees responsible for managing, conserving, and protecting the natural resources found in park units. It addresses management of natural resources, resource uses, and planning.	TBC	
Cooperative Agreement between NPS and GGNPC	Cooperative Agreement P19AC00821 (DUNS No. 5555500453)	Cooperative agreement to support GGNRA Public Programs through funding that will occur in subsequent task agreements between August 2, 2019, and July 30, 2020. Agreement between the NPS and GGNPC to work closely and collaboratively to implement their shared goals regarding public engagement, resource protection, and visitor enjoyment.	TBC	
NPS-GGNRA Superintendent's Compendium	June 17, 2020 Superintendent's Compendium for the GGRNA	Establishes regulatory provisions for the proper management and protection of land and water administered by the NPS within the GGNRA.	TBC	
National Historic Preservation Act (1966)	Public Law 89-665; 54 U.S.C. 300101 et seq.	Applies to the site if the selected removal action impacts any historic sites protected by the act.	TBC	

Text Table 4.2 Location-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Programmatic Agreement Among the Golden Gate National Recreation Area, National Park Service, The Advisory Council on Historic Preservation, and the California State Historic Preservation Officer, and the Federated Indians of Graton Rancheria Regarding Operational and Maintenance Activities in Golden Gate National Recreational Area	July, 2014	Programmatic agreement regarding the Park's undertakings with regards to historic properties.	TBC	

4.3. Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. These requirements are triggered by the particular removal activities selected.

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
ARARs				
Federal Occupational Safety and Health (OSHA) Act; Worker Protection Standards	29 USC §§ 651 et seq., 29 CFR Part 1910	Regulates worker health and safety.	Applicable	
Federal Resource Conservation and Recovery Act (RCRA); Identification and Listing of Hazardous Waste	40 CFR Part 261, Subparts C and D	Establishes requirements for the identification and management of solid and hazardous wastes and defines those solid wastes that are subject to and regulated as hazardous wastes under 40 CFR Parts 262-270.	Applicable	
RCRA – Hazardous Waste Treatment Standards	40 CFR Part 268, Subpart D	Establishes treatment standards for hazardous wastes or hazardous waste extracts before land disposal is allowed.	Applicable	
PCB Waste Management	40 CFR Part 761	Regulates the management and disposal of PCB-contaminated articles and remediation wastes.		

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
RCRA – Hazardous Waste Management Standards for Treatment, Storage and/or Disposal Facilities	40 CFR Parts 264 and 265 (including Subpart N for landfills)	Establishes management standards, and cleanup and closure requirements for facilities at which hazardous wastes are treated, stored and/or disposed.	Applicable.	
RCRA – Hazardous Waste Management Standards for Generators and Transporters	40 CFR Parts 260 through 263	Establishes requirements for (1) the identification and management of solid and hazardous wastes, and (2) the generation and/or transportation of hazardous wastes.	Applicable	
Federal Hazardous Materials Transportation Act (HMTA) - Hazardous Materials Transportation Regulations	49 USC § 5101 et seq.; 49 CFR Parts 171-177	Imposes identification, labeling, packaging, and shipping requirements with respect to the shipment of Department of Transportation-defined hazardous materials.	Applicable	

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Clean Water Act (CWA) (1972)	Public Law 92 – 500	Its objective is to restore and maintain the chemical, physical, and biological integrity of the nation's water by preventing point and nonpoint pollution sources, providing assistance to publicly owned treatment works, for the improvement of wastewater treatment, and maintaining the integrity of wetlands.	Applicable	
CWA – Storm Water Requirements	33 USC Section 1342; 40 CFR Part 122	Regulates the discharge of storm water from industrial and construction sites, inter alia. Requires implementation of best management practices, including run-on and run-off controls, sedimentation basins, etc.	Applicable	Applicable if more than 1 acre of land is disturbed, unless California requirements are more stringent. Relevant and appropriate for smaller areas.
California Code of Regulations	Title 23, Section 2550.7, and Title 27, Section 20415	Requires general monitoring of all areas at which waste has been discharged to land.	Applicable	

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
California Code of Regulations	Title 23, Section 2550.9, and Title 27 Section 20425	Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent.	Applicable	
California Hazardous Waste Control Law	22 CCR Chapter 11 §66261.24	Presents criteria for testing and identifying RCRA hazardous wastes, sets levels for total threshold limit concentrations (TTLC) and soluble threshold limit concentration (STLC).	Applicable	These criteria and TTLC and STLC levels will be applied for the characterization of excavated soil or other wastes generated by the remedial action.
California Hazardous Waste Control Law	22 CCR §66262.10 (a) and 66262.11	Establishes standards for generators of hazardous wastes in California, including those for hazardous waste determination, manifesting, transportation record keeping, and reporting.	Applicable	Substantive requirements will be applicable if excavated soils or treatment residuals exceed RCRA hazardous waste thresholds.

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
California Code of Regulations	22 CCR, Division 4.5, Chapter 13, §66263.10-.18	Establishes standards that apply to persons transporting hazardous wastes in California.	Applicable	These requirements will be followed for transporting hazardous waste off site.
California Hazardous Waste Control Law	22 CCR §66264.13 (a) and (b)	Requirements for analyzing wastes to determine whether waste is hazardous.	Applicable	Waste will be analyzed.
California Hazardous Waste Control Law	22 CCR §66264.171 through §66264.173	Containers of RCRA hazardous waste must be: (1) maintained in good condition; (2) compatible with hazardous waste to be stored; and (3) closed during storage except to add or remove waste.	Applicable	
California Hazardous Waste Control Law	22 CCR §66264.174	Inspect container storage areas weekly for deterioration.	Applicable	
California Hazardous Waste Control Law	22 CCR §66264.175 (a) and (b)	Place containers on a sloped, crack free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.	Applicable	

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
California Hazardous Waste Control Law	22 CCR §66264.178	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Applicable	
California Hazardous Waste Control Law	22 CCR §66264.601 (b), (c), and (d)	Design and operating standards for unit in which hazardous waste is stored or treated. Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary tanks and container storage areas.	Applicable	
California Hazardous Waste Control Law	22 CCR §66264.111	Minimize the need for further maintenance controls and minimize or eliminate, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated rainfall or runoff, or waste decomposition products to groundwater, surface water, or the atmosphere.	Applicable	
California Hazardous Waste Control Law	22 CCR §66264.250 through 66264.259	Regulates the storage and treatment of hazardous waste in piles.	Applicable	

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Remediation Waste Staging Piles	40 CFR §264.554	States a staging pile must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the staging pile originated.	Applicable	
Hazardous Waste Disposal Site Approval	Title 27, Section 20210, and Title 23 Section 2520 of the CCR	Requires that wastes identified as hazardous be allowed only at waste management units that have been approved and classified.	Applicable	
Hazardous Waste Labeling	CCR Title 22, Sections 66262.30 through 66262.33 of the CCR	Requires that containers used to contain hazardous wastes are packaged, labeled, marked, and placarded in accordance with RCRA and Department of Transportation requirements.	Applicable	
California Code of Regulations	22 CCR §66264.25(b)	Requires cover and cover systems and all containment and control features remaining after closure to withstand the maximum credible earthquake without decreasing environmental and public health protection.	Relevant and appropriate	Not applicable unless a cap/cover is installed as part of the remedy.

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
Corrective Management Rule	22 CCR §66268.124, 66264.91, 66262.100, 66264.708; 66270.30; and 66272.1	Identifies hazardous wastes that are restricted from land disposal.	Relevant and appropriate	Applicable if excavated soil or treatment residuals exceed limits before treatment. TTLC/STLC will be used to determine if they exceed disposal limits, if necessary.
California Code of Regulations	22 CCR §67391.1(a), (b), and (d)	States that if a remedy results at levels not suitable for unrestricted use, then the Remedial Action Plan/Record of Decision is to clearly define and include limitations on land use and hazardous substances remaining on the property.	Relevant and appropriate	Applicable if post-closure land-use restrictions are required.
California Code of Regulations	23 CCR §2250.7 through 2250.10	Requires remedial action monitoring.	Relevant and appropriate	Applicable if groundwater monitoring will be performed.

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
California Code of Regulations	27 CCR §20200(c) and 20210	Requires generators to properly characterize waste and dispose of designated waste at Class I or II units.	Relevant and appropriate	If drums or containers are discovered during excavation, or if waste is produced (for example, drill cuttings, used oil) the contents will be analyzed in accordance with these requirements to select the appropriate off-site disposal requirements.
National Environmental Policy Act (NEPA)	42 U.S.C. §4321 et seq. (1969)	NEPA's basic policy is to assure that all branches of government give proper consideration to the environment prior to undertaking any major federal action that significantly affects the environment.	Relevant and Appropriate	
California Environmental Quality Act (CEQA)	California Code of Regulations, Chapter 3 of Title 14	Requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.	Relevant and Appropriate	
CAA – National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61, Subpart K, and 40 CFR § 50.6	Imposes management requirements for hazardous emissions, toxic pollutants, and particulate matter in the air.	Relevant and Appropriate	

Text Table 4.3 Action-Specific ARARs: Hawk Hill				
Standard, Requirement, Criteria, or Limitation	**Citation**	**Requirement Description**	**Applicable or Relevant and Appropriate or TBC?**	**Comment**
CAA – National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes air quality standards protective of public health.	Relevant and Appropriate	
TBCs				
None				

5. Removal Action Objectives and Removal Goals

This Section presents the RAOs and scope for the NTCRA. RAOs define what the removal action is intended to accomplish. Specific RAOs are presented in Section 5.1. Other aspects of the RAOs are described therein and in Section 5.2.1 (Background and Reference Concentrations). The proposed Removal Goals were determined by applying the understanding of the CSM (Section 2), accounting for the results of the risk assessment (Section 3), and taking into consideration ARARs (Section 4) relevant to the scope of the NTCRA.

5.1. Identification of Removal Action Objectives

The RAOs for this EE/CA are as follows:

- Eliminate, or reduce to the extent practicable, levels of COCs DNOC, PCBs (total), arsenic, and lead in soil at select areas where concentrations could pose unacceptable risk to human health via direct human contact.
- Eliminate, or reduce to the extent practicable, levels of COECs lead and zinc in soil at select areas where concentrations could pose unacceptable risk to ecological receptors.
- Eliminate contaminant-related constraints on the full enjoyment and utilization of park resources consistent with NPS mandates.
- Attain all other federal and state ARARs.

5.2. Response Action: Removal Action Goals Selection

Removal action goals (RGs) are selected with consideration for the risk-based PRGs discussed in Section 3.3, ARAR-specific PRGs noted in Section 4.1, and background concentrations for naturally-occurring COCs/COECs in soil as noted in Section 5.2.1 to ensure that the removal action will be technically feasible and cost effective.

5.2.1. Background and Reference Concentrations

To ensure cleanup will be technically feasible and cost effective, and to reduce the potential for recontamination of clean areas from surrounding sources, the selection of RGs accounts for background concentrations of naturally occurring chemicals (e.g., metals) in soil. Section 2.8.6 discusses how the HHRA and ERA accounted for naturally occurring concentrations in characterizing potential site-related risks to human health and the environment and what data were used for this purpose.

With regards to selecting appropriate RGs for this Site, the calculated BTVs were used. As discussed in Section 2.8.6, BTVs represent estimates of the upper-end of the range of background concentrations, and soil concentrations below these levels would reasonably be considered naturally occurring. The following table presents the BTVs for the COC/CEC that have naturally occurring concentrations at the Site.

Text Table 5-1: Background Threshold Values	
COC/CEC	**BTV**
Arsenic	3.2 mg/kg
Lead	45 mg/kg
Zinc	120 mg/kg

5.2.2. Removal Goal Selection

A comparison of the risk-based human health and ecological PRGs, ARAR-based PRGs, and representative background and reference concentrations is presented in Text Table 5-2. The lower (i.e., more protective) of the human health or ecological PRG was chosen as the RG unless the background concentration of the contaminant judged to be representative of unimpacted conditions was greater than the PRGs, in which case the background concentration was selected as the RG. In the case of arsenic, the ARAR-specific PRG calculated was used as this concentration represents California EPA's recommended approach to characterizing naturally occurring levels of arsenic in soil.

The selected RGs and the basis for selection are included in Text Table 5-2.

Text Table 5-2 RG Selection						
COC or CEC	**Background or Reference Value**	**Human Health PRG**	**Ecological PRG**	**ARAR-Based PRG**	**Basis for RG**	**RG**
Soil						
DNOC	NA	16 mg/kg Park Resident	NC	NC	Human Health PRG	16 mg/kg
PCBs (total)	NA	0.23 mg/kg Park Resident	NC	NC	Human Health PRG	0.23 mg/kg
Arsenic	3.2 mg/kg	0.11 mg/kg Park Resident	NC	4.7 mg/kg	ARAR-specific PRG	4.7 mg/kg
Lead	45 mg/kg	80 mg/kg Park Resident	260 mg/kg Plants	NC	Human Health PRG	80 mg/kg

Text Table 5-2 RG Selection						
COC or CEC	**Background or Reference Value**	**Human Health PRG**	**Ecological PRG**	**ARAR-Based PRG**	**Basis for RG**	**RG**
Zinc	120 mg/kg	NC	360 mg/kg Plants	NC	Ecological PRG	360 mg/kg
Notes: NA – Not applicable NC - PRG not calculated [not a risk driver for human or ecological exposure or did not have ARAR-specific level]						

5.3. Determination of Removal Action Scope

The scope of the removal action is to address COCs in soil that exceed the RGs. As described in Section 2.9, Hawk Hill will continue to be operated as a recreational site open to visitors, with plans to renovate and improve accessibility to the public while keeping site resources unimpaired for the enjoyment of future generations. Currently, the GGNPC and the NPS are planning Phase 3 of the Hawk Hill Visitor Improvement Project, which will involve the rehabilitation of the historic military structures, including the SF-87C Target Tracking Radar Platforms, improve sustainability and accessibility of overlooks and seating, expand educational opportunities through enhanced wayfinding and interpretive materials, and protect natural and cultural resources. Phase 3 of the Hawk Hill Visitor Improvement Project will comprise of performing the proposed removal action of contaminated soil and hazardous building materials

6. Identification of Removal Action Alternatives

The purpose of this section it to present the removal action alternatives proposed to achieve the RAOs identified in Section 5. The selected removal action must meet the RAOs and comply with ARARs. The location of the Site within a unit of the National Park System must be considered when evaluating removal alternatives. General response actions are categories of remedial options for the Site that, when implemented, will allow for site conditions to achieve the RAOs. The identified potential remedial technologies and process options were preliminarily screened according to their overall applicability (technical implementability) to soil, the COCs, and the site-specific conditions. The purpose of this screening effort is to evaluate the available technologies and process options and to eliminate those not applicable to the Site. The following potential remedial technologies were evaluated through a preliminary screening, as follows:

- No Action

  No action leaves contaminated materials in their current condition and assumes no further remedial activities will occur. No monitoring is associated with this technology.

  Preliminary Screening Evaluation
  Consistent with the NCP and CERCLA guidance, a “no action” alternative is retained for further evaluation as a baseline for comparison to other remedial alternatives developed.

- Institutional Controls

  Institutional controls (ICs) restrict access to or control the use of the Site (e.g., zoning, deed restrictions, environmental easements, or access restrictions). Enforcement of ICs can require periodic inspections and patrols, training for park personnel required to access the restricted areas, and potentially legal action against trespassers.

  Preliminary Screening Evaluation
  Institutional controls are not appropriate for NPS cleanup actions unless the ICs will not impair the purpose, or fundamental resources and values for which the park was established to preserve and protect. ICs must be documented in the Superintendent’s Compendium for that NPS unit. ICs which prohibit or limit access to the Site, such as fencing or creating limited or restricted access areas, will not allow for the full enjoyment and utilization of park resources consistent with NPS mandates. Therefore, ICs such as fencing or access restrictions do not meet the RAOs or ARARs and are not considered for further evaluation. However, residential use of the Site is not a likely exposure scenario. Therefore, planning restrictions prohibiting future residential use of the Site could be combined with existing planning restrictions prohibiting taking of lupine with other remedial activities to address risks posed to park visitors, workers and ecological receptors (the reasonably foreseeable users of the Site) and would still allow for full enjoyment and utilization of park resources. Existing planning restrictions prohibiting taking of lupine (e.g., formal NEPA evaluation, consultation with other agencies, habitat restoration and site monitoring) would

continue to protect the lupine and prevent human exposure to lead left in the ground around undisturbed lupine plants as part of the remedial alternative. Therefore, a restriction on residential use of the Site is retained for further evaluation in combination with other remedial technologies as a component of a remedial alternative.

- Containment

Containment is a type of engineering control used to reduce the mobility of, and exposure to, COCs in soils. These goals are accomplished by creating a barrier that prevents direct exposure and transport of waste from the contaminated source area. Engineering controls do not reduce the volume or toxicity of the hazardous material. One type of EC applicable to COCs at the Site is containment via capping in place, either through asphalt or placing a clean soil barrier over contaminated soils.

Preliminary Screening Evaluation
Containment has been implemented extensively with proven success and would meet some of the RAOs and ARARs for this Site, however capping would require placing asphalt or soil cover over contaminated soil which could reduce the quality of habitat and would not achieve the non-impairment RAO. Restrictions on use and prohibitions on digging in capped areas would be required through implementation of ICs and would be difficult to enforce for ecological receptors. Given that containment will not allow for the full enjoyment and utilization of park resources consistent with NPS mandates, containment is not considered for further evaluation.

- Treatment

According to the Federal Remediation Technologies Roundtable Remediation Technologies Screening Matrix and Reference Guide 4.0[39], potentially applicable treatment technologies for metals in soil include *in-situ* solidification/stabilization (S/S) or *ex-situ* physical or chemical treatment. Available *ex-situ* physical/chemical treatment technologies for metals in soil include chemical extraction, chemical reduction/oxidation, separation, soil washing followed by precipitation, and S/S.

Preliminary Screening Evaluation
The relatively small quantity of soil requiring treatment combined with the site conditions, including steep embankments and the absence of suitable areas to install treatment equipment make *in-situ* and *ex-situ* treatment options less favorable and more costly compared to other available technologies; therefore, treatment technologies have not been retained for further evaluation.

- Excavation and Off-Site Disposal

Excavation and off-site disposal involve removal of contaminated soil and subsequent off-site disposal in a landfill licensed to accept the waste. Excavated areas are backfilled with clean soil,

[39] http://www.frtr.gov/matrix2/top_page.html

returned to original grade, if necessary, and revegetated or otherwise stabilized to prevent erosion. Excavated soil would be stockpiled at an on-site staging area for waste characterization or would be characterized in-situ to facilitate direct loading of soil into trucks. Excavated soil would be transported off-site to an appropriate disposal facility.

Preliminary Screening Evaluation

Excavation of soil at the Site is implementable although site specific conditions, such as the presence of steep slopes, existing structures and retaining walls, and sensitive ecological receptors at the Site would require special consideration to comply with ARARs. Excavations on steep hillsides and/or near existing structures and retaining walls would require evaluation by a geotechnical engineer to ensure excavations can be completed safely and without damage to existing structures. Excavation activities would need to consider potential impacts to ecological receptors, including the mission blue butterfly. Off-site disposal of lower-concentration metals contaminated soil can be less expensive when compared to treatment options and can provide the most definitive removal of contaminants from a site. Excavation and off-site disposal are anticipated to meet the RAOs and expected to comply with ARARs, therefore, excavation and off-site disposal are retained for further evaluation.

Remedial alternatives were developed using the remedial technologies retained following the initial screening. Each alternative is described in the following subsections. Cost estimate details for each alternative are provided in Appendix C. The costs were estimated using recent costs for projects of similar scope located in the Bay Area, as well as methodologies prescribed by USEPA in cost estimating guidance for CERCLA sites (USEPA 2000).

6.1. Alternative 1: No Action

Consistent with the NCP and CERCLA guidance, a “no action” alternative is considered as a baseline for comparison. Under this alternative, no remedial action, monitoring, or maintenance would be performed. This alternative would not include a mechanism to prevent future exposure to contaminants and would fail to achieve the RAOs for the Site. If no action is taken, lead, arsenic, PCBs, zinc, and DNOC in soil would continue to pose a potential unacceptable risk to human and ecological receptors.

6.2. Alternative 2: Limited Soil Removal and Off-Site Disposal, Residential Use Restriction

Alternative 2 would involve limited excavation and off-site disposal of shallow soil from the approximate areas shown on Figure 6-1. This alternative would excavate soil to address residual risk for the reasonably foreseeable future land users (park visitors, park workers, and ecological receptors) but would leave soil in place that exceeds levels that pose an unacceptable risk to the park resident via direct contact. The alternative would rely on a residential use restriction to address the remaining residual risks posed to the park resident.

The horizontal and vertical limits of excavations under Alternative 2 were estimated using the existing soil data set. Under this alternative, an estimated total of 100 bank cubic yards (BCY) of soil would be excavated from the areas described below. Additional details regarding volume estimates are provided in Attached Table 6-1.

AOI-16 (Casemate 2): soil excavation to an estimated depth of 0.5-foot bgs to address arsenic in shallow soil within Casemate 2. An estimated 0.4 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for arsenic analysis.

AOI-18 (Radar Pad 1): soil excavation to depths between 1 and 1.5 feet bgs to address elevated lead concentrations detected in soil east of the radar pad. The vertical extent of excavation is not bounded in the vicinity of SS-5-2. An estimated 9 BCY would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-19 (Radar Platform): soil excavations to depths of 1-foot bgs to address elevated lead detected in soil within the dripline of the elevated radar platform. An estimated 15 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-20 (Battery Commander Station): soil excavations to depths of 1-foot bgs to address elevated lead detected in shallow soil northeast of the Battery Commander Station. An estimated 7 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis. In addition, sediment containing elevated levels of lead was identified in an internal drain in the upper room of the Battery Commander Station (sample identification ID-U). Under Alternative 2, sediment would not be removed from the drain line but access to the drain line would be capped and the material left in place.

AOI-21 (East Retaining Wall): soil excavations to depths of 1 and 1.5 feet bgs to address elevated lead detected in shallow soil adjacent to the east retaining wall. An estimated 27 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-23 (Northwest Retaining Wall): soil excavations to depths between 1 and 1.5 feet bgs to address elevated lead detected in shallow soil adjacent to the northwest retaining wall. The vertical extent of excavations is not bounded in a number of soil sample locations collected from this AOI. An estimated 28 cubic yards of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-24 (Drainage Outlet 1): soil excavation to depths at least 2 feet bgs to address elevated lead, zinc, PCBs, and DNOC detected in sediment at the drainage outlet. An estimated 16 cubic yards of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead, zinc, PCBs, and DNOC analysis.

To reduce potential impacts to the mission blue butterfly, work would be implemented outside of the flight period for the mission blue butterfly which occurs generally from mid-February to mid-July. Due to the steep slopes, soil excavation activities would also need to be completed when soil is the driest during the summer months (generally June, July, August, and September) in order to be completed safely. Excavations that are adjacent to existing structures and retaining walls (e.g., AOI-18, AOI-21, AOI-23, and AOI-24) would require evaluation by a geotechnical engineer prior to the excavations to ensure slope stability and to preserve the integrity of the existing structures and containment walls.

The excavation areas under Alternative 2 would require removal of existing vegetation, clearing and grubbing of approximately 0.1 acre, though potentially more if the results of confirmation soil samples indicate additional soil removal is necessary to remove soil above RGs. Dust control measures and stormwater pollution control best management practices would be implemented during soil disturbing activities. Confirmation soil samples would be collected from the excavation bottom and sidewalls at a frequency of one sample per 25 square feet of excavation bottom (minimum one sample per excavation) and one sample every 25 linear feet of excavation sidewall (minimum four sidewall samples per excavation). Confirmation sampling results would be evaluated relative to the RGs to confirm if the limits of excavation are complete. Upon receipt of acceptable soil confirmation sample results, the excavations would be backfilled with clean fill material imported to the Site that complies with the NPS specifications and SOPs for imported fill material. Disturbed areas would be stabilized to prevent erosion utilizing a weed-free seed mixture approved for use at the Site.

Excavated soil would be transported and disposed of off-site at a waste facility licensed to accept the type of waste identified. The type of facility will depend on the class and concentration of hazardous materials in the waste. Characterization of soil for disposal will be governed by receiving facility requirements, such as the number of samples and required analyses per unit volume of soil, and leachate testing procedures such as the California Waste Extraction Test (WET) and the federal Toxicity Characteristic Leachate Procedure (TCLP). Based on initial WET and TCLP testing conducted by Weiss (Weiss 2019), it is assumed that the excavated soil where it contains elevated concentrations of lead would require off-site disposal as California non-RCRA hazardous waste at a Class I disposal facility. The closest Class I facility is the Kettleman Hills landfill located in Kettleman City, California. Ultimately, however, the determination of the appropriate disposal facility would be based on the results of additional waste characterization sampling. Soil excavated from AOI-24 would require segregation from other excavated soil due

to elevated levels of PCBs and Performance-Based disposal in accordance with 40 CFR Part 761(b).

This alternative is expected to comply with ARARs, through the following:

- Excavations are not anticipated to extend into the boundaries of the areas designated as habitat for the mission blue butterfly to comply with the Endangered Species Act.
- Existing site structures will not be demolished to complete the excavation activities and will be preserved to protect historic resources at the Site.
- Dust control measures will be implemented during soil disturbing activities to comply with local air district requirements.
- Soil backfill and site restoration for the excavation areas will be implemented in accordance with requirements consistent with NPS guidance.
- Standard health and safety procedures would be implemented during excavation and soil handling activities to protect workers consistent with OSHA requirements.
- Excavated soil will be characterized to identify proper waste handling and disposal requirements. Soils characterized as hazardous wastes will be handled in accordance with applicable state and federal regulations. Soil excavated from AOI-24 contains PCBs greater than 1 milligram per kilogram (mg/kg) and Performance-based disposal will comply with 40 CFR Part 761(b). Hazardous wastes will be transported under the appropriate waste documentation procedures.
- Stormwater BMPs will be implemented to comply with the Clean Water Act.

6.3. Alternative 3: Excavation and Off-Site Disposal

Alternative 3 would involve excavation and off-site disposal of shallow soil from the approximate areas shown on Figure 6-2. This alternative would excavate soil where COCs have been detected above RGs. Under this alternative, additional land use restrictions are not anticipated to be required.

The horizontal and vertical limits of excavations under Alternative 3 were estimated using the existing soil data set. Under this alternative, an estimated total of 300 BCY of soil would be excavated from the areas described below. Additional details regarding volume estimates are provided in Attached Table 6-2.

AOI-14 (Casemate 1): soil excavation to an estimated depth of 1-foot bgs to address lead in shallow soil around the dripline of the Casemate 1 roof and walls. An estimated 6 BCY

of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-16 (Casemate 2): soil excavation to an estimated depth of 1-foot bgs to address lead in shallow soil around the dripline of the Casemate 2 roof and walls. An estimated 35 BCY of soil would be excavated from this area. Soil excavation to an estimated depth of 0.5-foot bgs would also be completed to address arsenic in shallow soil within Casemate 2. An estimated 0.4 BCY of soil would be excavated from this area Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead or arsenic analysis.

AOI-18 (Radar Pad 1): soil excavation to depths between 1 and 1.5 feet bgs to address elevated lead concentrations detected in soil east of the radar pad. The vertical extent of excavation is not bounded in the vicinity of SS-5-2. An estimated 55 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-19 (Radar Platform): soil excavations to depths of 1-foot bgs to address elevated lead detected in soil within the dripline of the elevated radar platform. An estimated 23 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-20 (Battery Commander Station): soil excavation to a depth of 1-foot bgs to address elevated lead detected in shallow soil northeast of the Battery Commander Station. An estimated 7 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis. In addition, sediment from within an internal drain in the upper room of the Battery Commander Station (ID-U) would require removal. Confirmation samples would not be collected from the internal drain unit. The extent of lead-impacted soil in the drain line is not known but is assumed to be approximately 3 cubic yards based on an assumption that the drainpipe is 18-inches in diameter and approximately 40 feet long[40] and fully filled with soil. It is assumed the soil inside the drainpipe could be removed pneumatically and containerized for disposal.

AOI-21 (East Retaining Wall): soil excavations to depths between 1 and 1.5 feet bgs to address elevated lead detected in shallow soil adjacent to the east retaining wall. The vertical extent of excavations is not bounded in a number of soil sample locations collected from this AOI. An estimated 79 BCY of soil would be excavated. Confirmation

[40] Based on historical drawings of Battery Commander Station from 1963.

soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-22 (Radar Pad 2): soil excavations to a depth of 1-foot bgs to address elevated lead detected in shallow soil. An estimated 9 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-23 (Northwest Retaining Wall): soil excavations to depths between 1 and 1.5 feet bgs to address elevated lead detected in shallow soil adjacent to the northwest retaining wall. The vertical extent of excavations is not bounded in a number of soil sample locations collected from this AOI. An estimated 51 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

AOI-24 (Drainage Outlet 1): soil excavation to depths at least 2 feet bgs to address elevated lead, zinc, PCBs, and DNOC detected in sediment at the drainage outlet. An estimated 22 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead, zinc, PCBs, and DNOC analysis.

AOI-25 (Radar Pad 3): soil excavations to depths of at least 1-foot bgs to address elevated lead detected in shallow soil west of the painted retaining wall. The vertical extent of excavation is not bounded in the vicinity of SS-3-2. An estimated 6 BCY of soil would be excavated. Confirmation soil samples would be collected from the excavation sidewalls and bottom and submitted for lead analysis.

Implementation of this alternative would result in removal of soil exceeding RGs, to the extent technically feasible. Given the distance of the mission blue butterfly habitat from the proposed excavation areas (Figure 6-2), it is not anticipated that the excavations would extend into the mission blue butterfly host plant areas. However, because the previous investigations have not fully delineated the lateral and vertical extents of soil exceeding the RGs, there is uncertainty regarding the lateral extent of excavation under this alternative.

In consideration of this uncertainty, this alternative assumes the following:

- Excavation of soil would be conducted to remove soil above the RGs to the extent technically feasible.

- Even if the results of sidewall confirmation sampling indicated concentrations above RGs, further excavation would only be conducted up to the area of critical habitat for

the mission blue butterfly. This prevents any loss or impact to current mission blue butterfly habitat.

- Because the Endangered Species Act places restrictions on use of critical habitat, implementation of this alternative will not require additional institutional controls.

The approximate extents of mission blue butterfly habitat (as mapped in 2019) is presented on Figure 6-2.

Similar to Alternative 2, work would be conducted outside of the flight period for the mission blue butterfly and during the driest summer months to avoid the rain while working on the steep slopes. Similar to Alternative 2, excavations that are adjacent to existing structures and retaining walls (e.g., AOI-18, AOI-21, AOI-23, AOI-24, and AOI-25) will require evaluation by a geotechnical engineer prior to the excavations to ensure slope stability and to preserve the integrity of the existing structures and containment walls. Deeper excavations adjacent to existing retaining walls may not be technically feasible without severely compromising structural integrity.

The excavation areas under Alternative 3 would require removal of existing vegetation (clearing and grubbing of approximately 0.2 acres, though potentially more if the results of confirmation soil samples indicate additional soil removal is necessary to remove soil above RGs). Similar to Alternative 2, dust control measures and stormwater pollution control best management practices would be implemented during soil disturbing activities. Soil confirmation samples would be collected from the excavation sidewalls and bottoms at the same frequency as described under Alternative 2. Excavation backfilling and restoration would be conducted as described under Alternative 2.

Implementation of this alternative would achieve RAOs by removing soil where COCs are present in soil exceeding RGs but would not extend into areas of critical habitat for the mission blue butterfly. Additional institutional controls will not be necessary to prevent unacceptable risks since the Endangered Species Act places restrictions on use of critical habitat.

This alternative is expected to comply with ARARs, through the following:

- Excavations are not anticipated to extend into the boundaries of the areas designated as critical habitat for the mission blue butterfly to comply with the Endangered Species Act.

- Existing site structures will not be demolished to complete the excavation activities and will be preserved to protect historic resources at the Site.

- Dust control measures will be implemented during soil disturbing activities to comply with local air district requirements.

- Soil backfill and site restoration for the excavation areas will be implemented in accordance with requirements consistent with NPS guidance.

- Standard health and safety procedures would be implemented during excavation and soil handling activities to protect workers consistent with OSHA requirements.

- Excavated soil will be characterized to identify proper waste handling and disposal requirements. Soil characterized as hazardous wastes will be handled in accordance with applicable state and federal regulations. Soil excavated from AOI-24 contains PCBs greater than 1 mg/kg and Performance-based disposal will comply with 40 CFR Part 761(b). Hazardous waste will be transported under the appropriate waste documentation procedures.

- Stormwater BMPs will be implemented to comply with the Clean Water Act.

7. Comparative Analysis of Removal Action Alternatives

The purpose of Section 7 is to provide a comparative analysis against each of the evaluation criterion of the alternatives presented in Section 6. This will identify the advantages and disadvantages of each alternative relative to one another.

Pursuant to the NCP, each alternative described above was analyzed using the following evaluation criteria: effectiveness, implementability, and cost. The effectiveness of each alternative was evaluated by each alternative's protectiveness of human health and the environment; attainment of ARARs; reduction of toxicity, mobility, or volume through treatment; long-term effectiveness and permanence; and short-term effectiveness. The implementability criterion addresses the technical feasibility of implementing the response (including availability of services and materials), the administrative feasibility, and State and community acceptance. Projected costs were calculated using direct capital costs, indirect capital costs, and annual post-removal site control costs. Consistent with guidance, the costs presented are estimated using current costs of labor and materials, and actual costs are expected to range from 30 percent below to 50 percent above the costs presented. The projected costs presented for the EE/CA removal action alternatives are estimates only for the sole purpose of comparing alternatives and should not be considered design-level cost estimates. Details that formed the basis for the removal action alternative cost projections are provided in Appendix C.

7.1. Effectiveness

This section evaluates the alternative's ability to meet the RAOs as identified in Section 5; in particular, its ability to achieve the criteria of protectiveness of human health and the environment and to attain ARARs. Other factors that affect the overall protectiveness of a removal action include preference for treatment to reduce contaminant toxicity, mobility, or volume for principal threats, short-term effectiveness, and long-term effectiveness/permanence. Details regarding the effectiveness evaluation criteria are presented in the following subsections.

Overall Protection of Human Health and the Environment

Under Alternative 1, the Site would remain as it currently exists and no active efforts to minimize contaminated areas or migration pathways would be made. Therefore, COCs in soil would continue to pose an unacceptable risk to human health and the environment.

Alternative 2 would excavate soil to address residual unacceptable risk for the likely foreseeable future land users (park visitors, park workers, and ecological receptors) but would leave soil in place that exceeds levels that pose an unacceptable risk to the park resident via direct contact. The alternative would rely on a residential use restriction to address the remaining residual unacceptable risks. The combination of partial soil removal and a land use restriction would provide a moderate level of protection to human health and the environment at the Site.

Under Alternative 3, excavated soil with COCs above the RGs would be removed from the Site and disposed at an off-site facility. This would provide a high level of protection to human health and the environment at the Site. Although the excavation extents are not anticipated to extend into the mission blue butterfly habitat, no excavation within the habitat would be conducted under Alternative 3.

Of the alternatives evaluated, Alternative 3 provides the highest level of protection to human health and the environment.

Compliance with ARARs

Alternative 1 does not comply with ARARs.

Alternative 2 partially complies with ARARs by removing soil with COCs detected above RGs that represent material that would warrant remedial action to address unacceptable risks to likely anticipated future land users (park visitors, park workers, and ecological receptors). Under Alternative 2 institutional controls would be required to address residual unacceptable risks, which would not be compliant with certain location-specific ARARs by potentially limiting certain land use scenarios (e.g., park resident).

Alternative 3 best complies with ARARs and removes soil with COCs detected above the RGs to the extent technically feasible. Alternative 3 complies with the Endangered Species Act by not conducting excavations that would extend into the mission blue butterfly habitat.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not reduce the toxicity, mobility or volume of contamination at the Site. The COCs are not biodegradable and will continue to pose an unacceptable risk to human health and the environment.

Neither Alternative 2 or 3 reduce toxicity, mobility, or volume through treatment. Reduction in the mobility of the contaminants using Alternative 2 and 3 would be achieved by removing contaminated soil to a RCRA or other appropriately licensed facility (based on final characterization); no reduction of contaminant toxicity or volume would be achieved.

Short-Term Effectiveness

Alternative 1 has poor short-term effectiveness because potential risk from COCs at the Site is not reduced. The length of time until protection is achieved is indefinite under this alternative.

Alternative 2 and 3 offer equal short-term effectiveness as both alternatives would be completed in a relatively short period of time, less than six months, and no permanent facilities would be required. A small increase to short-term risk to human health would be encountered during the excavation and transportation phase of Alternative 2 and 3, as follows:

- Short-term air quality impacts to the immediate environment may occur during excavation of contaminated soil. These short-term risks could be mitigated through appropriate dust control procedures.

- Access to and use of portions of the Hawk Hill area may be restricted and/or impacted by noise and dust during excavation, loading and hauling, and restoration activities. A small increase in short-term risk to human health would be encountered during the excavation and transport phase of this work due to the truck trips required. These impacts could be mitigated through a transportation plan for the waste materials.

Impacts associated with construction activities are considered short-term and should not significantly impact human health.

Long-Term Effectiveness

Alternative 1 does not provide long term effectiveness or a permanent remedy for COC-contaminated soil at the Site.

Alternative 2 provides a moderate level of long-term effectiveness by removing soil with COCs detected above RGs that represent material that would warrant remedial action to address unacceptable risks to likely anticipated future land users (park visitors, park workers, and ecological receptors). Alternative 2 would require institutional controls to address potentially unacceptable residential risks. Human health protection would be dependent upon the enforcement of institutional controls to prevent residential use of the Site.

Alternative 3 provides the highest level of long-term effectiveness and is a permanent remedy for the Site. This alternative effectively eliminates the unacceptable risks to human health and the environment posed by the impacted soil. This alternative is expected to allow for unrestricted use at the Site.

7.2. Implementability

This section provides an evaluation of the technical and administrative feasibility of implementing the alternative and the materials and services that would be required for its implementation.

Technical Feasibility

- Technical Implementation Considerations
  No technical implementation considerations are associated with Alternative 1 because no action is taken. Alternatives 2 and 3 are considered technically feasible presumptive remedies, having been implemented with success at innumerable sites with similar contaminants. Alternatives 2 and 3 will require technical oversight to ensure removal of soils exceeding RGs. Due to the steep slopes, soil excavation activities would need to be completed when soils are the driest during the summer months (generally June, July August, and September) to be completed safely. Excavations that are adjacent to existing structures and retaining walls will require evaluation by a geotechnical engineer prior to excavations to ensure slope stability and to preserve the integrity of the existing structures and containment walls. Deeper excavations adjacent to existing retaining walls may not be technically feasible without severely compromising structural integrity. Alternative 2 and 3 will require contractors licensed to perform hazardous waste removal and licensed hazardous waste haulers to transport the material to the waste facility.

- Availability of Services and Materials
  No services or materials for Alternative 1 are required. Equipment, personnel, and other materials for Alternative 2 and 3 are readily available. Outside laboratory testing for soil confirmation sampling and waste characterization sampling are anticipated to be readily available. The capacity of an appropriately licensed off-site waste facility to accommodate the anticipated soil excavation volumes is anticipated.

Administrative Feasibility

This section provides an evaluation of the activities needed for coordination with other offices and agencies. Under CERCLA, federal, state, and local permits are not required for on-site CERCLA response actions; however, the substantive requirements of all permits that would otherwise be required must be met (40 CFR Section 300.400(e)). Alternative 2 would require procedures to administer the land use restrictions and ongoing routine inspections and reporting to ensure the Site was not used for residential purposes in the future. For this evaluation, it is anticipated that on-going operations and maintenance (O&M) would consist of an annual inspection plus a periodic review of remedy effectiveness conducted once every 5 years. It is anticipated that land use restrictions would not be required under Alternative 3.

State (Support Agency) Acceptance

State acceptance of Alternative 1 is unlikely given no active efforts to minimize contaminated areas or migration pathways would be made. State acceptance of Alternative 2 is considered moderately likely due to the need for an institutional control. Alternative 3 is commonly used at sites of this type. State acceptance of Alternative 3 is considered highly likely. Final state acceptance will be determined following public comment.

Community Acceptance

A Community Involvement Plan (CIP) dated September 9, 2020, was prepared and is available at the Planning, Environment and Public Comment website for the Site.[41] Community acceptance will be determined following the community review and comment period following the completion of the EE/CA. These comments will be addressed prior to issuing the Action Memorandum and selecting the final NTCRA.

7.3. Cost

This section provides an evaluation of the costs associated with implementing the removal action alternative. Cost estimates are based on currently available costs and approximate time and materials requirements developed for the sole purpose of comparing alternatives. The EE/CA cost estimates should not be considered design-level estimates. They are representative within −30 to +50 percent and were prepared with consideration to the guidance provided in the USEPA's "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA 2000).

There are no capital, operation, or maintenance costs associated with Alternative 1.

The estimated net present value for costs associated with Alternative 2 is approximately **$282,000** ($152,000 capital cost plus $130,000 O&M costs [net present value]). The capital costs include the labor, equipment, and materials to implement the excavation and off-site disposal activities described under Alternative 2, as well as an estimate of the professional and technical services necessary to support the implementation. Unit costs were generally obtained from recent project experience in the Bay Area, but do not assume prevailing wage or other escalation factors typically used by the NPS for construction cost estimating. Professional services include project management, remedial design, and construction management and were estimated using the rule-of-thumb percentages provided in the USEPA's "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study." Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of institutional controls (e.g., licensing). Activities that are part of remedial design include the various design components such as plans, specifications, and schedule at the preliminary,

[41] https://parkplanning.nps.gov/hawk_hill_haz_manage

intermediate, and final design phases. Construction management applies to capital cost and includes services to manage construction or installation of the remedial action, except any similar services provided as part of regular construction activities. Activities include review of submittals, construction observation or oversight, engineering survey for construction, preparation of an O&M manual, documentation of quality control/quality assurance, and record drawings. Lastly a scope contingency of 30% and a bid contingency of 10% has been added to the capital costs. Scope contingency covers unknown costs due to scope changes that may occur during design. Bid contingency covers unknown costs associated with constructing or implementing a given project scope. In addition, the costs for Alternative 2 include costs for 30 years of inspections and reporting required to ensure the site is not developed for residential use to comply with the land use restrictions. Additional details to support this cost estimate are presented in Appendix C.

The estimated capital cost to implement Alternative 3 is approximately **$348,000**. The costs were developed using the same procedures as under Alternative 2. The capital costs include the labor, equipment, and materials to implement the excavation and off-site disposal activities described under Alternative 3, as well as an estimate of the professional and technical services necessary to support the implementation. Unit costs were generally obtained from recent project experience in the Bay Area, but do not assume prevailing wage or other escalation factors typically used by the NPS for construction cost estimating. Professional services include project management, remedial design, and construction management and were estimated using the rule-of-thumb percentages provided in the USEPA's "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study." A scope contingency of 30% and a bid contingency of 10% has been added to the capital costs. There are no O&M costs associated with Alternative 3. Additional details to support this cost estimate are presented in Appendix C.

7.4. Summary of the Alternatives Comparative Analysis

Text Table 7.6 summarizes the results of the evaluation of the effectiveness, implementability, and cost criteria for each alternative.

Text Table 7.6 Comparison of Alternatives

Criterion	Alternative		Alternative 1: No action	Alternative 2: Limited Soil Removal and Off-Site Disposal, Residential Use Restriction	Alternative 3: Excavation and Off-Site Disposal
Effectiveness	Protective of	HH?	*No*	*Moderate - relies on ICs*	*Yes*
		Env?	*No*	*Yes*	*Yes*
	Complies with ARARs?		*No*	*Moderate -relies on IC which may not meet reqs of Organic Act*	*Yes*
	Reduces Toxicity, Mobility, or Volume		*No*	*No - does not reduce toxicity or volume through treatment*	*No - does not reduce toxicity or volume through treatment*
	Effectiveness Duration	Short Term	*No*	*Yes*	*Yes*
		Long Term	*No*	*Moderate - relies on ICs for long-term protection*	*Yes*
Implementability	Feasibility	Tech.	*High*	*High*	*High*
		Admin	*Low*	*Moderate - would require procedures to administer the land use restrictions and ongoing routine inspections*	*High*
	Acceptance	State	*Not expected*	*Moderate – acceptability of land use restrictions is not known*	*Yes*
		Community	*Not expected*	*Moderate – acceptability of land use restrictions is not known*	*Yes*
Cost			*$0*	*$282K*	*$348K*

8. Recommended Removal Action Alternative

The purpose of Section 8 is to describe the recommended removal action alternative and the reason for the selection.

Taking into consideration the evaluation criteria presented in this EE/CA, the recommended removal action alternative for the Site is Alternative 3. Alternative 3 involves excavation and off-site disposal of shallow soil from the approximate areas shown on Figure 6-2. This alternative would excavate soil where COCs have been detected above RGs. Under this alternative, additional land use restrictions are not anticipated to be required even if the results of sidewall confirmation sampling indicate concentrations above RGs. To comply with the Endangered Species Act, the excavations would not extend within the habitat area. Additional institutional controls will not be necessary to prevent unacceptable risks since the Endangered Species Act places restrictions on use of critical habitat. The estimated cost to complete Alternative 3 is $348K.

Alternative 3 is the recommended removal action alternative based on the results of the comparative analysis completed in Section 7, which determined that it is protective of both human health and the environment, complies with the ARARs, is most effective in both short- and long-term durations, is highly technically feasible, is highly administratively feasible, and anticipated to be accepted by both state and community stakeholders.

9. References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs). November.

Agency for Toxic Substances and Disease Registry (ATSDR). 2020. Minimal Risk Levels (MRLs). October.

Baes III, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Released Radionuclides through Agriculture (AD-89-T-2-A-106) (formerly EPA078-D-X0304), Oak Ridge National Laboratory, ORNL-5786.

Burmaster, David E. 2000. Distributions of Total Job Tenure for Men and Women in Selected Industries and Occupations in the United States, February 1996. Risk Analysis. Volume 20. Pages 205-224. April.

California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC). 2009. Arsenic Strategies Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals. January.

California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC). 2015. Preliminary Endangerment Assessment Guidance Manual. October.

California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC). 2016. Screening Level Human Health Risk Assessments. HERO HHRA NOTE No. 4. October 26.

California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC). 2019a. Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. April 9.

California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC). 2019b. HERO HHRA Note Number: 10, Toxicity Criteria. February 25.

California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC). 2020. HERO HHRA Note Number: 3, DTSC-Modified Screening Levels (DTSC-SLs). June.

Coast Ride Ecology. 2018. Survey Results for the Mission Blue Butterfly at GGNRA, Marin Headlands, CA. 2018. Prepared for GG National Parks Conservancy. Prepared by Coast Ride Ecology LLC., San Francisco. December.

Cowherd, C., G. Muleski, P. Engelhart, and D. Gillette. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. EPA/600/8-85/002. NTIS PB85- 192219. Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, DC.

Dettling M.D., and D.L. Humple. 2015. Determining Bird Species Composition and Abundance at Hawk Hill following Tree Removal. A report to the Golden Gate National Parks Conservancy. Point Blue Conservation Science, Petaluma, CA. Contribution #2034.

Efroymson R.A., M.E. Will, G.W. Suter II, A.C. Wooten. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Prepared for the U.S. Department of Energy, Office of Environmental Management. ES/ER/TM-85/R3.

GGNPC. 2020. Personal communication with GGNPC wildlife specialist.

Golden Gate Raptor Observatory (GGRO). 2019. Golden Gate Raptor Observatory Season Summary 2018. Golden Gate National Parks Conservancy.

Jury, W.A, W.F. Spencer, and W.J. Farmer. 1983. *Behavior Assessment Model for Trace Organics in Soil: I. Model Description*. J. Environ. Qual. 12(4):448-64.

Los Alamos National Laboratory (LANL) 2017. EcoRisk Database, Release 4.1. October.

May & Associates. 2009. Biological Assessment, Marin Headlands - Fort Baker Transportation Management Plan and Coastal Trail Corridor Enhancement Project. December 10.

National Oceanic and Atmospheric Administration (NOAA). 2019. Comparative Climatic Data for the United States Through 2018. National Centers for Environmental Information, Asheville, NC. https://www.ncdc.noaa.gov/data-access/quick-links#ccd.

National Park Service (NPS). 2015. Technical Glossary, NPS Contaminated Site. Version 1. June. Available on the NPS website, CSPortal.

National Park Service (NPS). 2018. NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes, Revision 3. Environmental Compliance and Response Branch, Contaminated Sites Program. November. *Available on the NPS website, CSPortal.*

National Park Service (NPS). 2015. NPS-Specific CERCLA ARARs and TBCs. Contaminated Sites Program, Environmental Compliance and Response Branch. February 3. *Available on the NPS website, CSPortal.*

National Park Service (NPS). 2006. Management Policies 2006. ISBN 0-16-076874-8. https://www.nps.gov/policy/mp2006.pdf.

Naval Facilities Engineering Command (NAVFAC). 2009. Final Report Demonstration and Certification of Amphibian Ecological Risk Assessment Protocol (NAVFAC/ESTCP). ESTCP Project ER-0514 TR-2318-ENV. April.

New Jersey Department of Environmental Protection (NJDEP). 2009. Derivation of Ingestion-Based Soil Remediation Criteria for Cr+6 Based on NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate. April.

Research Triangle Institute, Center for Environmental Analysis. 1995. Supplemental Technical Support Document for Hazardous Waste Identification Rule: Risk Assessment for Human and Ecological Receptors--Volume 1, TABLE A-1. November.

Roth/LaMotte Landscape Architecture and Preservation Architecture. 2008. Battery Construction 129, Hawk Hill, Historic Structures Report. September 17.

Tetra Tech, Inc. 2009a. Final Records Research Report, Former Fort Barry, FUDS Number J09CA3107. December 30.

TetraTech, Inc. 2009b. Final Records Research Report, Former Fort Cronkhite, FUDS Number J09CA3111.

TetraTech, Inc. 2009c. Site Inspection Report, Former Fort Cronkhite, FUDS Number J09CA3111. December.

Treadwell & Rollo. 2012. Hawk Hill/Hill 129 Hazardous Materials Survey Report, Golden Gate National Recreation Area, Marin Headlands, California. September 12.

Treadwell & Rollo. 2013. Hawk Hill/Hill 129 Casemate One Gun Pit Sediment Sampling, Golden Gate National Recreation Area, Marin Headlands, California. October 4.

Weiss Associates. 2019a. Hazardous Materials Assessment Report for Golden Gate National Parks Conservancy, Hawk Hill Visitor Improvement Project, Marin Headlands, California. March 22.

Weiss Associates. 2019b. Site Management Plan for Golden Gate National Parks Conservancy, Hawk Hill, Marin Headlands, California. May 29.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revisions. Prepared by the Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory for the U.S. Department of Energy. ES/ER/TM-86/R3.

Sample, B.E., W.N. Beyer, and R. Wentsel. 2019. Revisiting the Avian Eco-SSL for Lead: Recommendations for Revision. Integrated Environmental Assessment and Management. Volume 15, Number 5. Pages 739-749. March.

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB). 2019. Environmental Screening Levels.

Stanek, Edward J. III et al. 1997. Soil Ingestion in Adults—Results of a Second Pilot Study. Ecotoxicology and Environmental Safety. Volume 36. Pages 249-257. April.

U.S. Department of the Interior (USDOI). 2016. Central Hazardous Materials Fund (CHF) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Process for CHF Projects. PEP – Environmental Compliance Memorandum No. ECM16-3. February.

U.S. Environmental Protection Agency (USEPA). 1988. CERCLA Compliance with Other Laws Manual (Part I). EPA/540/G-89/006. August.

U.S. Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) - Interim Final. Washington, D.C.: U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/1-89/002. http://www.epa.gov/oswer/riskassessment/ragsa/pdf/rags_a.pdf

U.S. Environmental Protection Agency (USEPA). 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." Memorandum from T. Fields, Jr., Office of Emergency Remedial Response, to B. Diamond, Office of Waste Programs Enforcement. OSWER Directive 9285.6-03. March 25.

U.S. Environmental Protection Agency (USEPA). 1991b. Human Health Evaluation Manual, Supplemental Risk Assessment Guidance for Superfund, Volume I: (Part B, Development of Risk-Based Preliminary Remediation Goals). Interim. Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, DC. NTIS PB92-963333.

U.S. Environmental Protection Agency (USEPA). 1992. CERCLA/Superfund Orientation Manual. EPA/542/R-92/005. October.

U.S. Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Volume I of II. Office of Health and Environmental Assessment, Office of Research and Development, Washington, DC. EPA/600/R-93/187. December.

U.S. Environmental Protection Agency (USEPA). 1993a. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. EPA/540/R/93/057. August. http://www.lm.doe.gov/cercla/documents/fernald_docs/cat/112317.pdf

U.S. Environmental Protection Agency (USEPA). 1994. Risk Assessment Issue Paper for Derivation of a Provisional RfC for Silver [CASRN 7440-22-4]. National Center for Environmental Assessment. June 30.

U.S. Environmental Protection Agency (USEPA). 1996. Office of Solid Waste and Emergency Response (OSWER). Soil Screening Guidance: Technical Background Document, 2nd Ed. EPA/540/R95/128. May.

U.S. Environmental Protection Agency (USEPA). 1997a. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. EPA 540-R-97-006. June.

U.S. Environmental Protection Agency (USEPA). 1997b. Superfund Chemical Data Matrix (SCDM). Office of Emergency and Remedial Response. September 12.

U.S. Environmental Protection Agency (USEPA). 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. July.

U.S. Environmental Protection Agency (USEPA). 2002. Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites. EPA/540/R-01/003.

U.S. Environmental Protection Agency (USEPA). 2003a. Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53. December.

U.S. Environmental Protection Agency (USEPA). 2003b. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil [Adult Lead Model (ALM)], EPA 540 R 030001. OSWER 9285.7 54. January.

U.S. Environmental Protection Agency (USEPA). 2004a. Office of Emergency and Remedial Response. Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). USEPA/540/R/99/005. September.

U.S. Environmental Protection Agency (USEPA). 2004b. WATER9. Version 2.0.0. Office of Air Quality Planning and Standards. July.

U.S. Environmental Protection Agency (USEPA). 2005a. Risk Assessment Forum. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001B. March.

U.S. Environmental Protection Agency (USEPA). 2005b. Ecological Soil Screening Levels for Lead. Interim Final. Office of Solid Waste and Emergency Response. Directive 9285.7-70

U.S. Environmental Protection Agency (USEPA). 2005c. Ecological Soil Screening Levels for Antimony. Interim Final. Office of Solid Waste and Emergency Response. Directive 9285.7-61

U.S. Environmental Protection Agency (USEPA). 2008. Child-Specific Exposure Factors Handbook. Report prepared for the Environmental Protection Agency, National Center for Environmental Assessment, Office of Research and Development, Washington, DC. EPA/600/R-06/096F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=199243

U.S. Environmental Protection Agency (USEPA). 2008a. Ecological Soil Screening Levels for Chromium. Interim Final. Office of Solid Waste and Emergency Response. Directive 9285.7-66

U.S. Environmental Protection Agency (USEPA). 2009. Office of Emergency and Remedial Response. Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). USEPA/540/R/070/002. January.

U.S. Environmental Protection Agency (USEPA). 2014a. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. OSWER Directive 9200.1-120. February 6.

U.S. Environmental Protection Agency (USEPA). 2014b. Superfund Chemical Data Matrix (SCDM). Office of Superfund Remediation and Technology Innovation. June 20.

U.S. Environmental Protection Agency (USEPA). 2018. Region 4 Ecological Risk Assessment Supplemental Guidance. U.S. Environmental Protection Agency, Scientific Support Section Superfund Division.

U.S. Environmental Protection Agency (USEPA). 2020a. List of Lists - Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. EPA 550-B-20-001. August.

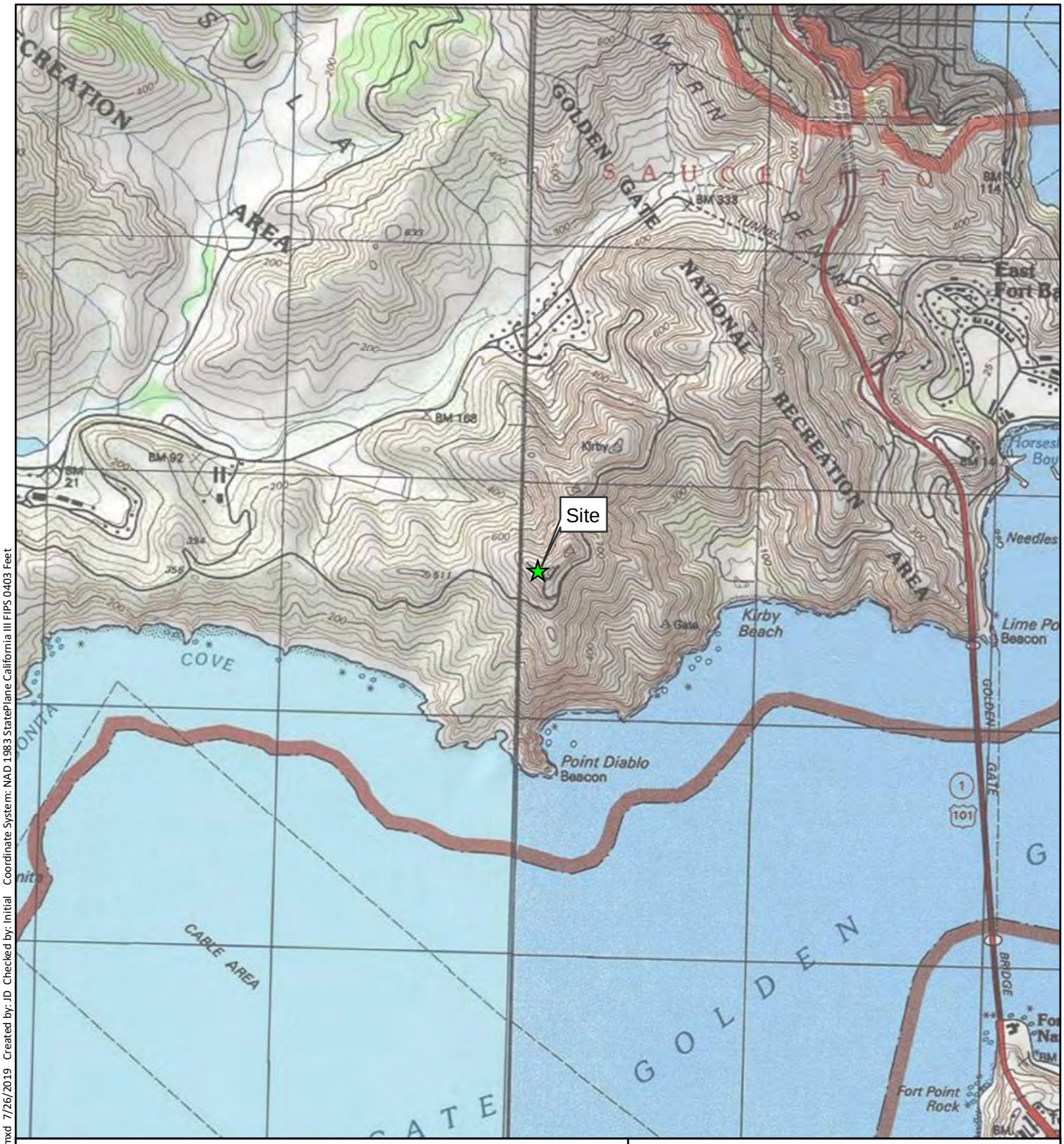
U.S. Environmental Protection Agency (USEPA). 2020b. USEPA, Regional Screening Levels (RSLs). May.

U.S. Environmental Protection Agency (USEPA). 2021. Integrated Risk Information System (IRIS). https://www.epa.gov/iris.

U.S. Environmental Protection Agency (USEPA). 2021. Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV) Database. https://www.epa.gov/pprtv.

FIGURES

- Figure 1-1: Site Location
- Figure 2-1: Site Layout
- Figure 2-2: Soil Sampling Locations
- Figure 2-3: Scenarios of Potential Human Exposure
- Figure 2-4: Scenarios of Potential Ecological Exposure
- Figure 3-1: Locations with Potentially Unacceptable Risk – Human Health
- Figure 3-2: Locations with Lead in Soil Above Residential Screening Level
- Figure 3-3: Outcome of the Simple BERA for Terrestrial Plants and Soil Invertebrates
- Figure 6-1: Alternative 2 Estimated Excavation Extents
- Figure 6-2: Alternative 3 Estimated Excavation Extents



0 2,000 4,000 Feet

1 inch = 2,000 feet

N

Legend

Site Location

Base Map: USGS San Francisco North (1995) 7.5 Minute Quadrangle.

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy

PROJECT: Hawk Hill
Marin Headlands, CA

PROJECT NUMBER: 0151.006.001

Site Location

FIGURE 1-1

File: K:\GIS\Prj\0151.006 Hawk Hill\(20190726) Site Location.mxd 7/26/2019 Created by: JD Checked by: Initial Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet

Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy

PROJECT: Hawk Hill
Marin Headlands, CA

PROJECT NUMBER: 0151.006.001

Site Layout

FIGURE 2-1

File: N:\GIS\Pr\0151.006 Hawk Hill\20190725_0151.006_HawkHill_SiteLayout.mxd 10/7/2020 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet

Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy

PROJECT: Hawk Hill, Marin Headlands, CA

PROJECT NUMBER: 0151.006.001

Sampling Locations

FIGURE 2-2

File: N:\GIS\Prj\0151.006 Hawk Hill\20210222_0151.006_HawkHill_SamplingLocations_Lead.mxd 2/22/2021 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet

Primary Source(s)	Primary Release Mechanism(s)	Exposure Media	Exposure Routes	On-Site: Resident	Park Worker	Maint. Worker	Const. Worker	Recreator	Out-of-Bound Visitor
Former Fuel Oil Storage Tanks; Former Distribution Transformer; Building Materials	Direct Release; Storm Water Runoff	Surface Soil	Incidental Ingestion and Dermal Contact	○	●	●	○	●	●
			Inhalation of Particulates in Outdoor Air	○	●	●	○	●	●
			Inhalation of Vapors in Outdoor Air	○	●	●	○	●	●
			Inhalation of Vapor in Indoor Air (Vapor Intrusion)						
	Leaching; Infiltration	Subsurface Soil	Incidental Ingestion and Dermal Contact			●	○		
			Inhalation of Particulates in Outdoor Air			●	○		
			Inhalation of Vapors in Outdoor Air	○	●	●	○	●	●
			Inhalation of Vapor in Indoor Air (Vapor Intrusion)						
	Direct Release; Storm Water Runoff	Sediment	Incidental Ingestion and Dermal Contact			●	○		●
		Standing Water	Incidental Ingestion and Dermal Contact			●	○		●
			Inhalation of Vapors			●	○		●

● - Potentially Complete Pathway (Current and Future)

○ - Potentially Complete Pathway (Future)

- Pathway is Not Complete

SAFETY FIRST

terraphase engineering

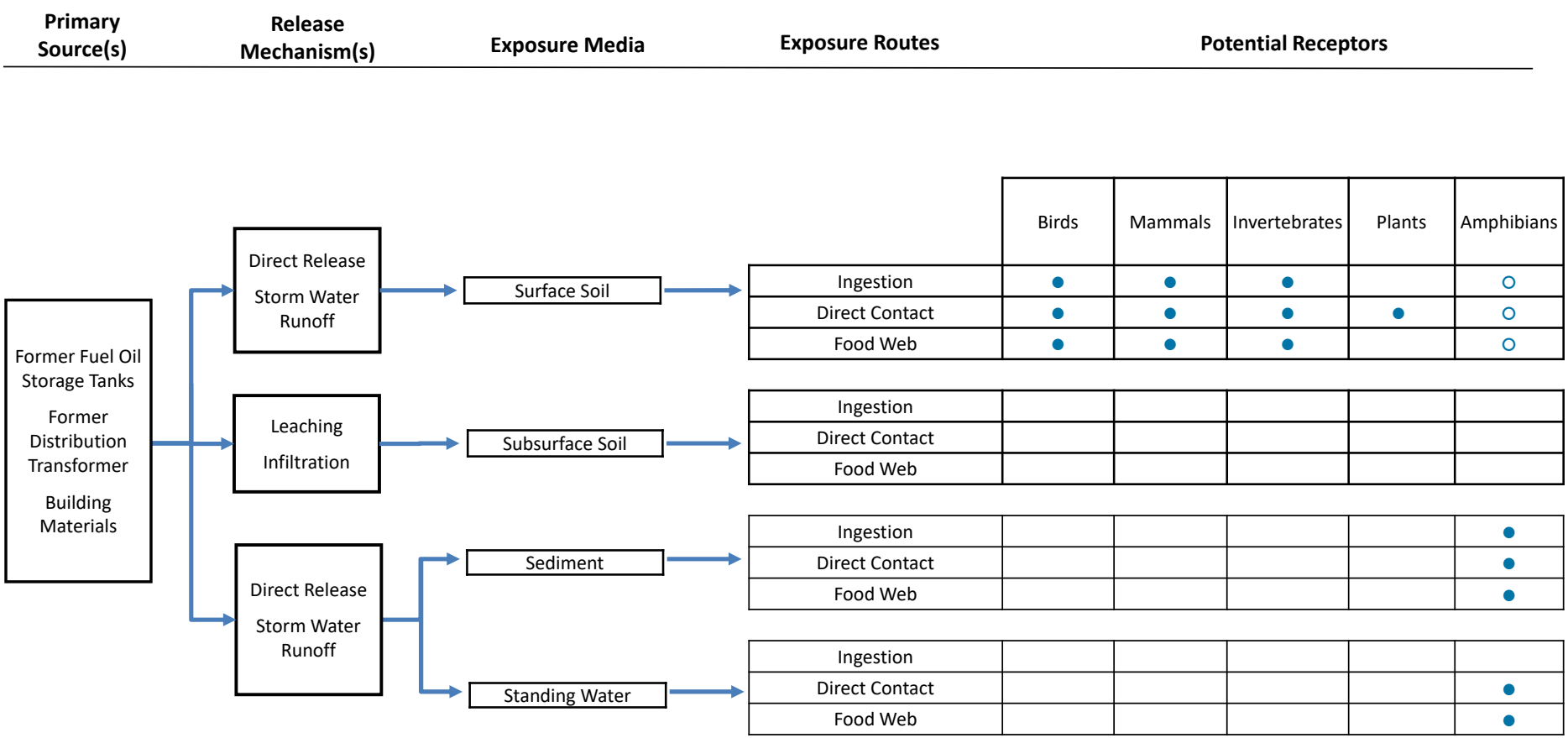
CLIENT: National Park Service

PROJECT: Hawk Hill

PROJECT NUMBER: 0151.006.006

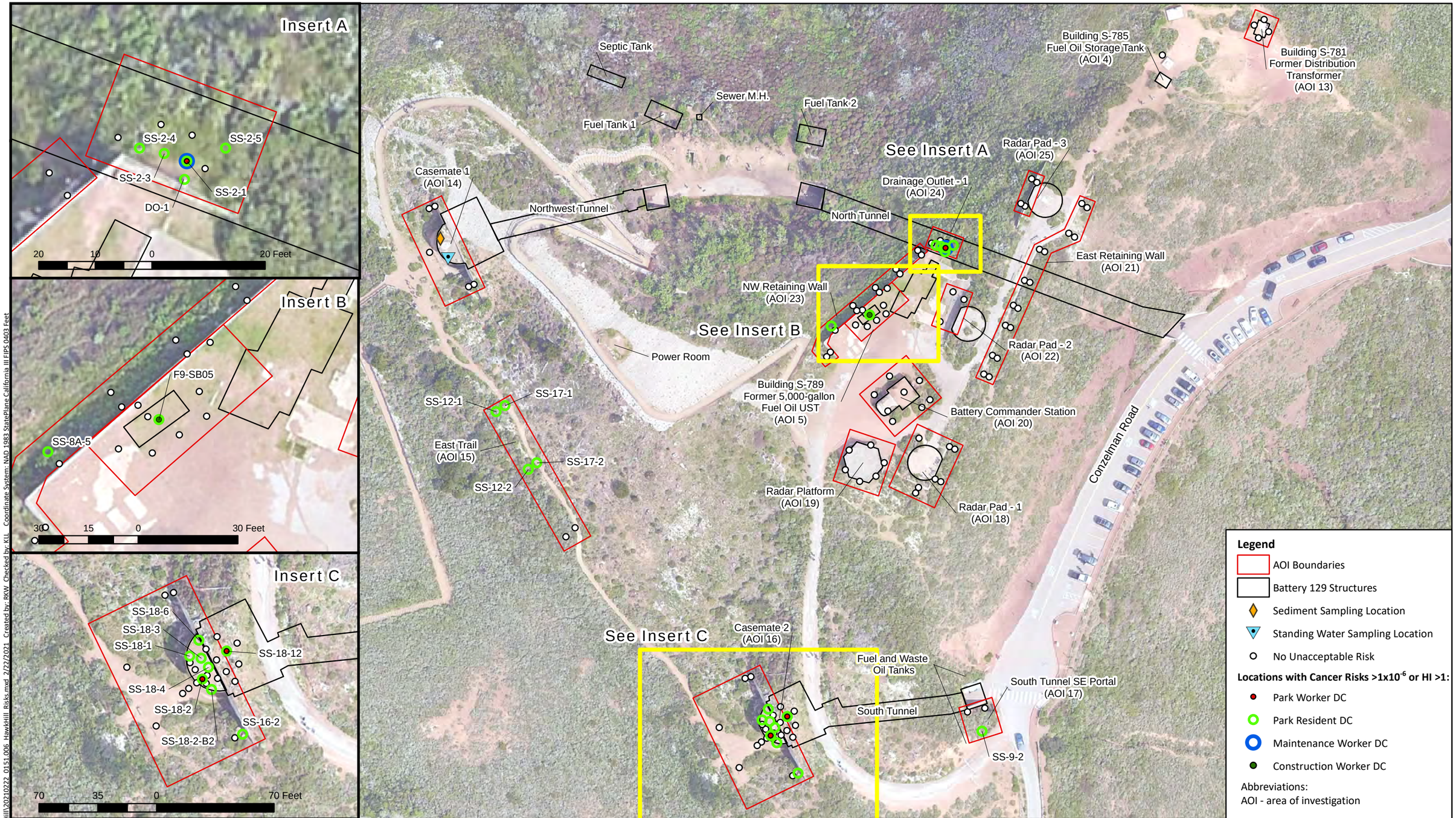
Preliminary Scenarios of Potential Human Exposure

FIGURE 2-3



● - Potentially Complete Pathway
○ - Potentially Complete Pathway, but Insignificant
  - Pathway is Not Complete

SAFETY FIRST	CLIENT: National Park Service	Preliminary Scenarios of Potential Ecological Exposure
terraphase engineering	PROJECT: Hawk Hill	
	PROJECT NUMBER: 0151.006.006	FIGURE 2-4



Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

N

SAFETY FIRST

terraphase engineering

CLIENT:	Golden Gate National Park Conservancy
PROJECT:	Hawk Hill Marin Headlands, CA
PROJECT NUMBER:	0151.006.001

Locations With Potentially Unacceptable Risk

FIGURE 3-1

File: N:\GIS\Prj\0151.006 Hawk Hill\20210222_0151.006_HawkHill_Risks.mxd 2/22/2021 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet

Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy

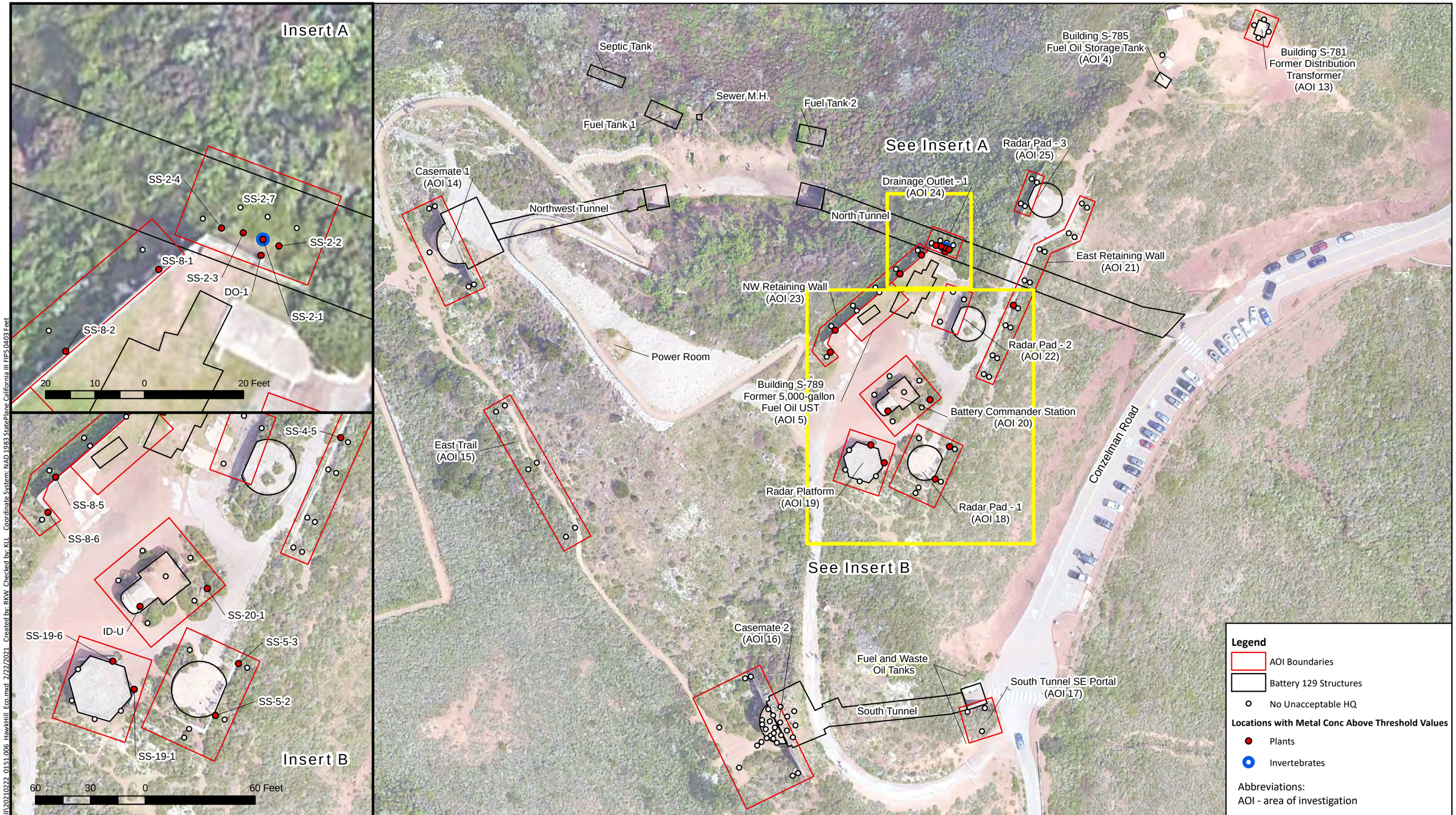
PROJECT: Hawk Hill, Marin Headlands, CA

PROJECT NUMBER: 0151.006.001

Locations Exceeding Screening Levels for Lead

FIGURE 3-2

File: N:\GIS\Prj\0151.006 Hawk Hill\20210222_0151.006_HawkHill_SamplingLocations_Lead.mxd 2/22/2021 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet



Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

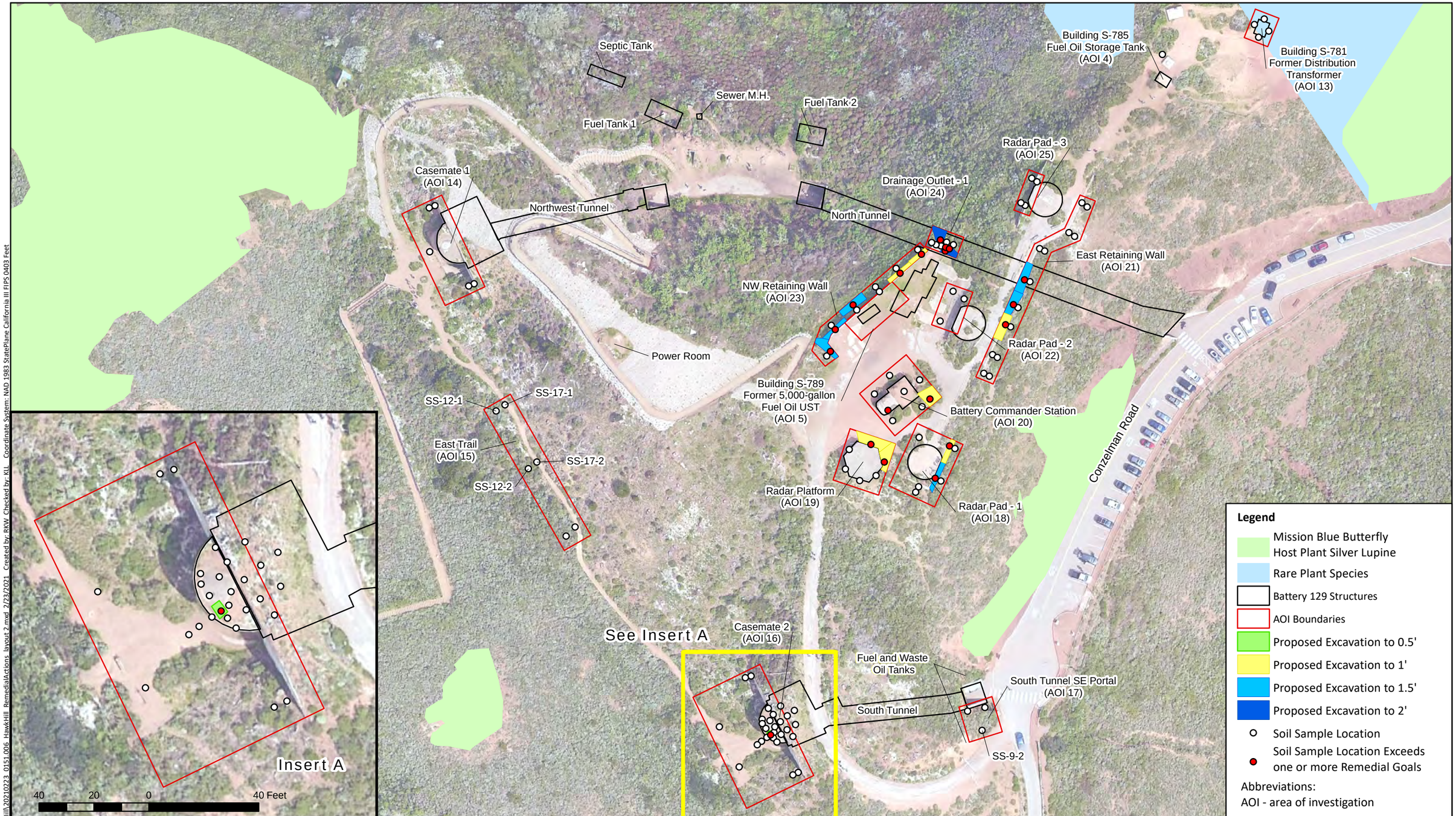
N

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy	Outcome of the Simple BERA for Terrestrial Plants and Soil Invertebrates
PROJECT: Hawk Hill Marin Headlands, CA	
PROJECT NUMBER: 0151.006.001	FIGURE 3-3

File: N:\GIS\Pr\0151.006 Hawk Hill\20210222_0151.006_HawkHill_Eco.mxd 2/22/2021 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet



Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy

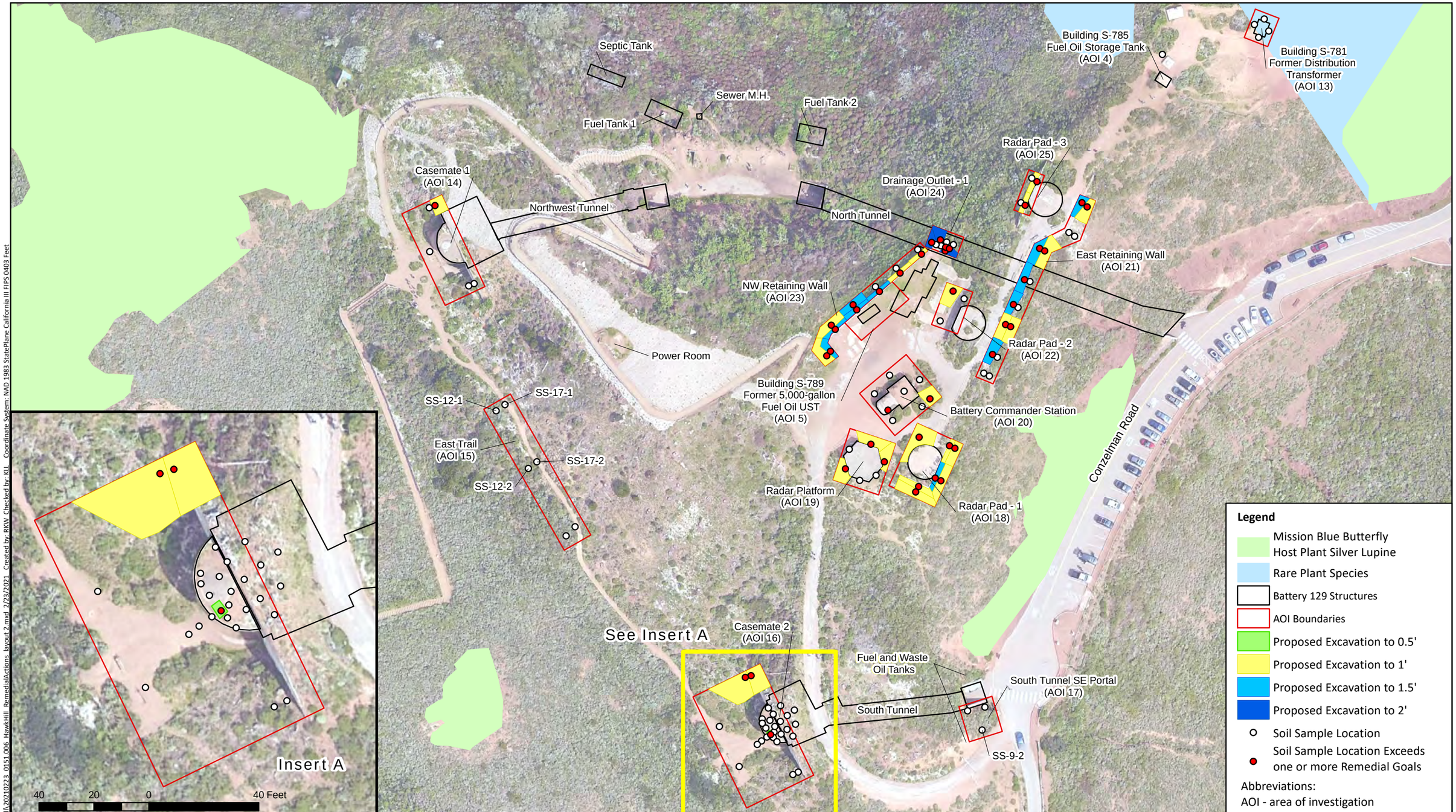
PROJECT: Hawk Hill
Marin Headlands, CA

PROJECT NUMBER: 0151.006.001

Alternative 2
Estimated Excavation Extents

FIGURE 6-1

File: N:\GIS\Pr\0151.006 Hawk Hill\20210223_0151.006_HawkHill_RemedialActions_layout 2.mxd 2/23/2021 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet



Notes: Aerial imagery source - GoogleEarth March 2018

0 40 80 120 160 Feet

1 inch = 80 feet

N

SAFETY FIRST

terraphase engineering

CLIENT: Golden Gate National Park Conservancy

PROJECT: Hawk Hill
Marin Headlands, CA

PROJECT NUMBER: 0151.006.001

Alternative 3
Estimated Excavation Extents

FIGURE 6-2

File: N:\GIS\Pr\0151.006 Hawk Hill\20210223_0151.006_HawkHill_RemedialActions_layout 2.mxd 2/23/2021 Created by: RKW Checked by: KLL Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet

TABLES

- Table 2-1: Summary of Soil Analytical Results
- Table 2-2: Background Soil Sampling Results and Statistics
- Table 2-3: Scenarios for Potential Human Exposure
- Table 3-1: Chemicals of Potential Concern
- Table 3-2: High-End Exposure Factors
- Table 3-3: Upper-Bound Background Soil Cumulative Cancer Risks and Noncancer HIs
- Table 3-4: Upper-Bound Site-Related Cumulative Soil Cancer Risks and Noncancer HIs
- Table 3-5: Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
- Table 3-6: Upper-Bound Site-Related Sediment Cumulative Cancer Risks and Noncancer HIs
- Table 3-7: Site-Related Sediment Single-Chemical Cancer Risk and Noncancer HQ
- Table 3-8: Standing Water Screening Results
- Table 3-9: Lead Soil Screening Summary
- Table 3-10: Soil Ecological Screening and Baseline Summary
- Table 3-11: Standing Water Ecological Summary (Amphibians)
- Table 3-12: Sediment Ecological Screening Summary (Amphibians)
- Table 3-13: Soil Samples Exceeding Terrestrial Plant and Soil Invertebrate Threshold Values
- Table 3-14: Human Health and Ecological Preliminary Risk-Based Removal Goals (PRGs)
- Table 6-1: Minimum Excavation and Confirmation Sample Quantities (Alternative 2)
- Table 6-2: Minimum Excavation and Confirmation Sample Quantities (Alternative 3)

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	AOI13-SS-01	AOI13-SS-02	AOI13-SS-03	AOI13-SS-04	AOI5-SS-01	BC-1	BC-1	BC-2	BC-2	BC-3	BC-3	BC-4	BC-4	BC-5
AOI		AOI 13	AOI 13	AOI 13	AOI 13	AOI 05	AOI 20	AOI 20	AOI 20	AOI 20	AOI 20	AOI 20	AOI 20	AOI 20	AOI 20
Field Sample ID		FOCR-AOI13-SS-01-0.5	FOCR-AOI13-SS-02-0.5	FOCR-AOI13-SS-03-0.5	FOCR-AOI13-SS-04-0.5	FOCR-AOI5-SS-01-25	BC-1-3	BC-1-8	BC-2-3	BC-2-8	BC-3-3	BC-3-8	BC-4-3	BC-4-8	BC-5-3
Collection Depth		0.5	0.5	0.5	0.5	25	3	8	3	8	3	8	3	8	3
Depth Units		ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	in	in	in	in	in	in	in	in	in
Sample Date		8/5/2009	8/5/2009	8/5/2009	8/5/2009	9/11/2009	8/15/2012	8/15/2012	8/15/2012	8/15/2012	8/15/2012	8/15/2012	8/15/2012	8/15/2012	8/15/2012
Comments															
VOCs															
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs															
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST															
Diesel Range Organics	260	--	--	--	--	**1400 (11)**	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs															
Aroclor-1260	0.24	0.054 (0.013)	0.066 (0.013)	0.013 (0.013)	U (0.013)	--	--	--	--	--	--	--	--	--	--
INORG															
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	--	--	--	--	--	28 (0.5)	33 (0.5)	22 (0.5)	22 (0.5)	63 (0.5)	16 (0.5)	17 (0.5)	7.8 (0.5)	15 (0.5)
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	BC-5	BC-L-COMP	DO-1	DO-1	DO-1	F9-SB01	F9-SB01	F9-SB01	F9-SB02	F9-SB02	F9-SB03	F9-SB03	F9-SB04	F9-SB04	F9-SB05	F9-SB05
AOI		AOI 20	AOI 20	AOI 24	AOI 24	AOI 24	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05
Field Sample ID		BC-5-8	BC-L-COMP	DO-1-3	DO-1-3-R	DO-1-8	F9-SB01-01	F9-SB01-02	F9-SB01-07	F9-SB02-01	F9-SB02-02	F9-SB03-01	F9-SB03-02	F9-SB04-01	F9-SB04-02	F9-SB05-01	F9-SB05-02
Collection Depth		8		3	0 - 3	8	8	15	8	10	19.75	10	19.5	10	20	10	20
Depth Units		in		in	in bgs	in	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs
Sample Date		8/15/2012	8/15/2012	8/15/2012	11/24/2020	8/15/2012	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003
Comments									Field Duplicate								
VOCs																	
Benzene	0.33	--	--	--	--	--	--	U (0.0062)	U (0.0082)	U (0.0054)	U (0.0064)	U (0.005)	U (0.0058)	U (0.0064)	U (0.0068)	0.00042	0.00044
Ethyl Benzene	5.8	--	--	--	--	--	--	U (0.0062)	U (0.0082)	U (0.0054)	U (0.0064)	U (0.005)	U (0.0058)	U (0.0064)	U (0.0068)	U (0.0063)	0.003
Toluene	1100	--	--	--	--	--	--	0.001	0.0016	0.001	0.00097	0.00077	0.00094	0.00084	0.0011	0.0011	U (0.0054)
Xylenes (total)	580	--	--	--	--	--	--	U (0.0062)	U (0.0035)	U (0.0054)	U (0.0064)	U (0.005)	U (0.0058)	U (0.0064)	U (0.0068)	U (0.0063)	0.015
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	6.2 (1)	--	--	--	110	U (10)	21	U (5.5)	U (5.4)	U (6.1)	U (5.6)	U (5.6)	U (5.6)	**2700**	**4100**
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	36 (5)	--	--	--	71	U (11)	U (11)	U (11)	U (11)	U (12)	U (11)	U (11)	U (11)	U (1100)	U (230)
PCBs																	
Aroclor-1260	0.24	--	--	--	**1.6 (0.25)**	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	2.7 (0.5)	--	2.1 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	**2.6 (0.5)**	--	**3.4 (0.5)**	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	380 (5)	--	490 (5)	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	U (0.5)	--	0.56 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	4.8 (0.25)	--	5.8 (0.25)	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	**51 (0.5)**	--	**43 (0.5)**	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	14 (0.5)	--	19 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	90 (0.5)	--	110 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Lead	80	13 (0.5)	30 (0.5)	**130 (0.5)**	--	74 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Mercury	1	--	--	0.074 (0.05)	--	0.058 (0.05)	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	U (0.5)	--	U (0.5)	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	24 (0.5)	--	27 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	U (0.5)	--	0.54 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	U (0.5)	--	U (0.5)	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	U (0.5)	--	U (0.5)	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	66 (0.5)	--	87 (0.5)	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	1000 (5)	--	1000 (5)	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	F9-SB06	F9-SB07	F9-SB07	F9-SB08	F9-SB08	F9-SB08	ID-U	SS-12-1	SS-12-1	SS-12-1	SS-12-2	SS-12-2	SS-12-3	SS-12-3	SS-13-1	SS-13-2
AOI		AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 05	AOI 20	AOI 15	AOI 15	AOI 15	AOI 15	AOI 15	AOI 15	AOI 15	AOI 16	AOI 16
Field Sample ID		F9-SB06-01	F9-SB07-01	F9-SB07-02	F9-SB08-01	F9-SB08-02	F9-SB08-03	ID-U	SS-12-1-06	SS-12-1-36	SS-12-1-36	SS-12-2-06	SS-12-2-36	SS-12-3-06	SS-12-3-36	SS-13-1-06	SS-13-2-06
Collection Depth		9	10	22.5	10	20	29		6	36	36	6	36	6	36	6	6
Depth Units		ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs		in	in	in	in	in	in	in	in	in
Sample Date		1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	1/1/2003	8/15/2012	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/29/2018	3/29/2018
Comments																	
VOCs																	
Benzene	0.33	U (0.0052)	0.00053	0.00058	U (0.0069)	U (0.0054)	U (0.0054)	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	U (0.0052)	U (0.0063)	U (0.0047)	U (0.0069)	U (0.0054)	U (0.0054)	--	--	--	--	--	--	--	--	--	--
Toluene	1100	U (0.0011)	U (0.0014)	U (0.00077)	U (0.00091)	U (0.0013)	U (0.00099)	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	U (0.0052)	U (0.0063)	U (0.0047)	U (0.0069)	U (0.0054)	U (0.0054)	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	U (7.1)	U (5.5)	U (5.6)	U (5.2)	U (5.4)	U (5.4)	--	U (1.1)	U (1.1)	--	U (1.1)	U (1.1)	U (1.1)	U (1.1)	U (1.2)	U (1)
Gasoline Range Organics	430	--	--	--	--	--	--	--	U (0.18)	--	U (0.17)	U (0.15)	U (0.16)	U (0.17)	U (0.16)	U (0.17)	U (0.23)
Motor Oil	12000	37	18	U (11)	U (10)	U (11)	U (11)	--	U (5.6)	U (5.6)	--	U (5.6)	U (5.5)	U (5.7)	U (5.7)	U (5.8)	15 (5.1)
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	0.42 J (0.56)	0.43 J (0.56)	--	0.38 J (0.56)	0.36 J (0.55)	0.38 J (0.57)	0.45 J (0.57)	0.74 (0.58)	0.5 J (0.51)
Arsenic	0.11	--	--	--	--	--	--	--	**3.4 (0.56)**	**4.1 (0.56)**	--	**3.4 (0.56)**	**4 (0.55)**	**3.3 (0.57)**	**3.2 (0.57)**	**2.5 (0.58)**	**2.7 (0.51)**
Barium	15000	--	--	--	--	--	--	--	410 (5.6)	400 (5.6)	--	490 (5.6)	430 (5.5)	630 (5.7)	520 (5.7)	440 (5.8)	460 (5.1)
Beryllium	16	--	--	--	--	--	--	--	0.37 J (0.56)	0.35 J (0.56)	--	0.48 J (0.56)	0.42 J (0.55)	0.49 J (0.57)	0.53 J (0.57)	0.43 J (0.58)	0.42 J (0.51)
Cadmium	71	--	--	--	--	--	--	--	0.093 J (0.28)	U (0.28)	--	0.16 J (0.28)	U (0.28)	0.13 J (0.29)	0.093 J (0.28)	U (0.29)	U (0.26)
Chromium (total)	0.3	--	--	--	--	--	--	--	**23 (0.56)**	**28 (0.56)**	--	**30 (0.56)**	**31 (0.55)**	**28 (0.57)**	**29 (0.57)**	**20 (0.58)**	**21 (0.51)**
Cobalt	23	--	--	--	--	--	--	--	16 (0.56)	12 (0.56)	--	19 (0.56)	11 (0.55)	21 (0.57)	18 (0.57)	17 (0.58)	16 (0.51)
Copper	3100	--	--	--	--	--	--	--	41 (0.56)	33 (0.56)	--	55 (0.56)	31 (0.55)	56 (0.57)	57 (0.57)	59 (0.58)	60 (0.51)
Lead	80	--	--	--	--	--	--	**1900 (0.5)**	16 (0.56)	8.7 (0.56)	--	13 (0.56)	8.8 (0.55)	15 (0.57)	9.4 (0.57)	7.7 (0.58)	10 (0.51)
Mercury	1	--	--	--	--	--	--	--	0.052 (0.019)	0.033 (0.019)	--	0.044 (0.019)	0.027 (0.019)	0.044 (0.019)	0.028 (0.019)	0.021 (0.02)	0.015 J (0.017)
Molybdenum	390	--	--	--	--	--	--	--	0.89 (0.56)	1.1 (0.56)	--	0.81 (0.56)	0.7 (0.55)	0.81 (0.57)	0.84 (0.57)	0.82 (0.58)	0.83 (0.51)
Nickel	820	--	--	--	--	--	--	--	23 (0.56)	18 (0.56)	--	30 (0.56)	14 (0.55)	29 (0.57)	29 (0.57)	20 (0.58)	22 (0.51)
Selenium	390	--	--	--	--	--	--	--	0.51 J (0.56)	0.79 (0.56)	--	0.48 J (0.56)	0.86 (0.55)	0.53 J (0.57)	0.34 J (0.57)	0.39 J (0.58)	0.39 J (0.51)
Silver	390	--	--	--	--	--	--	--	U (0.56)	U (0.56)	--	U (0.56)	U (0.55)	U (0.57)	U (0.57)	U (0.58)	U (0.51)
Thallium	0.78	--	--	--	--	--	--	--	0.13 J (0.56)	0.17 J (0.56)	--	0.15 J (0.56)	U (0.55)	0.14 J (0.57)	0.15 J (0.57)	0.13 J (0.58)	0.13 J (0.51)
Vanadium	390	--	--	--	--	--	--	--	50 (0.56)	52 (0.56)	--	83 (0.56)	45 (0.55)	83 (0.57)	67 (0.57)	47 (0.58)	51 (0.51)
Zinc	23000	--	--	--	--	--	--	--	38 (5.6)	25 (5.6)	--	50 (5.6)	20 (5.5)	52 (5.7)	42 (5.7)	28 (5.8)	32 (5.1)

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-14-1	SS-14-1	SS-15-1	SS-15-1	SS-15-2	SS-15-2	SS-15A-1	SS-15A-1	SS-15A-2	SS-15A-2	SS-16-1	SS-16-1	SS-16-2	SS-16-2	SS-16A-1	SS-16A-1
AOI		AOI 14	AOI 14	AOI 14	AOI 14	AOI 14	AOI 14	AOI 14	AOI 14	AOI 14	AOI 14	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16
Field Sample ID		SS-14-1-03	SS-14-1-12	SS-15-1-03	SS-15-1-12	SS-15-2-03	SS-15-2-12	SS-15A-1-03	SS-15A-1-18	SS-15A-2-03	SS-15A-2-18	SS-16-1-03	SS-16-1-12	SS-16-2-03	SS-16-2-12	SS-16A-1-03	SS-16A-1-18
Collection Depth		3	12	3	12	3	12	3	18	3	18	3	12	3	12	3	18
Depth Units		in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in
Sample Date		3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	7/12/2018	7/12/2018
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	3.6 (1.2)	2.8 (1.2)	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	17 (5.8)	14 (5.8)	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	12 (0.58)	6.9 (0.58)	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	**4.1 (0.58)**	**3 (0.58)**	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	370 (5.8)	320 (5.8)	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	0.44 J (0.58)	0.43 J (0.58)	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	0.27 J (0.29)	0.15 J (0.29)	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	**24 (0.58)**	**26 (0.58)**	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	11 (0.58)	8.3 (0.58)	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	59 (0.58)	55 (0.58)	--	--
Lead	80	**81 (0.53)**	13 (0.54)	**240 (0.55)**	39 (0.58)	66 (0.61)	18 (0.55)	47 (0.56)	18 (0.55)	18 (0.54)	11 (0.56)	**97 (0.54)**	51 (0.56)	32 (0.58)	20 (0.58)	**100 (0.56)**	24 (0.54)
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	0.06 (0.02)	0.036 (0.02)	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	0.91 (0.58)	0.83 (0.58)	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	20 (0.58)	18 (0.58)	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	0.59 (0.58)	0.44 J (0.58)	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	U (0.58)	U (0.58)	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	0.13 J (0.58)	U (0.58)	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	47 (0.58)	38 (0.58)	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	220 (5.8)	150 (5.8)	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-16A-2	SS-16A-2	SS-17-1	SS-17-2	SS-17-3	SS-18-1	SS-18-1	SS-18-2	SS-18-2	SS-18-10	SS-18-11	SS-18-12	SS-18-13	SS-18-14	SS-18-2	SS-18-2-A1
AOI		AOI 16	AOI 16	AOI 15	AOI 15	AOI 15	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16
Field Sample ID		SS-16A-2-03	SS-16A-2-18	SS-17-1-03	SS-17-2-03	SS-17-3-03	SS-18-1-03	SS-18-1-12	SS-18-2-03	SS-18-2-12	SS-18-10-0.5	SS-18-11-0.5	SS-18-12-0.5	SS-18-13-0.5	SS-18-14-0.5	SS-18-2-1.0	SS-18-2-A1-0.5
Collection Depth		3	18	3	3	3	3	12	3	12	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1	0 - 0.5
Depth Units		in	in	in	in	in	in	in	in	in	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs
Sample Date		7/12/2018	7/12/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/28/2018	3/29/2018	3/29/2018	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	U (1.1)	U (1.1)	U (1.1)	2 (1.1)	U (1.1)	2.6 (1.1)	4.9 (1.1)	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	U (0.17)	U (0.17)	U (0.15)	U (0.13)	U (0.17)	U (0.16)	U (0.13)	--	--	--	--	--	--	--
Motor Oil	12000	--	--	U (5.5)	U (5.5)	U (5.5)	16 (5.6)	U (5.7)	180 (5.4)	190 (5.3)	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	0.46 J (0.55)	0.42 J (0.55)	0.35 J (0.55)	1 (0.56)	0.64 (0.57)	1.1 (0.54)	0.99 (0.53)	--	--	--	--	--	--	--
Arsenic	0.11	--	--	**3.5 (0.55)**	**3.7 (0.55)**	**3.2 (0.55)**	**4 (0.56)**	**3.6 (0.57)**	**5.6 (0.54)**	**4 (0.53)**	**3 (0.2)**	**3 (0.22)**	**4.5 F1 (0.23)**	**2.7 (0.22)**	**2.7 (0.22)**	**3.5 F1 (0.22)**	**2.4 (0.22)**
Barium	15000	--	--	540 (5.5)	560 (5.5)	580 (5.5)	380 (5.6)	300 (5.7)	570 (5.4)	430 (5.3)	--	--	--	--	--	--	--
Beryllium	16	--	--	0.49 J (0.55)	0.5 J (0.55)	0.44 J (0.55)	0.5 J (0.56)	0.42 J (0.57)	0.45 J (0.54)	0.54 (0.53)	--	--	--	--	--	--	--
Cadmium	71	--	--	0.065 J (0.27)	U (0.27)	U (0.28)	0.11 J (0.28)	0.08 J (0.28)	0.12 J (0.27)	0.12 J (0.26)	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	**27 (0.55)**	**29 (0.55)**	**29 (0.55)**	**25 (0.56)**	**27 (0.57)**	**31 (0.54)**	**55 (0.53)**	--	--	--	--	--	--	--
Cobalt	23	--	--	20 (0.55)	20 (0.55)	17 (0.55)	13 (0.56)	10 (0.57)	16 (0.54)	13 (0.53)	--	--	--	--	--	--	--
Copper	3100	--	--	59 (0.55)	59 (0.55)	58 (0.55)	70 (0.56)	52 (0.57)	89 (0.54)	60 (0.53)	--	--	--	--	--	--	--
Lead	80	20 (0.54)	14 (0.56)	10 (0.55)	11 (0.55)	8.4 (0.55)	19 (0.56)	20 (0.57)	73 (0.54)	54 (0.53)	--	--	--	--	--	--	--
Mercury	1	--	--	0.034 (0.019)	0.03 (0.019)	0.04 (0.019)	0.036 (0.019)	0.028 (0.019)	0.3 (0.018)	0.053 (0.018)	--	--	--	--	--	--	--
Molybdenum	390	--	--	0.92 (0.55)	0.8 (0.55)	0.66 (0.55)	0.79 (0.56)	0.93 (0.57)	0.74 (0.54)	0.91 (0.53)	--	--	--	--	--	--	--
Nickel	820	--	--	37 (0.55)	29 (0.55)	28 (0.55)	23 (0.56)	22 (0.57)	46 (0.54)	63 (0.53)	--	--	--	--	--	--	--
Selenium	390	--	--	0.56 (0.55)	0.5 J (0.55)	0.4 J (0.55)	0.43 J (0.56)	0.44 J (0.57)	0.23 J (0.54)	0.17 J (0.53)	--	--	--	--	--	--	--
Silver	390	--	--	U (0.55)	U (0.55)	U (0.55)	U (0.56)	U (0.57)	U (0.54)	U (0.53)	--	--	--	--	--	--	--
Thallium	0.78	--	--	0.15 J (0.55)	0.15 J (0.55)	0.13 J (0.55)	0.13 J (0.56)	0.11 J (0.57)	U (0.54)	U (0.53)	--	--	--	--	--	--	--
Vanadium	390	--	--	64 (0.55)	70 (0.55)	66 (0.55)	69 (0.56)	55 (0.57)	55 (0.54)	47 (0.53)	--	--	--	--	--	--	--
Zinc	23000	--	--	39 (5.5)	38 (5.5)	36 (5.5)	51 (5.6)	36 (5.7)	84 (5.4)	77 (5.3)	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-18-2-B1	SS-18-2-B2	SS-18-2-C1	SS-18-2-C2	SS-18-2-C3	SS-18-2-D1	SS-18-2-D2	SS-18-3	SS-18-3	SS-18-4	SS-18-5	SS-18-6	SS-18-7	SS-18-8	SS-18-9	SS-19-1
AOI		AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 16	AOI 19
Field Sample ID		SS-18-2-B1-0.5	SS-18-2-B2-0.5	SS-18-2-C1-0.5	SS-18-2-C2-0.5	SS-18-2-C3-0.5	SS-18-2-D1-0.5	SS-18-2-D2-0.5	SS-18-3-0.5	DUP-210203	SS-18-4-0.5	SS-18-5-0.5	SS-18-6-0.5	SS-18-7-0.5	SS-18-8-0.5	SS-18-9-0.5	SS-19-1-03
Collection Depth		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	3
Depth Units		ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	ft bgs	in
Sample Date		2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	2/3/2021	7/11/2018
Comments										Field Duplicate							
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	**2.9 (0.21)**	**3.7 (0.23)**	**2.7 (0.22)**	**3.2 (0.22)**	**2.3 (0.23)**	**2.6 (0.24)**	**3.3 (0.24)**	**4.4 (0.21)**	**3.3 (0.22)**	**3.7 (0.21)**	**3.3 (0.21)**	**3.6 (0.23)**	**3.1 (0.2)**	**2.9 (0.23)**	**2.4 (0.21)**	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**490**
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-19-1	SS-19-2	SS-19-2	SS-19-3	SS-19-3	SS-19-4	SS-19-4	SS-19-5	SS-19-5	SS-19-6	SS-19-6	SS-20-1	SS-20-1	SS-20-1	SS-20-1	SS-21-1
AOI		AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 19	AOI 20	AOI 20	AOI 20	AOI 20	AOI 18
Field Sample ID		SS-19-1-18	SS-19-2-03	SS-19-2-18	SS-19-3-03	SS-19-3-18	SS-19-4-03	SS-19-4-18	SS-19-5-03	SS-19-5-18	SS-19-6-03	SS-19-6-18	SS-20-1-03	SS-20-1-03-R	FD-01	SS-20-1-18	SS-21-1-03
Collection Depth		18	3	18	3	18	3	18	3	18	3	18	3	0 - 3	0 - 3	18	3
Depth Units		in	in	in	in	in	in	in	in	in	in	in	in	in bgs	in bgs	in	in
Sample Date		7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/12/2018	11/24/2020	11/24/2020	7/12/2018	7/12/2018
Comments															Field Duplicate		
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	0.13 (0.05)	U (0.05)	--	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	18	70	14	60	15	**110**	14	20	5	**560**	11	**490 (5.3)**	--	--	57 (0.54)	**130 (0.52)**
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-21-1	SS-21-1	SS-23-1	SS-2-1	SS-2-1	SS-2-1	SS-2-1	SS-2-2	SS-2-2	SS-2-2	SS-2-2	SS-2-3	SS-2-3	SS-2-3	SS-2-3	SS-2-4
AOI		AOI 18	AOI 18		AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24
Field Sample ID		SS-21-1-03-R	SS-21-1-18	SS-23-1-03-R	SS-2-1-03	SS-2-1-08	SS-2-1-14	SS-2-1-20	SS-2-2-03	SS-2-2-08	SS-2-2-14	SS-2-2-20	SS-2-3-03	SS-2-3-08	SS-2-3-14	SS-2-3-20	SS-2-4-03
Collection Depth		0 - 3	18	0 - 3	3	8	14	20	3	8	14	20	3	8	14	20	3
Depth Units		in bgs	in	in bgs	in	in	in	in	in	in	in	in	in	in	in	in	in
Sample Date		11/24/2020	7/12/2018	11/24/2020	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	U (0.0049)	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	U (0.0049)	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	U (0.0049)	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	**46 J (57)**	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	7.7 (2.2)	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	U (0.21)	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	82 (11)	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	0.078 (0.05)	--	U (0.05)	**15 (11)**	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	--	3.4 (0.55)	3 (0.55)	1.6 (0.55)	1.2 (0.56)	1.8 (0.57)	0.74 (0.55)	1.2 (0.56)	0.48 J (0.56)	0.59 (0.55)	0.55 (0.54)	0.46 J (0.55)	0.4 J (0.55)	0.64 (0.55)
Arsenic	0.11	--	--	--	**2.8 (0.55)**	**3.1 (0.55)**	**3.9 (0.55)**	**2.7 (0.56)**	**2.9 (0.57)**	**3.3 (0.55)**	**2.7 (0.56)**	**2.8 (0.56)**	**2.9 (0.55)**	**3.6 (0.54)**	**2.6 (0.55)**	**2.2 (0.55)**	**3.6 (0.55)**
Barium	15000	--	--	--	240 (5.5)	230 (5.5)	570 (5.5)	350 (5.6)	330 (5.7)	560 (5.5)	370 (5.6)	360 (5.6)	490 (5.5)	610 (5.4)	1300 (5.5)	850 (5.5)	680 (5.5)
Beryllium	16	--	--	--	0.35 (0.55)	0.42 (0.55)	0.89 (0.55)	0.5 J (0.56)	0.45 J (0.57)	0.71 (0.55)	0.55 J (0.56)	0.5 J (0.56)	0.67 (0.55)	0.89 (0.54)	0.78 (0.55)	0.71 (0.55)	0.91 (0.55)
Cadmium	71	--	--	--	6.6 (0.27)	8.2 (0.28)	7.3 (0.28)	3.3 (0.28)	1.7 (0.29)	0.17 J (0.28)	0.07 J (0.28)	0.14 J (0.28)	0.38 (0.27)	0.21 J (0.27)	0.21 J (0.27)	0.11 J (0.27)	U (0.27)
Chromium (total)	0.3	--	--	--	**36 (0.55)**	**44 (0.55)**	**30 (0.55)**	**26 (0.56)**	**58 (0.57)**	**20 (0.55)**	**28 (0.56)**	**39 (0.56)**	**18 (0.55)**	**21 (0.54)**	**18 (0.55)**	**15 (0.55)**	**32 (0.55)**
Cobalt	23	--	--	--	13 (0.55)	13 (0.55)	16 (0.55)	7.4 (0.56)	13 (0.57)	15 (0.55)	6.9 (0.56)	19 (0.56)	11 (0.55)	13 (0.54)	15 (0.55)	8.9 (0.55)	18 (0.55)
Copper	3100	--	--	--	90 (0.55)	76 (0.55)	130 (0.55)	81 (0.56)	75 (0.57)	140 (0.55)	54 (0.56)	61 (0.56)	130 (0.55)	170 (0.54)	150 (0.55)	130 (0.55)	210 (0.55)
Lead	80	--	71 (0.53)	--	**130 (0.55)**	70 (0.55)	39 (0.55)	12 (0.56)	**220 (0.57)**	17 (0.55)	15 (0.56)	13 (0.56)	18 (0.55)	15 (0.54)	11 (0.55)	9.7 (0.55)	18 (0.55)
Mercury	1	--	--	--	0.091 (0.019)	0.11 (0.019)	0.042 (0.019)	0.029 (0.019)	0.06 (0.019)	0.022 (0.019)	0.032 (0.019)	0.018 J (0.019)	0.015 JB (0.019)	0.011 JB (0.018)	0.01 J (0.019)	0.06 (0.019)	0.018 JB (0.019)
Molybdenum	390	--	--	--	0.55 (0.55)	0.45 (0.55)	0.33 J (0.55)	0.35 J (0.56)	0.58 (0.57)	0.31 J (0.55)	0.34 J (0.56)	0.4 J (0.56)	0.29 J (0.55)	0.29 J (0.54)	0.32 J (0.55)	U (0.55)	0.37 J (0.55)
Nickel	820	--	--	--	23 (0.55)	21 (0.55)	43 (0.55)	17 (0.56)	21 (0.57)	32 (0.55)	18 (0.56)	33 (0.56)	29 (0.55)	38 (0.54)	34 (0.55)	27 (0.55)	42 (0.55)
Selenium	390	--	--	--	0.44 (0.55)	0.38 (0.55)	0.4 J (0.55)	0.39 J (0.56)	0.61 (0.57)	0.52 J (0.55)	0.47 J (0.56)	0.62 (0.56)	0.44 J (0.55)	0.47 J (0.54)	0.35 J (0.55)	0.18 J (0.55)	0.38 J (0.55)
Silver	390	--	--	--	0.39 (0.55)	0.29 (0.55)	0.19 J (0.55)	U (0.56)	0.39 J (0.57)	0.064 J (0.55)	U (0.56)	U (0.56)	U (0.55)	U (0.54)	U (0.55)	U (0.55)	U (0.55)
Thallium	0.78	--	--	--	U (0.55)	U (0.55)	0.12 J (0.55)	0.12 J (0.56)	U (0.57)	U (0.55)	0.15 J (0.56)	0.14 J (0.56)	U (0.55)	U (0.54)	0.14 J (0.55)	U (0.55)	U (0.55)
Vanadium	390	--	--	--	51 (0.55)	83 (0.55)	53 (0.55)	46 (0.56)	54 (0.57)	51 (0.55)	52 (0.56)	110 (0.56)	41 (0.55)	45 (0.54)	48 (0.55)	33 (0.55)	47 (0.55)
Zinc	23000	--	--	--	4800 (5.5)	4300 (5.5)	2900 (5.5)	1400 (5.6)	410 (5.7)	60 (5.5)	29 (5.6)	63 (5.6)	110 (5.5)	86 (5.4)	75 (5.5)	55 (5.5)	70 (5.5)

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-2-4	SS-2-4	SS-2-4	SS-2-5	SS-2-5	SS-2-6	SS-2-6	SS-2-6	SS-2-6	SS-2-7	SS-2-7	SS-2-7	SS-2-7	SS-2-8	SS-2-8	SS-2-8
AOI		AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24	AOI 24
Field Sample ID		SS-2-4-08	SS-2-4-14	SS-2-4-20	SS-2-5-03	SS-2-5-08	SS-2-6-03	SS-2-6-08	SS-2-6-14	SS-2-6-20	SS-2-7-03	SS-2-7-08	SS-2-7-14	SS-2-7-20	SS-2-8-03	SS-2-8-08	SS-2-8-14
Collection Depth		8	14	20	3	8	3	8	14	20	3	8	14	20	3	8	14
Depth Units		in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in
Sample Date		3/27/2018	3/27/2018	3/27/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	0.54 J (0.55)	0.35 J (0.55)	0.59 (0.55)	1.2 (0.53)	0.57 (0.53)	1.4 (0.54)	0.84 (0.53)	--	--	1.4 (0.54)	0.66 (0.53)	--	--	0.77 (0.55)	0.69 (0.54)	--
Arsenic	0.11	**3.4 (0.55)**	**2.8 (0.55)**	**3.3 (0.55)**	**2.8 (0.53)**	**4 (0.53)**	**2.8 (0.54)**	**2.3 (0.53)**	--	--	**2.8 (0.54)**	**2.6 (0.53)**	--	--	**2 (0.55)**	**2.4 (0.54)**	--
Barium	15000	630 (5.5)	1200 (5.5)	640 (5.5)	430 (5.3)	530 (5.3)	470 (5.4)	400 (5.3)	--	--	410 (5.4)	420 (5.3)	--	--	390 (5.5)	400 (5.4)	--
Beryllium	16	0.87 (0.55)	0.71 (0.55)	1.1 (0.55)	0.45 J (0.53)	0.62 (0.53)	0.55 (0.54)	0.45 J (0.53)	--	--	0.49 J (0.54)	0.59 (0.53)	--	--	0.43 J (0.55)	0.44 J (0.54)	--
Cadmium	71	U (0.27)	0.094 J (0.28)	0.11 J (0.28)	1.2 (0.26)	0.26 J (0.26)	1.6 (0.27)	0.43 (0.26)	0.32 (0.27)	0.21 J (0.27)	1.5 (0.27)	0.66 (0.27)	0.24 J (0.27)	0.17 J (0.27)	0.65 (0.28)	0.38 (0.27)	0.16 J (0.27)
Chromium (total)	0.3	**16 (0.55)**	**18 (0.55)**	**31 (0.55)**	**29 (0.53)**	**26 (0.53)**	**30 (0.54)**	**21 (0.53)**	--	--	**100 (0.54)**	**30 (0.53)**	--	--	**29 (0.55)**	**31 (0.54)**	--
Cobalt	23	15 (0.55)	10 (0.55)	13 (0.55)	12 (0.53)	9.9 (0.53)	13 (0.54)	13 (0.53)	--	--	12 (0.54)	14 (0.53)	--	--	9.8 (0.55)	11 (0.54)	--
Copper	3100	160 (0.55)	110 (0.55)	150 (0.55)	63 (0.53)	81 (0.53)	99 (0.54)	67 (0.53)	--	--	77 (0.54)	69 (0.53)	--	--	77 (0.55)	74 (0.54)	--
Lead	80	14 (0.55)	9.9 (0.55)	17 (0.55)	63 (0.53)	17 (0.53)	**83 (0.54)**	32 (0.53)	--	--	**380 (0.54)**	31 (0.53)	--	--	**93 (0.55)**	72 (0.54)	--
Mercury	1	0.015 JB (0.019)	0.029 (0.019)	0.061 (0.019)	0.042 J (0.018)	0.013 (0.018)	0.029 (0.018)	0.03 (0.018)	--	--	0.058 (0.018)	0.037 (0.018)	--	--	0.025 (0.019)	0.028 (0.018)	--
Molybdenum	390	0.27 J (0.55)	0.3 J (0.55)	0.35 J (0.55)	1.1 (0.53)	0.42 J (0.53)	0.4 J (0.54)	0.4 J (0.53)	--	--	0.58 (0.54)	0.47 J (0.53)	--	--	0.37 J (0.55)	0.38 J (0.54)	--
Nickel	820	34 (0.55)	28 (0.55)	35 (0.55)	20 (0.53)	33 (0.53)	26 (0.54)	22 (0.53)	--	--	26 (0.54)	26 (0.53)	--	--	20 (0.55)	19 (0.54)	--
Selenium	390	0.42 J (0.55)	0.35 J (0.55)	0.79 (0.55)	0.42 J (0.53)	0.43 J (0.53)	0.46 J (0.54)	0.39 J (0.53)	--	--	0.42 J (0.54)	0.63 (0.53)	--	--	0.37 J (0.55)	0.38 J (0.54)	--
Silver	390	U (0.55)	U (0.55)	U (0.55)	0.078 J (0.53)	U (0.53)	0.17 J (0.54)	0.068 J (0.53)	--	--	0.31 J (0.54)	0.086 J (0.53)	--	--	0.15 J (0.55)	0.17 J (0.54)	--
Thallium	0.78	U (0.55)	0.13 J (0.55)	0.14 J (0.55)	U (0.53)	U (0.53)	U (0.54)	U (0.53)	--	--	U (0.54)	0.11 J (0.53)	--	--	U (0.55)	U (0.54)	--
Vanadium	390	39 (0.55)	41 (0.55)	56 (0.55)	54 (0.53)	48 (0.53)	48 (0.54)	44 (0.53)	--	--	47 (0.54)	68 (0.53)	--	--	40 (0.55)	46 (0.54)	--
Zinc	23000	49 (5.5)	44 (5.5)	56 (5.5)	150 (5.3)	71 (5.3)	340 (5.4)	170 (5.3)	170 (5.3)	120 (5.3)	320 (5.4)	180 (5.3)	100 (5.3)	120 (5.4)	170 (5.5)	110 (5.4)	67 (5.4)

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-2-8	SS-3-1	SS-3-1	SS-3-2	SS-3-2	SS-3A-1	SS-3A-1	SS-3A-2	SS-3A-2	SS-4-1	SS-4-1	SS-4-2	SS-4-2	SS-4-3	SS-4-3	SS-4-3
AOI		AOI 24	AOI 25	AOI 25	AOI 25	AOI 25	AOI 25	AOI 25	AOI 25	AOI 25	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21
Field Sample ID		SS-2-8-20	SS-3-1-03	SS-3-1-12	SS-3-2-03	SS-3-2-03-R	SS-3A-1-03	SS-3A-1-18	SS-3A-2-03	SS-3A-2-18	SS-4-1-03	SS-4-1-12	SS-4-2-03	SS-4-2-12	SS-4-3-03	SS-4-3-03-R	SS-4-3-12
Collection Depth		20	3	12	3	0 - 3	3	18	3	18	3	12	3	12	3	0 - 3	12
Depth Units		in	in	in	in	in bgs	in	in	in	in	in	in	in	in	in	in bgs	in
Sample Date		7/12/2018	3/27/2018	3/27/2018	3/27/2018	11/24/2020	7/11/2018	7/11/2018	7/11/2018	7/11/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	11/24/2020	3/27/2018
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	0.12 (0.05)	--	--	--	--	--	--	--	--	--	0.075 (0.05)	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	0.12 J (0.27)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	--	**170 (0.66)**	28 (0.57)	**160 (0.57)**	--	47	31	52	15	68 (0.54)	**100 (0.54)**	68 (0.56)	56 (0.55)	**170 (0.61)**	--	**120 (0.56)**
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	57 (5.4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-4-4	SS-4-4	SS-4-5	SS-4-5	SS-4-5	SS-4-6	SS-4-6	SS-4-7	SS-4-7	SS-4-8	SS-4-8	SS-4-8	SS-4A-1	SS-4A-1	SS-4A-2	SS-4A-2
AOI		AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21
Field Sample ID		SS-4-4-03	SS-4-4-12	SS-4-5-03	SS-4-5-03-R	SS-4-5-12	SS-4-6-03	SS-4-6-12	SS-4-7-03	SS-4-7-12	SS-4-8-03	SS-4-8-03-R	SS-4-8-12	SS-4A-1-03	SS-4A-1-18	SS-4A-2-03	SS-4A-2-18
Collection Depth		3	12	3	0 - 3	12	3	12	3	12	3	0 - 3	12	3	18	3	18
Depth Units		in	in	in	in bgs	in	in	in	in	in	in	in bgs	in	in	in	in	in
Sample Date		3/27/2018	3/27/2018	3/27/2018	11/24/2020	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	11/24/2020	3/27/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	0.078 (0.05)	--	--	--	--	--	--	0.064 (0.05)	--	--	--	--	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	**280 (0.56)**	**160 (0.56)**	**880 (5.6)**	--	**130 (0.55)**	**370 (0.58)**	20 (0.55)	**120 (0.56)**	**86 (0.56)**	64 (0.56)	--	25 (0.55)	**210**	24	68	80
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-4A-3	SS-4A-3	SS-4A-4	SS-4A-4	SS-4A-5	SS-4A-5	SS-4A-6	SS-4A-6	SS-4A-7	SS-4A-7	SS-4A-8	SS-4A-8	SS-5-1	SS-5-1	SS-5-2	SS-5-2
AOI		AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 21	AOI 18	AOI 18	AOI 18	AOI 18
Field Sample ID		SS-4A-3-03	SS-4A-3-18	SS-4A-4-03	SS-4A-4-18	SS-4A-5-03	SS-4A-5-18	SS-4A-6-03	SS-4A-6-18	SS-4A-7-03	SS-4A-7-18	SS-4A-8-03	SS-4A-8-18	SS-5-1-03	SS-5-1-12	SS-5-2-03	SS-5-2-03-R
Collection Depth		3	18	3	18	3	18	3	18	3	18	3	18	3	12	3	0 - 3
Depth Units		in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in bgs
Sample Date		7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	3/28/2018	3/28/2018	3/28/2018	11/24/2020
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.058 (0.05)
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	**170**	57	47	20	72	66	**240**	16	34	14	67	18	**100 (0.55)**	12 (0.57)	**590 (5.6)**	--
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-5-2	SS-5-3	SS-5-3	SS-5A-1	SS-5A-1	SS-5A-2	SS-5A-2	SS-5A-3	SS-5A-3	SS-7-1	SS-7-2	SS-7-SED	SS-8-1	SS-8-1	SS-8-2	SS-8-2
AOI		AOI 18	AOI 18	AOI 18	AOI 18	AOI 18	AOI 18	AOI 18	AOI 18	AOI 18	AOI 22	AOI 22	AOI 22	AOI 23	AOI 23	AOI 23	AOI 23
Field Sample ID		SS-5-2-12	SS-5-3-03	SS-5-3-12	SS-5A-1-03	SS-5A-1-18	SS-5A-2-03	SS-5A-2-18	SS-5A-3-03	SS-5A-3-18	SS-7-1	SS-7-2	SS-7-SED	SS-8-1-03	SS-8-1-12	SS-8-2-03	SS-8-2-03-R
Collection Depth		12	3	12	3	18	3	18	3	18	1	1	1	3	12	3	0 - 3
Depth Units		in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in bgs
Sample Date		3/28/2018	3/28/2018	3/28/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	7/11/2018	3/29/2018	3/29/2018	3/29/2018	3/27/2018	3/27/2018	3/27/2018	11/24/2020
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2 (0.049)
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	**580 (5.6)**	**780 (5.7)**	51 (0.57)	**87**	15	**150**	18	**150**	28	31 (0.51)	**92 (0.52)**	54 (0.51)	**1300 (3)**	74 (0.56)	**1100 (5.9)**	--
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-8-2	SS-8-3	SS-8-3	SS-8-4	SS-8-4	SS-8-5	SS-8-5	SS-8-6	SS-8-6	SS-8A-1	SS-8A-1	SS-8A-2	SS-8A-2	SS-8A-3	SS-8A-3	SS-8A-4
AOI		AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 23
Field Sample ID		SS-8-2-12	SS-8-3-03	SS-8-3-12	SS-8-4-03	SS-8-4-12	SS-8-5-03	SS-8-5-12	SS-8-6-03	SS-8-6-12	SS-8A-1-03	SS-8A-1-18	SS-8A-2-03	SS-8A-2-18	SS-8A-3-03	SS-8A-3-18	SS-8A-4-03
Collection Depth		12	3	12	3	12	3	12	3	12	3	18	3	18	3	18	3
Depth Units		in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in
Sample Date		3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/27/2018	3/28/2018	3/28/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018	7/12/2018
Comments																	
VOCs																	
Benzene	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PDIST																	
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs																	
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
INORG																	
Antimony	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	15000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium (total)	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	80	21 (0.55)	**170 (0.55)**	**110 (0.56)**	**200 (0.56)**	**110 (0.56)**	**700 (6)**	**190 (0.56)**	**130 (0.59)**	**1400 (5.5)**	45 (0.54)	30 (0.54)	34 (0.53)	14 (0.54)	64 (0.62)	24 (0.55)	**330 (0.51)**
Mercury	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	23000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

TABLE 2-1
Soil Analytical Results
GGNRA Hawk Hill, Marin Headlands, CA

Location	Residential Screening Level	SS-8A-4	SS-8A-5	SS-8A-5	SS-8A-6	SS-8A-6	SS-9-1	SS-9-1	SS-9-2	SS-9-3	SS-9-3
AOI		AOI 23	AOI 23	AOI 23	AOI 23	AOI 23	AOI 17	AOI 17	AOI 17	AOI 17	AOI 17
Field Sample ID		SS-8A-4-18	SS-8A-5-03	SS-8A-5-18	SS-8A-6-03	SS-8A-6-18	SS-9-1-12	SS-9-1-36	SS-9-2-12	SS-9-3-12	SS-9-3-36
Collection Depth		18	3	18	3	18	12	36	12	12	36
Depth Units		in	in	in	in	in	in	in	in	in	in
Sample Date		7/12/2018	7/12/2018	7/12/2018	7/11/2018	7/11/2018	3/29/2018	3/29/2018	3/29/2018	3/29/2018	3/29/2018
Comments											
VOCs											
Benzene	0.33	--	--	--	--	--	--	--	--	--	--
Ethyl Benzene	5.8	--	--	--	--	--	--	--	--	--	--
Toluene	1100	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	580	--	--	--	--	--	--	--	--	--	--
SVOCs											
4,6-Dinitro-2-methylphenol	5.1	--	--	--	--	--	--	--	--	--	--
PDIST											
Diesel Range Organics	260	--	--	--	--	--	--	--	--	--	--
Gasoline Range Organics	430	--	--	--	--	--	--	--	--	--	--
Motor Oil	12000	--	--	--	--	--	--	--	--	--	--
PCBs											
Aroclor-1260	0.24	--	--	--	--	--	--	--	--	--	--
INORG											
Antimony	31	--	2.3 (0.53)	0.57 (0.54)	--	--	0.45 J (0.61)	0.5 J (0.59)	0.55 J (0.58)	0.58 J (0.63)	0.58 J (0.62)
Arsenic	0.11	--	**3 (0.53)**	**4 (0.54)**	--	--	**2 (0.61)**	**3 (0.59)**	**3.4 (0.58)**	**2.1 (0.63)**	**2.5 (0.62)**
Barium	15000	--	370 (5.3)	370 (5.4)	--	--	180 (6.1)	230 (5.9)	340 (5.8)	370 (6.3)	220 (6.2)
Beryllium	16	--	0.44 J (0.53)	0.53 J (0.54)	--	--	0.44 J (0.61)	0.39 J (0.59)	0.38 J (0.58)	0.35 J (0.63)	0.42 J (0.62)
Cadmium	71	--	0.52 (0.26)	0.18 J (0.27)	--	--	U (0.31)	U (0.3)	0.1 J (0.29)	0.18 J (0.31)	U (0.31)
Chromium (total)	0.3	--	**62 (0.53)**	**43 (0.54)**	--	--	**22 (0.61)**	**25 (0.59)**	**27 (0.58)**	**20 (0.63)**	**25 (0.62)**
Cobalt	23	--	16 (0.53)	17 (0.54)	--	--	2.2 (0.61)	4.4 (0.59)	11 (0.58)	12 (0.63)	4.2 (0.62)
Copper	3100	--	60 (0.53)	43 (0.54)	--	--	48 (0.61)	46 (0.59)	51 (0.58)	60 (0.63)	57 (0.62)
Lead	80	**86 (0.54)**	**200 (0.53)**	58 (0.54)	**150**	62	6.7 (0.61)	7.7 (0.59)	23 (0.58)	31 (0.63)	14 (0.62)
Mercury	1	--	0.066 (0.018)	0.056 (0.018)	--	--	0.012 J (0.021)	0.039 (0.02)	0.064 (0.02)	0.047 (0.021)	0.039 (0.021)
Molybdenum	390	--	0.68 (0.53)	1.2 (0.54)	--	--	1.2 (0.61)	1.5 (0.59)	0.65 (0.58)	0.47 J (0.63)	0.52 J (0.62)
Nickel	820	--	25 (0.53)	40 (0.54)	--	--	12 (0.61)	11 (0.59)	20 (0.58)	25 (0.63)	14 (0.62)
Selenium	390	--	0.59 (0.53)	0.44 J (0.54)	--	--	0.61 J (0.61)	0.9 (0.59)	0.59 (0.58)	0.29 J (0.63)	0.53 J (0.62)
Silver	390	--	0.15 J (0.53)	U (0.54)	--	--	U (0.61)	U (0.59)	U (0.58)	U (0.63)	U (0.62)
Thallium	0.78	--	0.12 J (0.53)	0.11 J (0.54)	--	--	U (0.61)	U (0.59)	U (0.58)	U (0.63)	U (0.62)
Vanadium	390	--	66 (0.53)	65 (0.54)	--	--	42 (0.61)	44 (0.59)	52 (0.58)	35 (0.63)	38 (0.62)
Zinc	23000	--	120 (5.3)	52 (5.4)	--	--	18 (6.1)	15 (5.9)	43 (5.8)	74 (6.3)	32 (6.2)

Notes:

1 All concentrations are presented in mg/kg (ppm). Detection limts are in parentheses.

2 Only compounds with at least one detection are shown.

3 The Residential Screening Level is based on DTSC's HHRA Note 3 Residential Soil Screening Level. Where not available, the USEPA Residential Soil Regional Screening Level was used.

4 The Residential Screening Level for petroleum hydrocarbons is based on the SF RWQCB DEHHRL Soil ESL.

6 Grey shaded concentrations exceed the Residential Screening Level.

Abbreviations:

U -- Not Detected.
-- -- Not Analyzed.
J -- Estimated Concentration.
B -- Blank Contamination.
HHRA -- Human Health Risk Assessment
DEHHRL -- Direct Exposure Human Health Risk Levels

Table 2-2
Background Soil Sampling Results and Statistics
GGNRA Hawk Hill, Marin Headlands, CA

		Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Cobalt		Copper		Lead		Mercury		Molybdenum		Nickel		Selenium		Silver		Thallium		Vanadium		Zinc	
Sample ID	**Location ID**	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q	mg/kg	Q
950CR	950CR	1.5	U	1.25	U	36		0.1	U	0.25	U	2.6		2		9.4		5	U	0.105	U	1	U	5.4		12.5	U	0.5	U	2.5	U	2.4		5.4	
950CT002	950CT002	1.5	U	1.25	U	280		0.1	U	0.25	U	52		6.3		86		5	U	0.1	U	1	U	110		12.5	U	0.5	U	2.5	U	6.8		16	
950CT004	950CT004	1.5	U	1.25	U	23		0.1	U	0.25	U	0.5	U	1	U	3.1		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	0.5	U	1	U
950CT005	950CT005	1.5	U	1.25	U	96		0.1	U	0.25	U	1.5		13		20		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	2.8		5.5	
950CT006	950CT006	1.5	U	1.25	U	12		0.1	U	0.25	U	1.4		1	U	9.2		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	1.2		1	U
950CT007	950CT007	1.5	U	1.25	U	13		0.1	U	0.25	U	6.9		2.2		24		5	U	0.1	U	1	U	4		12.5	U	0.5	U	2.5	U	2.9		2.6	
950CT009	950CT009	1.5	U	1.25	U	160		0.1	U	0.25	U	0.5	U	2.7		35		5	U	0.1	U	1	U	7		12.5	U	0.5	U	2.5	U	3.4		5.3	
950CT010	950CT010	1.5	U	1.25	U	42		0.1	U	0.25	U	1.2		1	U	13		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	6.3		2.4	
950CT011	950CT011	1.5	U	1.25	U	17		0.1	U	0.25	U	2.4		2.8		12		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	11		8.1	
950CT012	950CT012	1.5	U	1.25	U	96		0.1	U	0.61		15		7.8		50		5	U	0.1	U	1	U	25		12.5	U	0.5	U	2.5	U	38		56	
950CT014	950CT014	1.5	U	1.25	U	13		0.1	U	0.25	U	0.5	U	1	U	6.1		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	2.2		1	U
950CT015	950CT015	1.5	U	1.25	U	31		0.1	U	0.25	U	1.6		1	U	26		5	U	0.1	U	1	U	4.3		12.5	U	0.5	U	2.5	U	2.9		7.1	
950CT016	950CT016	1.5	U	1.25	U	18		0.1	U	0.25	U	6.3		1	U	16		5	U	0.1	U	1	U	4.2		12.5	U	0.5	U	2.5	U	3		7.9	
950CT017	950CT017	1.5	U	1.25	U	12		0.1	U	0.25	U	2.4		1	U	15		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	4.4		3	
950CT018	950CT018	1.5	U	1.25	U	36		0.1	U	0.25	U	6.2		1	U	18		5	U	0.1	U	1	U	4.4		12.5	U	0.5	U	2.5	U	7.7		10	
950CT019	950CT019	1.5	U	1.25	U	12		0.1	U	0.25	U	2.5		1	U	11		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	3.3		2.7	
950CT020	950CT020	1.5	U	1.25	U	160		0.1	U	0.25	U	2.2		9.8		36		5	U	0.1	U	1	U	22		12.5	U	0.5	U	2.55	U	12		8.2	
950CT021	950CT021	1.5	U	1.25	U	92		0.1	U	0.25	U	4.3		3.9		26		5	U	0.1	U	1	U	5.1		12.5	U	0.5	U	2.5	U	9.6		4.4	
950CT022	950CT022	1.5	U	1.25	U	25		0.1	U	0.25	U	0.5	U	1	U	14		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	2.9		1	U
950CT023	950CT023	1.5	U	1.25	U	10		0.1	U	0.25	U	0.5	U	1	U	3.2		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	0.5	U	2	
950CT024	950CT024	1.5	U	1.25	U	190		0.1	U	0.25	U	0.5	U	1	U	4.6		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	4.9		4.8	
950CT025	950CT025	1.5	U	1.25	U	110		0.1	U	0.25	U	0.5	U	2.5		22		5	U	0.1	U	1	U	6.2		12.5	U	0.5	U	2.5	U	2.7		6	
950CT026	950CT026	1.5	U	1.25	U	46		0.1	U	0.25	U	0.5	U	3.7		13		5	U	0.1	U	1	U	4		12.5	U	0.5	U	2.5	U	1.3		3.8	
950CT027	950CT027	1.5	U	3.2		250		0.1	U	0.64		0.5	U	16		140		5	U	0.1	U	1	U	33		12.5	U	0.5	U	2.5	U	7.9		30	
950CT028	950CT028	1.5	U	1.25	U	31		0.1	U	0.25	U	0.5	U	2.3		15		5	U	0.1	U	1	U	6.2		12.5	U	0.5	U	2.5	U	1.6		14	
950CT029	950CT029	1.5	U	1.25	U	52		0.1	U	0.25	U	1.8		2		22		5	U	0.1	U	1	U	4.8		12.5	U	0.5	U	2.5	U	3.6		4.2	
950CT030	950CT030	1.5	U	1.25	U	120		0.1	U	0.25	U	4.1		10		52		5	U	0.1	U	1	U	9		12.5	U	0.5	U	2.5	U	9.4		16	
950CT031	950CT031	1.5	U	1.25	U	120		0.1	U	0.25	U	1.1		5.4		58		5	U	0.1	U	1	U	11		12.5	U	0.5	U	2.5	U	3.7		9	
950CT032	950CT032	1.5	U	1.25	U	50		0.1	U	0.25	U	1.9		2.2		25		5	U	0.1	U	1	U	5.5		12.5	U	0.5	U	2.5	U	4.5		4.6	
950CT033	950CT033	1.5	U	1.25	U	32		0.1	U	0.25	U	4		1	U	28		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	3.2		5.9	
950CT034	950CT034	1.5	U	1.25	U	79		0.25		0.25	U	3.5		3.1		88		5	U	0.1	U	1	U	15		12.5	U	0.5	U	2.5	U	7.2		20	
950SH001	950SH001	1.5	U	1.3	U	60		0.31		0.67		12		25		51		5	U	0.105	U	1.05	U	9.2		13	U	0.5	U	2.6	U	25		7.9	
950SH002	950SH002	1.5	U	1.3	U	210		0.44		1		13		87		210		5	U	0.105	U	1	U	58		13	U	0.5	U	2.55	U	47		17	
950SH003	950SH003	1.5	U	1.25	U	190		0.55		0.76		12		22		150		12		0.105	U	1	U	15		12.5	U	0.5	U	2.5	U	34		10	
950SH004	950SH004	1.5	U	1.25	U	320		0.27		0.25	U	5.9		16		310		5	U	0.105	U	1	U	22		12.5	U	0.5	U	2.5	U	7.6		47	
950SH005	950SH005	1.5	U	1.25	U	280		0.1	U	0.25	U	6.9		6.5		110		5	U	0.1	U	1	U	18		12.5	U	0.5	U	2.5	U	14		36	
950SH006	950SH006	1.5	U	1.25	U	270		0.39		0.96		11		8.2		110		20		0.105	U	1	U	19		12.5	U	0.5	U	2.5	U	17		51	
950SH007	950SH007	1.5	U	1.25	U	220		0.53		1.3		7		14		110		17		0.105	U	1	U	16		12.5	U	0.5	U	2.5	U	12		32	
950SH008	950SH008	1.5	U	1.25	U	250		0.34		1.1		6.7		6.1		110		13		0.105	U	1	U	16		12.5	U	0.5	U	2.5	U	12		34	
950SH009	950SH009	1.5	U	1.25	U	1100		0.72		1.7		6.8		8.7		120		37		0.1	U	1	U	38		12.5	U	0.5	U	2.5	U	17		140	
950SH010	950SH010	1.5	U			50		0.1	U	0.25	U	4.5		1.0	U	39		5	U	0.1	U	1	U	2	U	12.5	U	0.5	U	2.5	U	15		7.9	
950SH011	950SH011	1.5	U	1.25	U	170		0.4		0.98		7.2		2.4		76		5	U	0.105	U	1	U	4.5		12.5	U	0.5	U	2.55	U	34		12	
950SH012	950SH012	1.5	U	1.25	U	400		0.37		0.255	U	6.4		8.5		100		5	U	0.105	U	1	U	24		12.5	U	0.5	U	2.55	U	12		39	
950SH013	950SH013	1.5	U	1.25	U	220		0.32		0.255	U	6.4		3.9		140		5	U	0.105	U	1	U	16		12.5	U	0.5	U	2.55	U	7.4		46	
950SH014	950SH014	1.55	U	1.3	U	280		0.43		0.52		8.8		4.5		160		5	U	0.1	U	1	U	18		13	U	0.5	U	2.55	U	12		44	
950SH015	950SH015	1.55	U	1.3	U	280		0.4		0.255	U	9.1		4.5		100		5	U	0.105	U	1	U	23		13	U	0.5	U	2.55	U	11		51	
BKGDSB03	BKGDSB03	20.65	U	2.46		229		0.25	U	0.2575	U	48.4		15.3		49.4		45		0.036				32.5		0.125	U	0.2605	U	7.35	U	71.3		64.5	
Count		47		46		47		47		47		47		47		47		47		47		46		47		47		47		47		47		47	
Detected		0		2		47		14		11		37		33		47		6		1		0		34		0		0		0		45		43	
Minimum		1.5		1.25		10		0.1		0.3		1		1.0		3.1		5.0		0.036		1.0		2		0.125		0.2605		2.5		1		1	
Median		1.5		1.25		96		0.1		0.3		4		3		35		5		0.1		1.0		6		12.5		0.5		2.5		7		8	
Maximum		20.7		3.2		1100		0.72		1.7		52		87		310		45		0.105		1.1		110		13.0		0.5		7.35		71		140	
Arithmetic mean		1.9		1.3		145		0.20		0.4		6		7		61		7		0.10		1.0		14		12.3		0.5		2.6		11		19	
Standard deviation		2.8		0.3		177		0.16		0.3		10		13.2		63.1		8		0.01		0.0		19		1.8		0.03		0.7		14		25	
UCL on Mean		--		--		191		0.3		0.7		9		12		79		--		--		--		21		--		--		--		16		29	
EPC		--		3.2		191		0.3		0.7		9		12		79		7.0		0.036		--		21		--		--		--		16		29	
EPC Basis				Max		UCL		UCL		UCL		UCL		UCL		UCL		Mean		Max				UCL								UCL		UCL	
BG Threshold Value (BTV)		3.0		3.2		900		0.72		1.7		41		37		360		45		0.20		2.0		71		0.5		1		1		61		120	

Notes:
Concentrations for nondetects (U-qualified data) are 0.5 the analytical limits.
Q -- Data qualifier
U -- Non-detect
EPC -- Exposure Point Concentration
UCL -- Upper Confidence Limit on the Mean

Table 2-3
Scenarios for Potential Human Exposure
GGNRA Hawk Hill, Marin Headlands, CA

Receptor Population	Exposure Medium	Exposure Route	Potential Current Exposure?	Potential Future Exposure?	Comments
On-Site					
Residents	surface soil	incidental ingestion of and dermal contact with surface soil	No	Yes	COPCs at the Site are predominantly metals. Also, the presence of VOCs in soil at the Site is limited and the detected concentrations are very low. Potential future vapor intrusion is not expected to be a significant exposure pathway.
		inhalation of soil-derived vapors and airborne particulates (wind erosion) in outdoor air	No	Yes	
		inhalation of soil-derived vapors that migrate through building foundations into indoor air	No	Yes	
Park Workers (Including Volunteers and Scholars)	surface soil	incidental ingestion of and dermal contact with surface soil	Yes	Yes	Exposure to surface soil through incidental ingestion, dermal contact, and inhalation of vapor and particulates is possible in areas without ground cover.
		inhalation of soil-derived vapors and airborne particulates (wind erosion) in outdoor air	Yes	Yes	
		inhalation of soil-derived vapors that migrate through building foundations into indoor air	No	No	None of the structures at the Site are routinely occupied or expected to be routinely occupied in the future. Also, the presence of VOCs in soil at the Site is limited and the detected concentrations are very low. Potential future vapor intrusion is not expected to be a significant exposure pathway.
	subsurface soil	inhalation of soil-derived vapors in outdoor air	Yes	Yes	
		inhalation of soil-derived vapors that migrate through building foundations into indoor air	No	No	
Maintenance Workers	surface and subsurface soil	incidental ingestion of and dermal contact with soil; inhalation of soil-derived vapors and airborne particulates in work-space air	Yes	Yes	Exposures to surface and subsurface soil during occasional excavations are possible.
	sediment	ingestion and dermal contact	Yes	Yes	Exposures to sediment on-site while performing occassional maintenance activities are possible.
	standing water	ingestion, dermal contact, and inhalation of vapor	Yes	Yes	Exposures to standing water on-site while performing occassional maintenance activities are possible.
Construction Workers	surface and subsurface soil	incidental ingestion of and dermal contact with soil; inhalation of soil-derived vapors and airborne particulates in work-space air	No	Yes	Exposures to surface and subsurface soil during larger scale construction activities are possible in the future.
	sediment	ingestion and dermal contact	No	Yes	Exposures to sediment on-site while performing construction activities are possible in the future.
	standing water	ingestion, dermal contact, and inhalation of vapor	No	Yes	Exposures to standing water on-site while performing construction activities are possible in the future.
Recreators (Including Park Visitors and Birders)	surface soil	incidental ingestion of and dermal contact with surface soil	Yes	Yes	Exposure to surface soil through incidental ingestion, dermal contact, and inhalation of vapor and particulates is possible in areas without ground cover.
		inhalation of soil-derived vapors and airborne particulates (wind erosion) in outdoor air	Yes	Yes	
		inhalation of soil-derived vapors that migrate through building foundations into indoor air	No	No	None of the structures at the Site are routinely occupied or expected to be routinely occupied in the future. Also, the presence of VOCs in soil at the Site is limited and the detected concentrations are very low. Potential future vapor intrusion is not expected to be a significant exposure pathway.
	subsurface soil	inhalation of soil-derived vapors in outdoor air	Yes	Yes	
		inhalation of soil-derived vapors that migrate through building foundations into indoor air	No	No	
Out-of-Bound Visitors	surface soil	incidental ingestion of and dermal contact with surface soil	Yes	Yes	Exposure to surface soil is possible in uncapped areas, areas without ground cover, and in those areas where ground cover may be removed.
		inhalation of soil-derived vapors and airborne particulates (wind erosion) in outdoor air	Yes	Yes	
	subsurface soil	inhalation of soil-derived vapors in outdoor air	Yes	Yes	
	sediment	ingestion and dermal contact	Yes	Yes	
	standing water	ingestion, dermal contact, and inhalation of vapor	Yes	Yes	

Notes:
There are no off-site receptors that are exposed or could be exposed to site related contamination in the future.

Table 3-1
Chemicals of Potential Concern
Human Health Risk Assessment
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN
VOC	Benzene	71-43-2
VOC	Ethyl Benzene	100-41-4
VOC	Toluene	108-88-3
VOC	Xylenes (total)	1330-20-7
SVOC	4,6-Dinitro-2-methylphenol	534-52-1
PDIST	Diesel Range Organics	DRO
PCB	PCBs (total)	1336-36-3
INORG	Antimony	7440-36-0
INORG	Arsenic	7440-38-2
INORG	Barium	7440-39-3
INORG	Beryllium	7440-41-7
INORG	Cadmium	7440-43-9
INORG	Chromium (total)	7440-47-3
INORG	Cobalt	7440-48-4
INORG	Copper	7440-50-8
INORG	Lead	7439-92-1
INORG	Mercury	7439-97-6
INORG	Molybdenum	7439-98-7
INORG	Nickel	7440-02-0
INORG	Selenium	7782-49-2
INORG	Silver	7440-22-4
INORG	Thallium	7440-28-0
INORG	Vanadium	7440-62-2
INORG	Zinc	7440-66-6

Notes
CASRN -- Chemical Abstracts Service Registry Number
VOC -- volatile organic compound
SVOC -- semi-volatile organic compound
PDIST -- petroleum distillate

Table 3-2
High-End Exposure Factors
GGNRA Hawk Hill, Marin Headlands, CA

	Park Resident (Age 0-2)	Park Resident (Age 2-6)	Park Resident (Age 6-16)	Park Resident (Age 16-26)		Park Worker	Ref	Maintenance Worker	Ref	Construction Worker	Ref
Soil Ingestion											
Ingestion Rate (mg/d)	200	200	100	100	i	50	i, f	200	i, f	200	f, k
Exposure Frequency (d/yr)	350	350	350	350	i	250	i	52	f	250	i
Exposure Duration (yr)	2	4	10	10	i	25	i	10	e	1	f
Body Weight (kg-bw)	15	15	80	80	i	80	i	80	i	80	i
Averaging Time, carc (d)	25,550	25,550	25,550	25,550	a	25,550	a	25,550	a	25,550	a
Averaging Time, noncarc (d)	9,490	9,490	9,490	9,490	a	9,125	a	3,650	a	365	a
Soil Dermal Contact											
Adherence Factor (mg/cm^2)	0.2	0.2	0.07	0.07	i	0.12	i	0.12	i	0.12	i
Skin Surface Area (cm^2/d)	2,373	2,373	6,032	6,032	i	3,527	i	3,527	i	3,527	i
Exposure Frequency (d/yr)	350	350	350	350	i	250	i	52	f	250	i
Exposure Duration (yr)	2	4	10	10	i	25	i	10	e	1	f
Body Weight (kg-bw)	15	15	80	80	i	80	i	80	i	80	i
Averaging Time, carc (d)	25,550	25,550	25,550	25,550	a	25,550	a	25,550	a	25,550	a
Averaging Time, noncarc (d)	9,490	9,490	9,490	9,490	a	9,125	a	3,650	a	365	a
Outdoor Air Inhalation of Soil Vapor and/or Particulates											
Exposure Time (h/d)	24	24	24	24	d, i	8	d, i	8	d, i	8	d, i
Exposure Frequency (d/yr)	350	350	350	350	i	250	i	52	f	250	i
Exposure Duration (yr)	2	4	10	10	i	25	i	10	e	1	f
Averaging Time, carc (h)	613,200	613,200	613,200	613,200	a, d	613,200	a, d	613,200	a, d	613,200	a, d
Averaging Time, noncarc (h)	227,760	227,760	227,760	227,760	a, d	219,000	a, d	87,600	a, d	8,760	a, d

References:

a. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) Interim Final (USEPA 1989).
b. Standard default exposure factors. OSWER Directive 9285.6-03 (USEPA 1991).
d. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual: Part F, Supplemental Guidance for Inhalation Risk Assessment (USEPA 2009).
e. The 90th to 95th percentile job tenure for workers in construction (Burmaster 2000).
f. Based on professional judgment and site-specific considerations discussed in the text.
i. Standard default exposure factors. OSWER Directive 9200.1-120 (USEPA 2014).
k. 90th percentile soil ingestion rate per Stanek et al. (1997)

Table 3-3

Upper-Bound Background Soil Cumulative Cancer Risks and Noncancer HIs

GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Park Worker		Maintenance Worker		Construction Worker		Resident	
		Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI	Risk	HI	Risk	HI
Background-EPC	Background-EPC	**4E-06**	4E-01	1E-06	2E-01	5E-07	5E-02	**3E-05**	**3E+00**

Notes:

Cumulative cancer risk and HI estimates in excess of 1E-6 and 1, respectively, are shaded and bold.

Table 3-4
Upper-Bound Site-Related Soil Cumulative Cancer Risks and Noncancer HIs
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Park Worker		Maintenance Worker		Construction Worker		Park Resident	
		Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI	Risk	HI	Risk	HI
AOI 05	AOI5-SS-01	NC	3E-01	NC	1E-01	NC	1E+00	NC	1E+00
AOI 05	F9-SB01	NC	1E-02	NC	7E-03	NC	6E-02	NC	6E-02
AOI 05	F9-SB02	NC	1E-07	NC	7E-08	NC	1E-07	NC	6E-07
AOI 05	F9-SB03	NC	1E-07	NC	6E-08	NC	1E-07	NC	5E-07
AOI 05	F9-SB04	NC	2E-07	NC	7E-08	NC	1E-07	NC	6E-07
AOI 05	F9-SB05	2E-10	8E-01	4E-11	4E-01	1E-10	**3E+00**	8E-10	**4E+00**
AOI 05	F9-SB06	NC	NC	NC	NC	NC	NC	NC	NC
AOI 05	F9-SB07	3E-10	8E-06	5E-11	4E-06	2E-10	5E-06	1E-09	3E-05
AOI 05	F9-SB08	NC	NC	NC	NC	NC	NC	NC	NC
AOI 13	AOI13-SS-01	4E-08	3E-03	8E-09	1E-03	4E-09	2E-03	2E-07	1E-02
AOI 13	AOI13-SS-02	5E-08	3E-03	9E-09	2E-03	5E-09	3E-03	3E-07	2E-02
AOI 13	AOI13-SS-03	1E-08	6E-04	2E-09	3E-04	1E-09	6E-04	6E-08	4E-03
AOI 13	AOI13-SS-04	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-14-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-1	1E-06	1E-01	3E-07	8E-02	1E-07	3E-02	**8E-06**	8E-01
AOI 15	SS-12-2	1E-06	1E-01	3E-07	8E-02	1E-07	4E-02	**7E-06**	8E-01
AOI 15	SS-12-3	1E-07	4E-02	6E-08	4E-02	3E-08	5E-02	1E-06	3E-01
AOI 15	SS-17-1	4E-07	6E-02	1E-07	5E-02	6E-08	4E-02	**3E-06**	4E-01
AOI 15	SS-17-2	6E-07	8E-02	2E-07	6E-02	9E-08	4E-02	**5E-06**	6E-01
AOI 15	SS-17-3	2E-09	2E-02	1E-08	2E-02	7E-09	4E-02	8E-09	2E-01
AOI 16	SS-13-1	2E-09	2E-02	1E-08	2E-02	7E-09	3E-02	8E-09	2E-01
AOI 16	SS-13-2	1E-09	2E-02	1E-08	2E-02	5E-09	3E-02	6E-09	1E-01
AOI 16	SS-16-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16-2	1E-06	1E-01	3E-07	8E-02	1E-07	7E-02	**8E-06**	9E-01
AOI 16	SS-16A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-1	1E-06	1E-01	3E-07	7E-02	1E-07	3E-02	**7E-06**	7E-01
AOI 16	SS-18-10	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-11	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-12	**2E-06**	1E-01	4E-07	9E-02	2E-07	1E-03	**1E-05**	1E+00
AOI 16	SS-18-13	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-14	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2	**3E-06**	3E-01	8E-07	2E-01	4E-07	6E-02	**2E-05**	**2E+00**
AOI 16	SS-18-2-A1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2-B1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2-B2	6E-07	5E-02	2E-07	3E-02	8E-08	5E-04	**5E-06**	4E-01
AOI 16	SS-18-2-C1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2-C2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2-C3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2-D1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2-D2	1E-07	1E-02	3E-08	7E-03	2E-08	1E-04	9E-07	8E-02
AOI 16	SS-18-3	8E-07	7E-02	2E-07	4E-02	1E-07	6E-04	**6E-06**	5E-01
AOI 16	SS-18-4	6E-07	5E-02	2E-07	3E-02	8E-08	5E-04	**5E-06**	4E-01
AOI 16	SS-18-5	1E-07	1E-02	3E-08	7E-03	2E-08	1E-04	9E-07	8E-02
AOI 16	SS-18-6	5E-07	4E-02	1E-07	3E-02	6E-08	4E-04	**4E-06**	3E-01
AOI 16	SS-18-7	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-8	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-9	NC	NC	NC	NC	NC	NC	NC	NC
AOI 17	SS-9-1	1E-11	4E-03	1E-10	4E-03	6E-11	1E-02	6E-11	3E-02
AOI 17	SS-9-2	2E-07	3E-02	6E-08	2E-02	3E-08	2E-02	**2E-06**	2E-01
AOI 17	SS-9-3	5E-11	4E-03	4E-10	5E-03	2E-10	2E-02	2E-10	4E-02
AOI 18	SS-21-1	6E-08	4E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 18	SS-5-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-2	4E-08	3E-03	8E-09	1E-03	5E-09	3E-03	3E-07	2E-02
AOI 18	SS-5-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-4	NC	NC	NC	NC	NC	NC	NC	NC

Table 3-4
Upper-Bound Site-Related Soil Cumulative Cancer Risks and Noncancer HIs
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Park Worker		Maintenance Worker		Construction Worker		Park Resident	
		Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI	Risk	HI	Risk	HI
AOI 19	SS-19-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-L-COMP	NC	1E-03	NC	6E-04	NC	5E-03	NC	5E-03
AOI 20	ID-U	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	SS-20-1	5E-08	3E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 21	SS-4-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-3	6E-08	4E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 21	SS-4-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-5	6E-08	4E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 21	SS-4-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-7	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-8	5E-08	3E-03	9E-09	1E-03	5E-09	3E-03	3E-07	2E-02
AOI 21	SS-4A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-7	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-8	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-SED	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-2	2E-07	9E-03	3E-08	5E-03	2E-08	9E-03	9E-07	5E-02
AOI 23	SS-8-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-5	1E-06	1E-01	3E-07	8E-02	1E-07	4E-02	**7E-06**	8E-01
AOI 23	SS-8A-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	DO-1	1E-06	1E-01	3E-07	8E-02	2E-07	1E-01	**9E-06**	8E-01
AOI 24	SS-2-1	**1E-05**	1E+00	**2E-06**	7E-01	1E-06	9E-01	**7E-05**	**8E+00**
AOI 24	SS-2-2	1E-07	4E-02	6E-08	4E-02	3E-08	8E-02	9E-07	4E-01
AOI 24	SS-2-3	5E-07	7E-02	1E-07	6E-02	7E-08	8E-02	**4E-06**	5E-01
AOI 24	SS-2-4	5E-07	7E-02	1E-07	6E-02	7E-08	9E-02	**4E-06**	6E-01
AOI 24	SS-2-5	1E-06	9E-02	3E-07	6E-02	1E-07	4E-02	**7E-06**	7E-01
AOI 24	SS-2-6	5E-10	9E-03	4E-09	1E-02	2E-09	4E-02	2E-09	8E-02
AOI 24	SS-2-7	8E-10	2E-02	7E-09	2E-02	3E-09	4E-02	4E-09	1E-01
AOI 24	SS-2-8	1E-11	5E-03	1E-10	6E-03	6E-11	2E-02	6E-11	4E-02
AOI 25	SS-3-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3-2	9E-08	6E-03	2E-08	3E-03	1E-08	5E-03	5E-07	3E-02
AOI 25	SS-3A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3A-2	NC	NC	NC	NC	NC	NC	NC	NC
Unassigned	SS-23-1	NC	NC	NC	NC	NC	NC	NC	NC

Notes:
Cumulative cancer risk and HI estimates in excess of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HI estimates were not calculated for detected chemicals with inadequate toxicity or physical/chemical parameters or where chemical concentrations were non-detect.

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 05	AOI5-SS-01	PDIST	Diesel Range Organics	DRO		1.40E+03		1.40E+03	NC	**2.6E-01**	NC	1.4E-01	NC	**1.2E+00**	NC	**1.2E+00**
AOI 05	F9-SB01	VOC	Toluene	108-88-3	ID	1.60E-03		1.60E-03	NC	2.2E-07	NC	1.1E-07	NC	1.9E-07	NC	9.2E-07
AOI 05	F9-SB01	PDIST	Diesel Range Organics	DRO		6.55E+01		6.55E+01	NC	1.2E-02	NC	6.5E-03	NC	5.5E-02	NC	5.6E-02
AOI 05	F9-SB02	VOC	Toluene	108-88-3	ID	1.00E-03		1.00E-03	NC	1.4E-07	NC	6.8E-08	NC	1.2E-07	NC	5.8E-07
AOI 05	F9-SB03	VOC	Toluene	108-88-3	ID	9.40E-04		9.40E-04	NC	1.3E-07	NC	6.4E-08	NC	1.1E-07	NC	5.4E-07
AOI 05	F9-SB04	VOC	Toluene	108-88-3	ID	1.10E-03		1.10E-03	NC	1.5E-07	NC	7.5E-08	NC	1.3E-07	NC	6.4E-07
AOI 05	F9-SB05	VOC	Benzene	71-43-2	A	4.40E-04		4.40E-04	1.9E-10	6.0E-06	3.9E-11	3.0E-06	1.3E-10	3.5E-06	8.4E-10	2.5E-05
AOI 05	F9-SB05	VOC	Ethyl Benzene	100-41-4	D	3.00E-03		3.00E-03	NC	1.4E-07	NC	7.5E-08	NC	2.6E-07	NC	6.9E-07
AOI 05	F9-SB05	VOC	Toluene	108-88-3	ID	1.10E-03		1.10E-03	NC	1.5E-07	NC	7.5E-08	NC	1.3E-07	NC	6.4E-07
AOI 05	F9-SB05	VOC	Xylenes (total)	1330-20-7	ID	1.50E-02		1.50E-02	NC	5.7E-06	NC	2.7E-06	NC	2.4E-05	NC	2.3E-05
AOI 05	F9-SB05	PDIST	Diesel Range Organics	DRO		4.10E+03		4.10E+03	NC	**7.5E-01**	NC	**4.1E-01**	NC	**3.5E+00**	NC	**3.5E+00**
AOI 05	F9-SB07	VOC	Benzene	71-43-2	A	5.80E-04		5.80E-04	2.5E-10	7.9E-06	5.1E-11	3.9E-06	1.7E-10	4.7E-06	1.1E-09	3.2E-05
AOI 13	AOI13-SS-01	PCB	PCBs (total)	1336-36-3	B2	5.40E-02		5.40E-02	4.1E-08	2.5E-03	7.7E-09	1.2E-03	4.3E-09	2.4E-03	**2.4E-07**	1.5E-02
AOI 13	AOI13-SS-02	PCB	PCBs (total)	1336-36-3	B2	6.60E-02		6.60E-02	5.0E-08	3.1E-03	9.4E-09	1.5E-03	5.3E-09	2.9E-03	**2.9E-07**	1.8E-02
AOI 13	AOI13-SS-03	PCB	PCBs (total)	1336-36-3	B2	1.30E-02		1.30E-02	9.8E-09	6.1E-04	1.9E-09	3.0E-04	1.0E-09	5.8E-04	5.7E-08	3.5E-03
AOI 14	SS-14-1	INORG	Lead	7439-92-1	B2	8.10E+01		8.10E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-1	INORG	Lead	7439-92-1	B2	2.40E+02		2.40E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-2	INORG	Lead	7439-92-1	B2	6.60E+01		6.60E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-1	INORG	Lead	7439-92-1	B2	4.70E+01		4.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-2	INORG	Lead	7439-92-1	B2	1.80E+01		1.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-1	INORG	Antimony	7440-36-0	ID	4.30E-01		4.30E-01	NC	4.6E-04	NC	3.8E-04	NC	1.8E-03	NC	4.2E-03
AOI 15	SS-12-1	INORG	Arsenic	7440-38-2	A	4.10E+00	3.2E+00	9.00E-01	**1.1E-06**	9.4E-02	**2.9E-07**	6.1E-02	1.4E-07	8.9E-04	**8.4E-06**	**6.8E-01**
AOI 15	SS-12-1	INORG	Barium	7440-39-3	NC	4.10E+02	1.9E+02	2.19E+02	NC	5.2E-04	NC	1.4E-03	NC	6.9E-03	NC	4.5E-03
AOI 15	SS-12-1	INORG	Beryllium	7440-41-7	B1	3.70E-01	2.9E-01	7.70E-02	7.7E-12	1.7E-04	6.3E-11	1.6E-04	3.0E-11	7.9E-04	3.4E-11	1.5E-03
AOI 15	SS-12-1	INORG	Chromium (total)	7440-47-3		2.80E+01	8.8E+00	1.92E+01	NC	5.9E-06	NC	1.4E-05	NC	6.6E-05	NC	5.2E-05
AOI 15	SS-12-1	INORG	Cobalt	7440-48-4	LC	1.60E+01	1.2E+01	3.65E+00	1.4E-09	5.3E-03	1.1E-08	5.8E-03	5.4E-09	4.2E-03	6.0E-09	4.7E-02
AOI 15	SS-12-1	INORG	Lead	7439-92-1	B2	1.60E+01		1.60E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-1	INORG	Mercury	7439-97-6	D	5.20E-02	3.6E-02	1.60E-02	NC	1.1E-03	NC	3.9E-04	NC	5.5E-04	NC	4.8E-03
AOI 15	SS-12-1	INORG	Molybdenum	7439-98-7		1.10E+00		1.10E+00	NC	9.4E-05	NC	7.8E-05	NC	3.8E-04	NC	8.5E-04
AOI 15	SS-12-1	INORG	Nickel	7440-02-0	A	2.30E+01	2.1E+01	1.56E+00	1.7E-11	7.4E-05	1.4E-10	3.2E-04	6.6E-11	2.2E-04	7.4E-11	6.0E-04
AOI 15	SS-12-1	INORG	Selenium	7782-49-2	D	7.90E-01		7.90E-01	NC	6.8E-05	NC	5.6E-05	NC	2.7E-04	NC	6.1E-04
AOI 15	SS-12-1	INORG	Thallium	7440-28-0	ID	1.70E-01		1.70E-01	NC	7.3E-03	NC	6.1E-03	NC	NC	NC	6.6E-02
AOI 15	SS-12-1	INORG	Vanadium	7440-62-2	ID	5.20E+01	1.6E+01	3.63E+01	NC	3.1E-03	NC	3.4E-03	NC	1.0E-02	NC	2.8E-02
AOI 15	SS-12-1	INORG	Zinc	7440-66-6	ID	3.80E+01	2.9E+01	8.84E+00	NC	1.3E-05	NC	1.1E-05	NC	5.1E-05	NC	1.1E-04
AOI 15	SS-12-2	INORG	Antimony	7440-36-0	ID	3.80E-01		3.80E-01	NC	4.1E-04	NC	3.4E-04	NC	1.6E-03	NC	3.7E-03
AOI 15	SS-12-2	INORG	Arsenic	7440-38-2	A	4.00E+00	3.2E+00	8.00E-01	**9.9E-07**	8.4E-02	**2.6E-07**	5.4E-02	1.2E-07	7.9E-04	**7.5E-06**	**6.1E-01**
AOI 15	SS-12-2	INORG	Barium	7440-39-3	NC	4.90E+02	1.9E+02	2.99E+02	NC	7.1E-04	NC	2.0E-03	NC	9.4E-03	NC	6.1E-03
AOI 15	SS-12-2	INORG	Beryllium	7440-41-7	B1	4.80E-01	2.9E-01	1.87E-01	1.9E-11	4.0E-04	1.5E-10	4.0E-04	7.3E-11	1.9E-03	8.2E-11	3.6E-03
AOI 15	SS-12-2	INORG	Chromium (total)	7440-47-3		3.10E+01	8.8E+00	2.22E+01	NC	6.9E-06	NC	1.6E-05	NC	7.6E-05	NC	6.0E-05
AOI 15	SS-12-2	INORG	Cobalt	7440-48-4	LC	1.90E+01	1.2E+01	6.65E+00	2.5E-09	9.6E-03	2.0E-08	1.1E-02	9.8E-09	7.6E-03	1.1E-08	8.6E-02
AOI 15	SS-12-2	INORG	Lead	7439-92-1	B2	1.30E+01		1.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-2	INORG	Mercury	7439-97-6	D	4.40E-02	3.6E-02	8.00E-03	NC	5.6E-04	NC	2.0E-04	NC	2.7E-04	NC	2.4E-03
AOI 15	SS-12-2	INORG	Molybdenum	7439-98-7		8.10E-01		8.10E-01	NC	6.9E-05	NC	5.8E-05	NC	2.8E-04	NC	6.3E-04
AOI 15	SS-12-2	INORG	Nickel	7440-02-0	A	3.00E+01	2.1E+01	8.56E+00	9.3E-11	4.0E-04	7.6E-10	1.7E-03	3.6E-10	1.2E-03	4.1E-10	3.3E-03
AOI 15	SS-12-2	INORG	Selenium	7782-49-2	D	8.60E-01		8.60E-01	NC	7.4E-05	NC	6.1E-05	NC	3.0E-04	NC	6.7E-04
AOI 15	SS-12-2	INORG	Thallium	7440-28-0	ID	1.50E-01		1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-12-2	INORG	Vanadium	7440-62-2	ID	8.30E+01	1.6E+01	6.73E+01	NC	5.8E-03	NC	6.4E-03	NC	1.9E-02	NC	5.2E-02
AOI 15	SS-12-2	INORG	Zinc	7440-66-6	ID	5.00E+01	2.9E+01	2.08E+01	NC	3.0E-05	NC	2.5E-05	NC	1.2E-04	NC	2.7E-04
AOI 15	SS-12-3	INORG	Antimony	7440-36-0	ID	4.50E-01		4.50E-01	NC	4.8E-04	NC	4.0E-04	NC	1.9E-03	NC	4.4E-03
AOI 15	SS-12-3	INORG	Arsenic	7440-38-2	A	3.30E+00	3.2E+00	1.00E-01	1.2E-07	1.0E-02	3.2E-08	6.8E-03	1.6E-08	9.9E-05	**9.4E-07**	7.6E-02
AOI 15	SS-12-3	INORG	Barium	7440-39-3	NC	6.30E+02	1.9E+02	4.39E+02	NC	1.0E-03	NC	2.9E-03	NC	1.4E-02	NC	8.9E-03

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 15	SS-12-3	INORG	Beryllium	7440-41-7	B1	5.30E-01	2.9E-01	2.37E-01	2.4E-11	5.1E-04	1.9E-10	5.0E-04	9.3E-11	2.4E-03	1.0E-10	4.6E-03
AOI 15	SS-12-3	INORG	Chromium (total)	7440-47-3		2.90E+01	8.8E+00	2.02E+01	NC	6.2E-06	NC	1.4E-05	NC	6.9E-05	NC	5.4E-05
AOI 15	SS-12-3	INORG	Cobalt	7440-48-4	LC	2.10E+01	1.2E+01	8.65E+00	3.2E-09	1.3E-02	2.6E-08	1.4E-02	1.3E-08	9.9E-03	1.4E-08	1.1E-01
AOI 15	SS-12-3	INORG	Lead	7439-92-1	B2	1.50E+01		1.50E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-3	INORG	Mercury	7439-97-6	D	4.40E-02	3.6E-02	8.00E-03	NC	5.6E-04	NC	2.0E-04	NC	2.7E-04	NC	2.4E-03
AOI 15	SS-12-3	INORG	Molybdenum	7439-98-7		8.40E-01		8.40E-01	NC	7.2E-05	NC	6.0E-05	NC	2.9E-04	NC	6.5E-04
AOI 15	SS-12-3	INORG	Nickel	7440-02-0	A	2.90E+01	2.1E+01	7.56E+00	8.2E-11	3.6E-04	6.7E-10	1.5E-03	3.2E-10	1.1E-03	3.6E-10	2.9E-03
AOI 15	SS-12-3	INORG	Selenium	7782-49-2	D	5.30E-01		5.30E-01	NC	4.5E-05	NC	3.8E-05	NC	1.8E-04	NC	4.1E-04
AOI 15	SS-12-3	INORG	Thallium	7440-28-0	ID	1.50E-01		1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-12-3	INORG	Vanadium	7440-62-2	ID	8.30E+01	1.6E+01	6.73E+01	NC	5.8E-03	NC	6.4E-03	NC	1.9E-02	NC	5.2E-02
AOI 15	SS-12-3	INORG	Zinc	7440-66-6	ID	5.20E+01	2.9E+01	2.28E+01	NC	3.3E-05	NC	2.7E-05	NC	1.3E-04	NC	3.0E-04
AOI 15	SS-17-1	INORG	Antimony	7440-36-0	ID	4.60E-01		4.60E-01	NC	4.9E-04	NC	4.1E-04	NC	2.0E-03	NC	4.5E-03
AOI 15	SS-17-1	INORG	Arsenic	7440-38-2	A	3.50E+00	3.2E+00	3.00E-01	**3.7E-07**	3.1E-02	9.7E-08	2.0E-02	4.7E-08	3.0E-04	**2.8E-06**	**2.3E-01**
AOI 15	SS-17-1	INORG	Barium	7440-39-3	NC	5.40E+02	1.9E+02	3.49E+02	NC	8.3E-04	NC	2.3E-03	NC	1.1E-02	NC	7.1E-03
AOI 15	SS-17-1	INORG	Beryllium	7440-41-7	B1	4.90E-01	2.9E-01	1.97E-01	2.0E-11	4.3E-04	1.6E-10	4.2E-04	7.7E-11	2.0E-03	8.6E-11	3.8E-03
AOI 15	SS-17-1	INORG	Chromium (total)	7440-47-3		2.70E+01	8.8E+00	1.82E+01	NC	5.6E-06	NC	1.3E-05	NC	6.2E-05	NC	4.9E-05
AOI 15	SS-17-1	INORG	Cobalt	7440-48-4	LC	2.00E+01	1.2E+01	7.65E+00	2.9E-09	1.1E-02	2.3E-08	1.2E-02	1.1E-08	8.7E-03	1.3E-08	9.9E-02
AOI 15	SS-17-1	INORG	Lead	7439-92-1	B2	1.00E+01		1.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-17-1	INORG	Molybdenum	7439-98-7		9.20E-01		9.20E-01	NC	7.9E-05	NC	6.6E-05	NC	3.2E-04	NC	7.1E-04
AOI 15	SS-17-1	INORG	Nickel	7440-02-0	A	3.70E+01	2.1E+01	1.56E+01	1.7E-10	7.4E-04	1.4E-09	3.1E-03	6.6E-10	2.2E-03	7.4E-10	6.0E-03
AOI 15	SS-17-1	INORG	Selenium	7782-49-2	D	5.60E-01		5.60E-01	NC	4.8E-05	NC	4.0E-05	NC	1.9E-04	NC	4.3E-04
AOI 15	SS-17-1	INORG	Thallium	7440-28-0	ID	1.50E-01		1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-17-1	INORG	Vanadium	7440-62-2	ID	6.40E+01	1.6E+01	4.83E+01	NC	4.2E-03	NC	4.6E-03	NC	1.4E-02	NC	3.7E-02
AOI 15	SS-17-1	INORG	Zinc	7440-66-6	ID	3.90E+01	2.9E+01	9.84E+00	NC	1.4E-05	NC	1.2E-05	NC	5.6E-05	NC	1.3E-04
AOI 15	SS-17-2	INORG	Antimony	7440-36-0	ID	4.20E-01		4.20E-01	NC	4.5E-04	NC	3.7E-04	NC	1.8E-03	NC	4.1E-03
AOI 15	SS-17-2	INORG	Arsenic	7440-38-2	A	3.70E+00	3.2E+00	5.00E-01	**6.2E-07**	5.2E-02	**1.6E-07**	3.4E-02	7.7E-08	4.9E-04	**4.7E-06**	**3.8E-01**
AOI 15	SS-17-2	INORG	Barium	7440-39-3	NC	5.60E+02	1.9E+02	3.69E+02	NC	8.8E-04	NC	2.4E-03	NC	1.2E-02	NC	7.5E-03
AOI 15	SS-17-2	INORG	Beryllium	7440-41-7	B1	5.00E-01	2.9E-01	2.07E-01	2.1E-11	4.5E-04	1.7E-10	4.4E-04	8.1E-11	2.1E-03	9.0E-11	4.0E-03
AOI 15	SS-17-2	INORG	Chromium (total)	7440-47-3		2.90E+01	8.8E+00	2.02E+01	NC	6.2E-06	NC	1.4E-05	NC	6.9E-05	NC	5.4E-05
AOI 15	SS-17-2	INORG	Cobalt	7440-48-4	LC	2.00E+01	1.2E+01	7.65E+00	2.9E-09	1.1E-02	2.3E-08	1.2E-02	1.1E-08	8.7E-03	1.3E-08	9.9E-02
AOI 15	SS-17-2	INORG	Lead	7439-92-1	B2	1.10E+01		1.10E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-17-2	INORG	Molybdenum	7439-98-7		8.00E-01		8.00E-01	NC	6.9E-05	NC	5.7E-05	NC	2.7E-04	NC	6.2E-04
AOI 15	SS-17-2	INORG	Nickel	7440-02-0	A	2.90E+01	2.1E+01	7.56E+00	8.2E-11	3.6E-04	6.7E-10	1.5E-03	3.2E-10	1.1E-03	3.6E-10	2.9E-03
AOI 15	SS-17-2	INORG	Selenium	7782-49-2	D	5.00E-01		5.00E-01	NC	4.3E-05	NC	3.6E-05	NC	1.7E-04	NC	3.9E-04
AOI 15	SS-17-2	INORG	Thallium	7440-28-0	ID	1.50E-01		1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-17-2	INORG	Vanadium	7440-62-2	ID	7.00E+01	1.6E+01	5.43E+01	NC	4.7E-03	NC	5.1E-03	NC	1.5E-02	NC	4.2E-02
AOI 15	SS-17-2	INORG	Zinc	7440-66-6	ID	3.80E+01	2.9E+01	8.84E+00	NC	1.3E-05	NC	1.1E-05	NC	5.1E-05	NC	1.1E-04
AOI 15	SS-17-3	INORG	Antimony	7440-36-0	ID	3.50E-01		3.50E-01	NC	3.8E-04	NC	3.1E-04	NC	1.5E-03	NC	3.4E-03
AOI 15	SS-17-3	INORG	Barium	7440-39-3	NC	5.80E+02	1.9E+02	3.89E+02	NC	9.2E-04	NC	2.5E-03	NC	1.2E-02	NC	7.9E-03
AOI 15	SS-17-3	INORG	Beryllium	7440-41-7	B1	4.40E-01	2.9E-01	1.47E-01	1.5E-11	3.2E-04	1.2E-10	3.1E-04	5.8E-11	1.5E-03	6.4E-11	2.9E-03
AOI 15	SS-17-3	INORG	Chromium (total)	7440-47-3		2.90E+01	8.8E+00	2.02E+01	NC	6.2E-06	NC	1.4E-05	NC	6.9E-05	NC	5.4E-05
AOI 15	SS-17-3	INORG	Cobalt	7440-48-4	LC	1.70E+01	1.2E+01	4.65E+00	1.7E-09	6.7E-03	1.4E-08	7.4E-03	6.8E-09	5.3E-03	7.6E-09	6.0E-02
AOI 15	SS-17-3	INORG	Lead	7439-92-1	B2	8.40E+00		8.40E+00	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-17-3	INORG	Mercury	7439-97-6	D	4.00E-02	3.6E-02	4.00E-03	NC	2.8E-04	NC	9.8E-05	NC	1.4E-04	NC	1.2E-03
AOI 15	SS-17-3	INORG	Molybdenum	7439-98-7		6.60E-01		6.60E-01	NC	5.7E-05	NC	4.7E-05	NC	2.3E-04	NC	5.1E-04
AOI 15	SS-17-3	INORG	Nickel	7440-02-0	A	2.80E+01	2.1E+01	6.56E+00	7.1E-11	3.1E-04	5.8E-10	1.3E-03	2.8E-10	9.4E-04	3.1E-10	2.5E-03
AOI 15	SS-17-3	INORG	Selenium	7782-49-2	D	4.00E-01		4.00E-01	NC	3.4E-05	NC	2.9E-05	NC	1.4E-04	NC	3.1E-04
AOI 15	SS-17-3	INORG	Thallium	7440-28-0	ID	1.30E-01		1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 15	SS-17-3	INORG	Vanadium	7440-62-2	ID	6.60E+01	1.6E+01	5.03E+01	NC	4.3E-03	NC	4.7E-03	NC	1.4E-02	NC	3.9E-02
AOI 15	SS-17-3	INORG	Zinc	7440-66-6	ID	3.60E+01	2.9E+01	6.84E+00	NC	9.8E-06	NC	8.1E-06	NC	3.9E-05	NC	8.8E-05
AOI 16	SS-13-1	INORG	Antimony	7440-36-0	ID	7.40E-01		7.40E-01	NC	7.9E-04	NC	6.6E-04	NC	3.2E-03	NC	7.2E-03

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 16	SS-13-1	INORG	Barium	7440-39-3	NC	4.40E+02	1.9E+02	2.49E+02	NC	5.9E-04	NC	1.6E-03	NC	7.8E-03	NC	5.1E-03
AOI 16	SS-13-1	INORG	Beryllium	7440-41-7	B1	4.30E-01	2.9E-01	1.37E-01	1.4E-11	3.0E-04	1.1E-10	2.9E-04	5.4E-11	1.4E-03	6.0E-11	2.7E-03
AOI 16	SS-13-1	INORG	Chromium (total)	7440-47-3		2.00E+01	8.8E+00	1.12E+01	NC	3.5E-06	NC	8.0E-06	NC	3.8E-05	NC	3.0E-05
AOI 16	SS-13-1	INORG	Cobalt	7440-48-4	LC	1.70E+01	1.2E+01	4.65E+00	1.7E-09	6.7E-03	1.4E-08	7.4E-03	6.8E-09	5.3E-03	7.6E-09	6.0E-02
AOI 16	SS-13-1	INORG	Lead	7439-92-1	B2	7.70E+00		7.70E+00	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-13-1	INORG	Molybdenum	7439-98-7		8.20E-01		8.20E-01	NC	7.0E-05	NC	5.8E-05	NC	2.8E-04	NC	6.4E-04
AOI 16	SS-13-1	INORG	Selenium	7782-49-2	D	3.90E-01		3.90E-01	NC	3.3E-05	NC	2.8E-05	NC	1.3E-04	NC	3.0E-04
AOI 16	SS-13-1	INORG	Thallium	7440-28-0	ID	1.30E-01		1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-13-1	INORG	Vanadium	7440-62-2	ID	4.70E+01	1.6E+01	3.13E+01	NC	2.7E-03	NC	3.0E-03	NC	8.9E-03	NC	2.4E-02
AOI 16	SS-13-2	INORG	Antimony	7440-36-0	ID	5.00E-01		5.00E-01	NC	5.4E-04	NC	4.5E-04	NC	2.1E-03	NC	4.8E-03
AOI 16	SS-13-2	INORG	Barium	7440-39-3	NC	4.60E+02	1.9E+02	2.69E+02	NC	6.4E-04	NC	1.8E-03	NC	8.4E-03	NC	5.5E-03
AOI 16	SS-13-2	INORG	Beryllium	7440-41-7	B1	4.20E-01	2.9E-01	1.27E-01	1.3E-11	2.7E-04	1.0E-10	2.7E-04	5.0E-11	1.3E-03	5.6E-11	2.5E-03
AOI 16	SS-13-2	INORG	Chromium (total)	7440-47-3		2.10E+01	8.8E+00	1.22E+01	NC	3.8E-06	NC	8.7E-06	NC	4.2E-05	NC	3.3E-05
AOI 16	SS-13-2	INORG	Cobalt	7440-48-4	LC	1.60E+01	1.2E+01	3.65E+00	1.4E-09	5.3E-03	1.1E-08	5.8E-03	5.4E-09	4.2E-03	6.0E-09	4.7E-02
AOI 16	SS-13-2	INORG	Lead	7439-92-1	B2	1.00E+01		1.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-13-2	INORG	Molybdenum	7439-98-7		8.30E-01		8.30E-01	NC	7.1E-05	NC	5.9E-05	NC	2.8E-04	NC	6.4E-04
AOI 16	SS-13-2	INORG	Nickel	7440-02-0	A	2.20E+01	2.1E+01	5.60E-01	6.1E-12	2.7E-05	4.9E-11	1.1E-04	2.4E-11	8.0E-05	2.7E-11	2.2E-04
AOI 16	SS-13-2	INORG	Selenium	7782-49-2	D	3.90E-01		3.90E-01	NC	3.3E-05	NC	2.8E-05	NC	1.3E-04	NC	3.0E-04
AOI 16	SS-13-2	INORG	Thallium	7440-28-0	ID	1.30E-01		1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-13-2	INORG	Vanadium	7440-62-2	ID	5.10E+01	1.6E+01	3.53E+01	NC	3.0E-03	NC	3.3E-03	NC	1.0E-02	NC	2.7E-02
AOI 16	SS-13-2	INORG	Zinc	7440-66-6	ID	3.20E+01	2.9E+01	2.84E+00	NC	4.1E-06	NC	3.4E-06	NC	1.6E-05	NC	3.7E-05
AOI 16	SS-16-1	INORG	Lead	7439-92-1	B2	9.70E+01		9.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16-2	PDIST	Diesel Range Organics	DRO		3.60E+00		3.60E+00	NC	6.6E-04	NC	3.6E-04	NC	3.0E-03	NC	3.1E-03
AOI 16	SS-16-2	INORG	Antimony	7440-36-0	ID	1.20E+01		1.20E+01	NC	1.3E-02	NC	1.1E-02	NC	5.1E-02	NC	1.2E-01
AOI 16	SS-16-2	INORG	Arsenic	7440-38-2	A	4.10E+00	3.2E+00	9.00E-01	**1.1E-06**	9.4E-02	**2.9E-07**	6.1E-02	1.4E-07	8.9E-04	**8.4E-06**	**6.8E-01**
AOI 16	SS-16-2	INORG	Barium	7440-39-3	NC	3.70E+02	1.9E+02	1.79E+02	NC	4.3E-04	NC	1.2E-03	NC	5.6E-03	NC	3.6E-03
AOI 16	SS-16-2	INORG	Beryllium	7440-41-7	B1	4.40E-01	2.9E-01	1.47E-01	1.5E-11	3.2E-04	1.2E-10	3.1E-04	5.8E-11	1.5E-03	6.4E-11	2.9E-03
AOI 16	SS-16-2	INORG	Chromium (total)	7440-47-3		2.60E+01	8.8E+00	1.72E+01	NC	5.3E-06	NC	1.2E-05	NC	5.9E-05	NC	4.6E-05
AOI 16	SS-16-2	INORG	Lead	7439-92-1	B2	3.20E+01		3.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16-2	INORG	Mercury	7439-97-6	D	6.00E-02	3.6E-02	2.40E-02	NC	1.7E-03	NC	5.9E-04	NC	8.2E-04	NC	7.2E-03
AOI 16	SS-16-2	INORG	Molybdenum	7439-98-7		9.10E-01		9.10E-01	NC	7.8E-05	NC	6.5E-05	NC	3.1E-04	NC	7.1E-04
AOI 16	SS-16-2	INORG	Selenium	7782-49-2	D	5.90E-01		5.90E-01	NC	5.1E-05	NC	4.2E-05	NC	2.0E-04	NC	4.6E-04
AOI 16	SS-16-2	INORG	Thallium	7440-28-0	ID	1.30E-01		1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-16-2	INORG	Vanadium	7440-62-2	ID	4.70E+01	1.6E+01	3.13E+01	NC	2.7E-03	NC	3.0E-03	NC	8.9E-03	NC	2.4E-02
AOI 16	SS-16-2	INORG	Zinc	7440-66-6	ID	2.20E+02	2.9E+01	1.91E+02	NC	2.7E-04	NC	2.3E-04	NC	1.1E-03	NC	2.5E-03
AOI 16	SS-16A-1	INORG	Lead	7439-92-1	B2	1.00E+02		1.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16A-2	INORG	Lead	7439-92-1	B2	2.00E+01		2.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-1	PDIST	Diesel Range Organics	DRO		2.00E+00		2.00E+00	NC	3.7E-04	NC	2.0E-04	NC	1.7E-03	NC	1.7E-03
AOI 16	SS-18-1	INORG	Antimony	7440-36-0	ID	1.00E+00		1.00E+00	NC	1.1E-03	NC	8.9E-04	NC	4.3E-03	NC	9.7E-03
AOI 16	SS-18-1	INORG	Arsenic	7440-38-2	A	4.00E+00	3.2E+00	8.00E-01	**9.9E-07**	8.4E-02	**2.6E-07**	5.4E-02	1.2E-07	7.9E-04	**7.5E-06**	**6.1E-01**
AOI 16	SS-18-1	INORG	Barium	7440-39-3	NC	3.80E+02	1.9E+02	1.89E+02	NC	4.5E-04	NC	1.2E-03	NC	5.9E-03	NC	3.8E-03
AOI 16	SS-18-1	INORG	Beryllium	7440-41-7	B1	5.00E-01	2.9E-01	2.07E-01	2.1E-11	4.5E-04	1.7E-10	4.4E-04	8.1E-11	2.1E-03	9.0E-11	4.0E-03
AOI 16	SS-18-1	INORG	Chromium (total)	7440-47-3		2.70E+01	8.8E+00	1.82E+01	NC	5.6E-06	NC	1.3E-05	NC	6.2E-05	NC	4.9E-05
AOI 16	SS-18-1	INORG	Cobalt	7440-48-4	LC	1.30E+01	1.2E+01	6.50E-01	2.4E-10	9.4E-04	2.0E-09	1.0E-03	9.5E-10	7.4E-04	1.1E-09	8.4E-03
AOI 16	SS-18-1	INORG	Lead	7439-92-1	B2	2.00E+01		2.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-1	INORG	Molybdenum	7439-98-7		9.30E-01		9.30E-01	NC	8.0E-05	NC	6.6E-05	NC	3.2E-04	NC	7.2E-04
AOI 16	SS-18-1	INORG	Nickel	7440-02-0	A	2.30E+01	2.1E+01	1.56E+00	1.7E-11	7.4E-05	1.4E-10	3.2E-04	6.6E-11	2.2E-04	7.4E-11	6.0E-04
AOI 16	SS-18-1	INORG	Selenium	7782-49-2	D	4.40E-01		4.40E-01	NC	3.8E-05	NC	3.1E-05	NC	1.5E-04	NC	3.4E-04
AOI 16	SS-18-1	INORG	Thallium	7440-28-0	ID	1.30E-01		1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-18-1	INORG	Vanadium	7440-62-2	ID	6.90E+01	1.6E+01	5.33E+01	NC	4.6E-03	NC	5.0E-03	NC	1.5E-02	NC	4.1E-02
AOI 16	SS-18-1	INORG	Zinc	7440-66-6	ID	5.10E+01	2.9E+01	2.18E+01	NC	3.1E-05	NC	2.6E-05	NC	1.3E-04	NC	2.8E-04

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 16	SS-18-12	INORG	Arsenic	7440-38-2	A	4.50E+00	3.2E+00	1.30E+00	**1.6E-06**	1.4E-01	**4.2E-07**	8.8E-02	**2.0E-07**	1.3E-03	**1.2E-05**	**9.8E-01**
AOI 16	SS-18-2	PDIST	Diesel Range Organics	DRO		4.90E+00		4.90E+00	NC	9.0E-04	NC	4.9E-04	NC	4.1E-03	NC	4.2E-03
AOI 16	SS-18-2	INORG	Antimony	7440-36-0	ID	1.10E+00		1.10E+00	NC	1.2E-03	NC	9.8E-04	NC	4.7E-03	NC	1.1E-02
AOI 16	SS-18-2	INORG	Arsenic	7440-38-2	A	5.60E+00	3.2E+00	2.40E+00	**3.0E-06**	**2.5E-01**	**7.7E-07**	**1.6E-01**	**3.7E-07**	2.4E-03	**2.2E-05**	**1.8E+00**
AOI 16	SS-18-2	INORG	Barium	7440-39-3	NC	5.70E+02	1.9E+02	3.79E+02	NC	9.0E-04	NC	2.5E-03	NC	1.2E-02	NC	7.7E-03
AOI 16	SS-18-2	INORG	Beryllium	7440-41-7	B1	5.40E-01	2.9E-01	2.47E-01	2.5E-11	5.3E-04	2.0E-10	5.2E-04	9.7E-11	2.5E-03	1.1E-10	4.8E-03
AOI 16	SS-18-2	INORG	Chromium (total)	7440-47-3		5.50E+01	8.8E+00	4.62E+01	NC	1.4E-05	NC	3.3E-05	NC	1.6E-04	NC	1.2E-04
AOI 16	SS-18-2	INORG	Cobalt	7440-48-4	LC	1.60E+01	1.2E+01	3.65E+00	1.4E-09	5.3E-03	1.1E-08	5.8E-03	5.4E-09	4.2E-03	6.0E-09	4.7E-02
AOI 16	SS-18-2	INORG	Copper	7440-50-8	D	8.90E+01	7.9E+01	9.86E+00	NC	4.2E-04	NC	3.5E-04	NC	1.7E-03	NC	3.8E-03
AOI 16	SS-18-2	INORG	Lead	7439-92-1	B2	7.30E+01		7.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2	INORG	Mercury	7439-97-6	D	3.00E-01	3.6E-02	2.64E-01	NC	1.8E-02	NC	6.5E-03	NC	9.1E-03	NC	8.0E-02
AOI 16	SS-18-2	INORG	Molybdenum	7439-98-7		9.10E-01		9.10E-01	NC	7.8E-05	NC	6.5E-05	NC	3.1E-04	NC	7.1E-04
AOI 16	SS-18-2	INORG	Nickel	7440-02-0	A	6.30E+01	2.1E+01	4.16E+01	4.5E-10	2.0E-03	3.7E-09	8.4E-03	1.8E-09	5.9E-03	2.0E-09	1.6E-02
AOI 16	SS-18-2	INORG	Selenium	7782-49-2	D	2.30E-01		2.30E-01	NC	2.0E-05	NC	1.6E-05	NC	7.9E-05	NC	1.8E-04
AOI 16	SS-18-2	INORG	Vanadium	7440-62-2	ID	5.50E+01	1.6E+01	3.93E+01	NC	3.4E-03	NC	3.7E-03	NC	1.1E-02	NC	3.0E-02
AOI 16	SS-18-2	INORG	Zinc	7440-66-6	ID	8.40E+01	2.9E+01	5.48E+01	NC	7.8E-05	NC	6.5E-05	NC	3.1E-04	NC	7.1E-04
AOI 16	SS-18-2-B2	INORG	Arsenic	7440-38-2	A	3.70E+00	3.2E+00	5.00E-01	**6.2E-07**	5.2E-02	**1.6E-07**	3.4E-02	7.7E-08	4.9E-04	**4.7E-06**	**3.8E-01**
AOI 16	SS-18-2-D2	INORG	Arsenic	7440-38-2	A	3.30E+00	3.2E+00	1.00E-01	1.2E-07	1.0E-02	3.2E-08	6.8E-03	1.6E-08	9.9E-05	**9.4E-07**	7.6E-02
AOI 16	SS-18-3	INORG	Arsenic	7440-38-2	A	3.85E+00	3.2E+00	6.50E-01	**8.1E-07**	6.8E-02	**2.1E-07**	4.4E-02	1.0E-07	6.4E-04	**6.1E-06**	**4.9E-01**
AOI 16	SS-18-4	INORG	Arsenic	7440-38-2	A	3.70E+00	3.2E+00	5.00E-01	**6.2E-07**	5.2E-02	**1.6E-07**	3.4E-02	7.7E-08	4.9E-04	**4.7E-06**	**3.8E-01**
AOI 16	SS-18-5	INORG	Arsenic	7440-38-2	A	3.30E+00	3.2E+00	1.00E-01	1.2E-07	1.0E-02	3.2E-08	6.8E-03	1.6E-08	9.9E-05	**9.4E-07**	7.6E-02
AOI 16	SS-18-6	INORG	Arsenic	7440-38-2	A	3.60E+00	3.2E+00	4.00E-01	**5.0E-07**	4.2E-02	1.3E-07	2.7E-02	6.2E-08	4.0E-04	**3.7E-06**	**3.0E-01**
AOI 17	SS-9-1	INORG	Antimony	7440-36-0	ID	5.00E-01		5.00E-01	NC	5.4E-04	NC	4.5E-04	NC	2.1E-03	NC	4.8E-03
AOI 17	SS-9-1	INORG	Barium	7440-39-3	NC	2.30E+02	1.9E+02	3.90E+01	NC	9.3E-05	NC	2.6E-04	NC	1.2E-03	NC	7.9E-04
AOI 17	SS-9-1	INORG	Beryllium	7440-41-7	B1	4.40E-01	2.9E-01	1.47E-01	1.5E-11	3.2E-04	1.2E-10	3.1E-04	5.8E-11	1.5E-03	6.4E-11	2.9E-03
AOI 17	SS-9-1	INORG	Chromium (total)	7440-47-3		2.50E+01	8.8E+00	1.62E+01	NC	5.0E-06	NC	1.2E-05	NC	5.6E-05	NC	4.4E-05
AOI 17	SS-9-1	INORG	Lead	7439-92-1	B2	7.70E+00		7.70E+00	NC	NC	NC	NC	NC	NC	NC	NC
AOI 17	SS-9-1	INORG	Mercury	7439-97-6	D	3.90E-02	3.6E-02	3.00E-03	NC	2.1E-04	NC	7.3E-05	NC	1.0E-04	NC	9.1E-04
AOI 17	SS-9-1	INORG	Molybdenum	7439-98-7		1.50E+00		1.50E+00	NC	1.3E-04	NC	1.1E-04	NC	5.1E-04	NC	1.2E-03
AOI 17	SS-9-1	INORG	Selenium	7782-49-2	D	9.00E-01		9.00E-01	NC	7.7E-05	NC	6.4E-05	NC	3.1E-04	NC	7.0E-04
AOI 17	SS-9-1	INORG	Vanadium	7440-62-2	ID	4.40E+01	1.6E+01	2.83E+01	NC	2.4E-03	NC	2.7E-03	NC	8.1E-03	NC	2.2E-02
AOI 17	SS-9-2	INORG	Antimony	7440-36-0	ID	5.50E-01		5.50E-01	NC	5.9E-04	NC	4.9E-04	NC	2.4E-03	NC	5.3E-03
AOI 17	SS-9-2	INORG	Arsenic	7440-38-2	A	3.40E+00	3.2E+00	2.00E-01	**2.5E-07**	2.1E-02	6.4E-08	1.4E-02	3.1E-08	2.0E-04	**1.9E-06**	**1.5E-01**
AOI 17	SS-9-2	INORG	Barium	7440-39-3	NC	3.40E+02	1.9E+02	1.49E+02	NC	3.5E-04	NC	9.7E-04	NC	4.7E-03	NC	3.0E-03
AOI 17	SS-9-2	INORG	Beryllium	7440-41-7	B1	3.80E-01	2.9E-01	8.70E-02	8.7E-12	1.9E-04	7.1E-11	1.8E-04	3.4E-11	8.9E-04	3.8E-11	1.7E-03
AOI 17	SS-9-2	INORG	Chromium (total)	7440-47-3		2.70E+01	8.8E+00	1.82E+01	NC	5.6E-06	NC	1.3E-05	NC	6.2E-05	NC	4.9E-05
AOI 17	SS-9-2	INORG	Lead	7439-92-1	B2	2.30E+01		2.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 17	SS-9-2	INORG	Mercury	7439-97-6	D	6.40E-02	3.6E-02	2.80E-02	NC	2.0E-03	NC	6.9E-04	NC	9.6E-04	NC	8.4E-03
AOI 17	SS-9-2	INORG	Molybdenum	7439-98-7		6.50E-01		6.50E-01	NC	5.6E-05	NC	4.6E-05	NC	2.2E-04	NC	5.0E-04
AOI 17	SS-9-2	INORG	Selenium	7782-49-2	D	5.90E-01		5.90E-01	NC	5.1E-05	NC	4.2E-05	NC	2.0E-04	NC	4.6E-04
AOI 17	SS-9-2	INORG	Vanadium	7440-62-2	ID	5.20E+01	1.6E+01	3.63E+01	NC	3.1E-03	NC	3.4E-03	NC	1.0E-02	NC	2.8E-02
AOI 17	SS-9-2	INORG	Zinc	7440-66-6	ID	4.30E+01	2.9E+01	1.38E+01	NC	2.0E-05	NC	1.6E-05	NC	7.9E-05	NC	1.8E-04
AOI 17	SS-9-3	INORG	Antimony	7440-36-0	ID	5.80E-01		5.80E-01	NC	6.2E-04	NC	5.2E-04	NC	2.5E-03	NC	5.6E-03
AOI 17	SS-9-3	INORG	Barium	7440-39-3	NC	3.70E+02	1.9E+02	1.79E+02	NC	4.3E-04	NC	1.2E-03	NC	5.6E-03	NC	3.6E-03
AOI 17	SS-9-3	INORG	Beryllium	7440-41-7	B1	4.20E-01	2.9E-01	1.27E-01	1.3E-11	2.7E-04	1.0E-10	2.7E-04	5.0E-11	1.3E-03	5.6E-11	2.5E-03
AOI 17	SS-9-3	INORG	Chromium (total)	7440-47-3		2.50E+01	8.8E+00	1.62E+01	NC	5.0E-06	NC	1.2E-05	NC	5.6E-05	NC	4.4E-05
AOI 17	SS-9-3	INORG	Lead	7439-92-1	B2	3.10E+01		3.10E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 17	SS-9-3	INORG	Mercury	7439-97-6	D	4.70E-02	3.6E-02	1.10E-02	NC	7.7E-04	NC	2.7E-04	NC	3.8E-04	NC	3.3E-03
AOI 17	SS-9-3	INORG	Molybdenum	7439-98-7		5.20E-01		5.20E-01	NC	4.5E-05	NC	3.7E-05	NC	1.8E-04	NC	4.0E-04
AOI 17	SS-9-3	INORG	Nickel	7440-02-0	A	2.50E+01	2.1E+01	3.56E+00	3.9E-11	1.7E-04	3.1E-10	7.2E-04	1.5E-10	5.1E-04	1.7E-10	1.4E-03
AOI 17	SS-9-3	INORG	Selenium	7782-49-2	D	5.30E-01		5.30E-01	NC	4.5E-05	NC	3.8E-05	NC	1.8E-04	NC	4.1E-04

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 17	SS-9-3	INORG	Vanadium	7440-62-2	ID	3.80E+01	1.6E+01	2.23E+01	NC	1.9E-03	NC	2.1E-03	NC	6.4E-03	NC	1.7E-02
AOI 17	SS-9-3	INORG	Zinc	7440-66-6	ID	7.40E+01	2.9E+01	4.48E+01	NC	6.4E-05	NC	5.3E-05	NC	2.6E-04	NC	5.8E-04
AOI 18	SS-21-1	PCB	PCBs (total)	1336-36-3	B2	7.80E-02		7.80E-02	5.9E-08	3.6E-03	1.1E-08	1.8E-03	6.2E-09	3.5E-03	**3.4E-07**	2.1E-02
AOI 18	SS-21-1	INORG	Lead	7439-92-1	B2	1.30E+02		1.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-1	INORG	Lead	7439-92-1	B2	1.00E+02		1.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-2	PCB	PCBs (total)	1336-36-3	B2	5.80E-02		5.80E-02	4.4E-08	2.7E-03	8.3E-09	1.3E-03	4.6E-09	2.6E-03	**2.5E-07**	1.6E-02
AOI 18	SS-5-2	INORG	Lead	7439-92-1	B2	5.90E+02		5.90E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-3	INORG	Lead	7439-92-1	B2	7.80E+02		7.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-1	INORG	Lead	7439-92-1	B2	8.70E+01		8.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-2	INORG	Lead	7439-92-1	B2	1.50E+02		1.50E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-3	INORG	Lead	7439-92-1	B2	1.50E+02		1.50E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-1	INORG	Lead	7439-92-1	B2	4.90E+02		4.90E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-2	INORG	Lead	7439-92-1	B2	7.00E+01		7.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-3	INORG	Lead	7439-92-1	B2	6.00E+01		6.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-4	INORG	Lead	7439-92-1	B2	1.10E+02		1.10E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-5	INORG	Lead	7439-92-1	B2	2.00E+01		2.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-6	INORG	Lead	7439-92-1	B2	5.60E+02		5.60E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-1	INORG	Lead	7439-92-1	B2	3.30E+01		3.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-2	INORG	Lead	7439-92-1	B2	2.20E+01		2.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-3	INORG	Lead	7439-92-1	B2	6.30E+01		6.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-4	INORG	Lead	7439-92-1	B2	1.70E+01		1.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-5	INORG	Lead	7439-92-1	B2	1.50E+01		1.50E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-L-COMP	PDIST	Diesel Range Organics	DRO		6.20E+00		6.20E+00	NC	1.1E-03	NC	6.2E-04	NC	5.2E-03	NC	5.3E-03
AOI 20	BC-L-COMP	INORG	Lead	7439-92-1	B2	3.00E+01		3.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	ID-U	INORG	Lead	7439-92-1	B2	1.90E+03		1.90E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	SS-20-1	PCB	PCBs (total)	1336-36-3	B2	6.88E-02		6.88E-02	5.2E-08	3.2E-03	9.8E-09	1.6E-03	5.5E-09	3.1E-03	**3.0E-07**	1.9E-02
AOI 20	SS-20-1	INORG	Lead	7439-92-1	B2	4.90E+02		4.90E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-1	INORG	Lead	7439-92-1	B2	1.00E+02		1.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-2	INORG	Lead	7439-92-1	B2	6.80E+01		6.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-3	PCB	PCBs (total)	1336-36-3	B2	7.50E-02		7.50E-02	5.6E-08	3.5E-03	1.1E-08	1.7E-03	6.0E-09	3.3E-03	**3.3E-07**	2.0E-02
AOI 21	SS-4-3	INORG	Lead	7439-92-1	B2	1.70E+02		1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-4	INORG	Lead	7439-92-1	B2	2.80E+02		2.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-5	PCB	PCBs (total)	1336-36-3	B2	7.80E-02		7.80E-02	5.9E-08	3.6E-03	1.1E-08	1.8E-03	6.2E-09	3.5E-03	**3.4E-07**	2.1E-02
AOI 21	SS-4-5	INORG	Lead	7439-92-1	B2	8.80E+02		8.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-6	INORG	Lead	7439-92-1	B2	3.70E+02		3.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-7	INORG	Lead	7439-92-1	B2	1.20E+02		1.20E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-8	PCB	PCBs (total)	1336-36-3	B2	6.40E-02		6.40E-02	4.8E-08	3.0E-03	9.2E-09	1.5E-03	5.1E-09	2.8E-03	**2.8E-07**	1.7E-02
AOI 21	SS-4-8	INORG	Lead	7439-92-1	B2	6.40E+01		6.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-1	INORG	Lead	7439-92-1	B2	2.10E+02		2.10E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-2	INORG	Lead	7439-92-1	B2	8.00E+01		8.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-3	INORG	Lead	7439-92-1	B2	1.70E+02		1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-4	INORG	Lead	7439-92-1	B2	4.70E+01		4.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-5	INORG	Lead	7439-92-1	B2	7.20E+01		7.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-6	INORG	Lead	7439-92-1	B2	2.40E+02		2.40E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-7	INORG	Lead	7439-92-1	B2	3.40E+01		3.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-8	INORG	Lead	7439-92-1	B2	6.70E+01		6.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-1	INORG	Lead	7439-92-1	B2	3.10E+01		3.10E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-2	INORG	Lead	7439-92-1	B2	9.20E+01		9.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-SED	INORG	Lead	7439-92-1	B2	5.40E+01		5.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-1	INORG	Lead	7439-92-1	B2	1.30E+03		1.30E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-2	PCB	PCBs (total)	1336-36-3	B2	2.00E-01		2.00E-01	**1.5E-07**	9.4E-03	2.9E-08	4.6E-03	1.6E-08	8.9E-03	**8.7E-07**	5.4E-02

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 23	SS-8-2	INORG	Lead	7439-92-1	B2	1.10E+03		1.10E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-3	INORG	Lead	7439-92-1	B2	1.70E+02		1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-4	INORG	Lead	7439-92-1	B2	2.00E+02		2.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-5	INORG	Lead	7439-92-1	B2	7.00E+02		7.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-6	INORG	Lead	7439-92-1	B2	1.40E+03		1.40E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-1	INORG	Lead	7439-92-1	B2	4.50E+01		4.50E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-2	INORG	Lead	7439-92-1	B2	3.40E+01		3.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-3	INORG	Lead	7439-92-1	B2	6.40E+01		6.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-4	INORG	Lead	7439-92-1	B2	3.30E+02		3.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-5	INORG	Antimony	7440-36-0	ID	2.30E+00		2.30E+00	NC	2.5E-03	NC	2.0E-03	NC	9.8E-03	NC	2.2E-02
AOI 23	SS-8A-5	INORG	Arsenic	7440-38-2	A	4.00E+00	3.2E+00	8.00E-01	**9.9E-07**	8.4E-02	**2.6E-07**	5.4E-02	1.2E-07	7.9E-04	**7.5E-06**	**6.1E-01**
AOI 23	SS-8A-5	INORG	Barium	7440-39-3	NC	3.70E+02	1.9E+02	1.79E+02	NC	4.3E-04	NC	1.2E-03	NC	5.6E-03	NC	3.6E-03
AOI 23	SS-8A-5	INORG	Beryllium	7440-41-7	B1	5.30E-01	2.9E-01	2.37E-01	2.4E-11	5.1E-04	1.9E-10	5.0E-04	9.3E-11	2.4E-03	1.0E-10	4.6E-03
AOI 23	SS-8A-5	INORG	Chromium (total)	7440-47-3		6.20E+01	8.8E+00	5.32E+01	NC	1.6E-05	NC	3.8E-05	NC	1.8E-04	NC	1.4E-04
AOI 23	SS-8A-5	INORG	Cobalt	7440-48-4	LC	1.70E+01	1.2E+01	4.65E+00	1.7E-09	6.7E-03	1.4E-08	7.4E-03	6.8E-09	5.3E-03	7.6E-09	6.0E-02
AOI 23	SS-8A-5	INORG	Lead	7439-92-1	B2	2.00E+02		2.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-5	INORG	Mercury	7439-97-6	D	6.60E-02	3.6E-02	3.00E-02	NC	2.1E-03	NC	7.3E-04	NC	1.0E-03	NC	9.1E-03
AOI 23	SS-8A-5	INORG	Molybdenum	7439-98-7		1.20E+00		1.20E+00	NC	1.0E-04	NC	8.6E-05	NC	4.1E-04	NC	9.3E-04
AOI 23	SS-8A-5	INORG	Nickel	7440-02-0	A	4.00E+01	2.1E+01	1.86E+01	2.0E-10	8.8E-04	1.6E-09	3.7E-03	7.9E-10	2.6E-03	8.8E-10	7.2E-03
AOI 23	SS-8A-5	INORG	Selenium	7782-49-2	D	5.90E-01		5.90E-01	NC	5.1E-05	NC	4.2E-05	NC	2.0E-04	NC	4.6E-04
AOI 23	SS-8A-5	INORG	Silver	7440-22-4	D	1.50E-01		1.50E-01	NC	1.5E-05	NC	4.6E-05	NC	2.2E-04	NC	1.2E-04
AOI 23	SS-8A-5	INORG	Thallium	7440-28-0	ID	1.20E-01		1.20E-01	NC	5.1E-03	NC	4.3E-03	NC	NC	NC	4.6E-02
AOI 23	SS-8A-5	INORG	Vanadium	7440-62-2	ID	6.60E+01	1.6E+01	5.03E+01	NC	4.3E-03	NC	4.7E-03	NC	1.4E-02	NC	3.9E-02
AOI 23	SS-8A-5	INORG	Zinc	7440-66-6	ID	1.20E+02	2.9E+01	9.08E+01	NC	1.3E-04	NC	1.1E-04	NC	5.2E-04	NC	1.2E-03
AOI 23	SS-8A-6	INORG	Lead	7439-92-1	B2	1.50E+02		1.50E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	DO-1	PCB	PCBs (total)	1336-36-3	B2	1.60E+00		1.60E+00	**1.2E-06**	7.5E-02	**2.3E-07**	3.7E-02	1.3E-07	7.1E-02	**7.0E-06**	**4.3E-01**
AOI 24	DO-1	INORG	Antimony	7440-36-0	ID	2.70E+00		2.70E+00	NC	2.9E-03	NC	2.4E-03	NC	1.2E-02	NC	2.6E-02
AOI 24	DO-1	INORG	Arsenic	7440-38-2	A	3.40E+00	3.2E+00	2.00E-01	**2.5E-07**	2.1E-02	6.4E-08	1.4E-02	3.1E-08	2.0E-04	**1.9E-06**	**1.5E-01**
AOI 24	DO-1	INORG	Barium	7440-39-3	NC	4.90E+02	1.9E+02	2.99E+02	NC	7.1E-04	NC	2.0E-03	NC	9.4E-03	NC	6.1E-03
AOI 24	DO-1	INORG	Beryllium	7440-41-7	B1	5.60E-01	2.9E-01	2.67E-01	2.7E-11	5.8E-04	2.2E-10	5.7E-04	1.1E-10	2.7E-03	1.2E-10	5.2E-03
AOI 24	DO-1	INORG	Cadmium	7440-43-9	B1	5.80E+00	6.6E-01	5.14E+00	9.0E-10	3.0E-03	7.3E-09	3.2E-03	3.5E-09	9.6E-03	3.9E-09	2.2E-02
AOI 24	DO-1	INORG	Chromium (total)	7440-47-3		5.10E+01	8.8E+00	4.22E+01	NC	1.3E-05	NC	3.0E-05	NC	1.5E-04	NC	1.1E-04
AOI 24	DO-1	INORG	Cobalt	7440-48-4	LC	1.90E+01	1.2E+01	6.65E+00	2.5E-09	9.6E-03	2.0E-08	1.1E-02	9.8E-09	7.6E-03	1.1E-08	8.6E-02
AOI 24	DO-1	INORG	Copper	7440-50-8	D	1.10E+02	7.9E+01	3.09E+01	NC	1.3E-03	NC	1.1E-03	NC	5.3E-03	NC	1.2E-02
AOI 24	DO-1	INORG	Lead	7439-92-1	B2	1.30E+02		1.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	DO-1	INORG	Mercury	7439-97-6	D	7.40E-02	3.6E-02	3.80E-02	NC	2.7E-03	NC	9.3E-04	NC	1.3E-03	NC	1.1E-02
AOI 24	DO-1	INORG	Nickel	7440-02-0	A	2.70E+01	2.1E+01	5.56E+00	6.0E-11	2.6E-04	4.9E-10	1.1E-03	2.4E-10	7.9E-04	2.6E-10	2.2E-03
AOI 24	DO-1	INORG	Selenium	7782-49-2	D	5.40E-01		5.40E-01	NC	4.6E-05	NC	3.9E-05	NC	1.9E-04	NC	4.2E-04
AOI 24	DO-1	INORG	Vanadium	7440-62-2	ID	8.70E+01	1.6E+01	7.13E+01	NC	6.1E-03	NC	6.7E-03	NC	2.0E-02	NC	5.5E-02
AOI 24	DO-1	INORG	Zinc	7440-66-6	ID	1.00E+03	2.9E+01	9.71E+02	NC	1.4E-03	NC	1.2E-03	NC	5.5E-03	NC	1.3E-02
AOI 24	SS-2-1	SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	4.60E+01		4.60E+01	NC	**4.5E-01**	NC	**2.5E-01**	NC	1.2E-01	NC	**2.9E+00**
AOI 24	SS-2-1	PDIST	Diesel Range Organics	DRO		7.70E+00		7.70E+00	NC	1.4E-03	NC	7.7E-04	NC	6.5E-03	NC	6.6E-03
AOI 24	SS-2-1	PCB	PCBs (total)	1336-36-3	B2	1.50E+01		1.50E+01	**1.1E-05**	**7.0E-01**	**2.1E-06**	**3.5E-01**	**1.2E-06**	**6.7E-01**	**6.6E-05**	**4.0E+00**
AOI 24	SS-2-1	INORG	Antimony	7440-36-0	ID	3.40E+00		3.40E+00	NC	3.6E-03	NC	3.0E-03	NC	1.5E-02	NC	3.3E-02
AOI 24	SS-2-1	INORG	Arsenic	7440-38-2	A	3.90E+00	3.2E+00	7.00E-01	**8.7E-07**	7.3E-02	**2.3E-07**	4.7E-02	1.1E-07	6.9E-04	**6.6E-06**	**5.3E-01**
AOI 24	SS-2-1	INORG	Barium	7440-39-3	NC	5.70E+02	1.9E+02	3.79E+02	NC	9.0E-04	NC	2.5E-03	NC	1.2E-02	NC	7.7E-03
AOI 24	SS-2-1	INORG	Beryllium	7440-41-7	B1	8.90E-01	2.9E-01	5.97E-01	6.0E-11	1.3E-03	4.9E-10	1.3E-03	2.3E-10	6.1E-03	2.6E-10	1.2E-02
AOI 24	SS-2-1	INORG	Cadmium	7440-43-9	B1	8.20E+00	6.6E-01	7.54E+00	1.3E-09	4.4E-03	1.1E-08	4.7E-03	5.2E-09	1.4E-02	5.8E-09	3.3E-02
AOI 24	SS-2-1	INORG	Chromium (total)	7440-47-3		4.40E+01	8.8E+00	3.52E+01	NC	1.1E-05	NC	2.5E-05	NC	1.2E-04	NC	9.4E-05
AOI 24	SS-2-1	INORG	Cobalt	7440-48-4	LC	1.60E+01	1.2E+01	3.65E+00	1.4E-09	5.3E-03	1.1E-08	5.8E-03	5.4E-09	4.2E-03	6.0E-09	4.7E-02
AOI 24	SS-2-1	INORG	Copper	7440-50-8	D	1.30E+02	7.9E+01	5.09E+01	NC	2.2E-03	NC	1.8E-03	NC	8.7E-03	NC	2.0E-02

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 24	SS-2-1	INORG	Lead	7439-92-1	B2	1.30E+02		1.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-1	INORG	Mercury	7439-97-6	D	1.10E-01	3.6E-02	7.40E-02	NC	5.2E-03	NC	1.8E-03	NC	2.5E-03	NC	2.2E-02
AOI 24	SS-2-1	INORG	Molybdenum	7439-98-7		5.50E-01		5.50E-01	NC	4.7E-05	NC	3.9E-05	NC	1.9E-04	NC	4.3E-04
AOI 24	SS-2-1	INORG	Nickel	7440-02-0	A	4.30E+01	2.1E+01	2.16E+01	2.3E-10	1.0E-03	1.9E-09	4.4E-03	9.1E-10	3.1E-03	1.0E-09	8.3E-03
AOI 24	SS-2-1	INORG	Selenium	7782-49-2	D	4.40E-01		4.40E-01	NC	3.8E-05	NC	3.1E-05	NC	1.5E-04	NC	3.4E-04
AOI 24	SS-2-1	INORG	Silver	7440-22-4	D	3.90E-01		3.90E-01	NC	3.8E-05	NC	1.2E-04	NC	5.8E-04	NC	3.2E-04
AOI 24	SS-2-1	INORG	Thallium	7440-28-0	ID	1.20E-01		1.20E-01	NC	5.1E-03	NC	4.3E-03	NC	NC	NC	4.6E-02
AOI 24	SS-2-1	INORG	Vanadium	7440-62-2	ID	8.30E+01	1.6E+01	6.73E+01	NC	5.8E-03	NC	6.4E-03	NC	1.9E-02	NC	5.2E-02
AOI 24	SS-2-1	INORG	Zinc	7440-66-6	ID	4.80E+03	2.9E+01	4.77E+03	NC	6.8E-03	NC	5.7E-03	NC	2.7E-02	NC	6.2E-02
AOI 24	SS-2-2	INORG	Antimony	7440-36-0	ID	1.80E+00		1.80E+00	NC	1.9E-03	NC	1.6E-03	NC	7.7E-03	NC	1.7E-02
AOI 24	SS-2-2	INORG	Arsenic	7440-38-2	A	3.30E+00	3.2E+00	1.00E-01	1.2E-07	1.0E-02	3.2E-08	6.8E-03	1.6E-08	9.9E-05	**9.4E-07**	7.6E-02
AOI 24	SS-2-2	INORG	Barium	7440-39-3	NC	5.60E+02	1.9E+02	3.69E+02	NC	8.8E-04	NC	2.4E-03	NC	1.2E-02	NC	7.5E-03
AOI 24	SS-2-2	INORG	Beryllium	7440-41-7	B1	7.10E-01	2.9E-01	4.17E-01	4.2E-11	9.0E-04	3.4E-10	8.8E-04	1.6E-10	4.3E-03	1.8E-10	8.1E-03
AOI 24	SS-2-2	INORG	Cadmium	7440-43-9	B1	1.70E+00	6.6E-01	1.04E+00	1.8E-10	6.1E-04	1.5E-09	6.5E-04	7.1E-10	1.9E-03	7.9E-10	4.5E-03
AOI 24	SS-2-2	INORG	Chromium (total)	7440-47-3		5.80E+01	8.8E+00	4.92E+01	NC	1.5E-05	NC	3.5E-05	NC	1.7E-04	NC	1.3E-04
AOI 24	SS-2-2	INORG	Cobalt	7440-48-4	LC	1.90E+01	1.2E+01	6.65E+00	2.5E-09	9.6E-03	2.0E-08	1.1E-02	9.8E-09	7.6E-03	1.1E-08	8.6E-02
AOI 24	SS-2-2	INORG	Copper	7440-50-8	D	1.40E+02	7.9E+01	6.09E+01	NC	2.6E-03	NC	2.2E-03	NC	1.0E-02	NC	2.4E-02
AOI 24	SS-2-2	INORG	Lead	7439-92-1	B2	2.20E+02		2.20E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-2	INORG	Mercury	7439-97-6	D	6.00E-02	3.6E-02	2.40E-02	NC	1.7E-03	NC	5.9E-04	NC	8.2E-04	NC	7.2E-03
AOI 24	SS-2-2	INORG	Molybdenum	7439-98-7		5.80E-01		5.80E-01	NC	5.0E-05	NC	4.1E-05	NC	2.0E-04	NC	4.5E-04
AOI 24	SS-2-2	INORG	Nickel	7440-02-0	A	3.30E+01	2.1E+01	1.16E+01	1.3E-10	5.5E-04	1.0E-09	2.3E-03	4.9E-10	1.7E-03	5.5E-10	4.5E-03
AOI 24	SS-2-2	INORG	Selenium	7782-49-2	D	6.20E-01		6.20E-01	NC	5.3E-05	NC	4.4E-05	NC	2.1E-04	NC	4.8E-04
AOI 24	SS-2-2	INORG	Silver	7440-22-4	D	3.90E-01		3.90E-01	NC	3.8E-05	NC	1.2E-04	NC	5.8E-04	NC	3.2E-04
AOI 24	SS-2-2	INORG	Thallium	7440-28-0	ID	1.50E-01		1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 24	SS-2-2	INORG	Vanadium	7440-62-2	ID	1.10E+02	1.6E+01	9.43E+01	NC	8.1E-03	NC	8.9E-03	NC	2.7E-02	NC	7.3E-02
AOI 24	SS-2-2	INORG	Zinc	7440-66-6	ID	4.10E+02	2.9E+01	3.81E+02	NC	5.4E-04	NC	4.5E-04	NC	2.2E-03	NC	4.9E-03
AOI 24	SS-2-3	INORG	Antimony	7440-36-0	ID	5.90E-01		5.90E-01	NC	6.3E-04	NC	5.3E-04	NC	2.5E-03	NC	5.7E-03
AOI 24	SS-2-3	INORG	Arsenic	7440-38-2	A	3.60E+00	3.2E+00	4.00E-01	**5.0E-07**	4.2E-02	1.3E-07	2.7E-02	6.2E-08	4.0E-04	**3.7E-06**	**3.0E-01**
AOI 24	SS-2-3	INORG	Barium	7440-39-3	NC	1.30E+03	1.9E+02	1.11E+03	NC	2.6E-03	NC	7.2E-03	NC	3.5E-02	NC	2.3E-02
AOI 24	SS-2-3	INORG	Beryllium	7440-41-7	B1	8.90E-01	2.9E-01	5.97E-01	6.0E-11	1.3E-03	4.9E-10	1.3E-03	2.3E-10	6.1E-03	2.6E-10	1.2E-02
AOI 24	SS-2-3	INORG	Chromium (total)	7440-47-3		2.10E+01	8.8E+00	1.22E+01	NC	3.8E-06	NC	8.7E-06	NC	4.2E-05	NC	3.3E-05
AOI 24	SS-2-3	INORG	Cobalt	7440-48-4	LC	1.50E+01	1.2E+01	2.65E+00	9.9E-10	3.8E-03	8.1E-09	4.2E-03	3.9E-09	3.0E-03	4.3E-09	3.4E-02
AOI 24	SS-2-3	INORG	Copper	7440-50-8	D	1.70E+02	7.9E+01	9.09E+01	NC	3.9E-03	NC	3.2E-03	NC	1.6E-02	NC	3.5E-02
AOI 24	SS-2-3	INORG	Lead	7439-92-1	B2	1.80E+01		1.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-3	INORG	Mercury	7439-97-6	D	6.00E-02	3.6E-02	2.40E-02	NC	1.7E-03	NC	5.9E-04	NC	8.2E-04	NC	7.2E-03
AOI 24	SS-2-3	INORG	Molybdenum	7439-98-7		3.20E-01		3.20E-01	NC	2.7E-05	NC	2.3E-05	NC	1.1E-04	NC	2.5E-04
AOI 24	SS-2-3	INORG	Nickel	7440-02-0	A	3.80E+01	2.1E+01	1.66E+01	1.8E-10	7.8E-04	1.5E-09	3.3E-03	7.0E-10	2.4E-03	7.8E-10	6.4E-03
AOI 24	SS-2-3	INORG	Selenium	7782-49-2	D	4.70E-01		4.70E-01	NC	4.0E-05	NC	3.4E-05	NC	1.6E-04	NC	3.6E-04
AOI 24	SS-2-3	INORG	Thallium	7440-28-0	ID	1.40E-01		1.40E-01	NC	6.0E-03	NC	5.0E-03	NC	NC	NC	5.4E-02
AOI 24	SS-2-3	INORG	Vanadium	7440-62-2	ID	4.80E+01	1.6E+01	3.23E+01	NC	2.8E-03	NC	3.0E-03	NC	9.2E-03	NC	2.5E-02
AOI 24	SS-2-3	INORG	Zinc	7440-66-6	ID	1.10E+02	2.9E+01	8.08E+01	NC	1.2E-04	NC	9.6E-05	NC	4.6E-04	NC	1.0E-03
AOI 24	SS-2-4	INORG	Antimony	7440-36-0	ID	6.40E-01		6.40E-01	NC	6.9E-04	NC	5.7E-04	NC	2.7E-03	NC	6.2E-03
AOI 24	SS-2-4	INORG	Arsenic	7440-38-2	A	3.60E+00	3.2E+00	4.00E-01	**5.0E-07**	4.2E-02	1.3E-07	2.7E-02	6.2E-08	4.0E-04	**3.7E-06**	**3.0E-01**
AOI 24	SS-2-4	INORG	Barium	7440-39-3	NC	1.20E+03	1.9E+02	1.01E+03	NC	2.4E-03	NC	6.6E-03	NC	3.2E-02	NC	2.1E-02
AOI 24	SS-2-4	INORG	Beryllium	7440-41-7	B1	1.10E+00	2.9E-01	8.07E-01	8.1E-11	1.7E-03	6.6E-10	1.7E-03	3.2E-10	8.2E-03	3.5E-10	1.6E-02
AOI 24	SS-2-4	INORG	Chromium (total)	7440-47-3		3.20E+01	8.8E+00	2.32E+01	NC	7.2E-06	NC	1.7E-05	NC	8.0E-05	NC	6.2E-05
AOI 24	SS-2-4	INORG	Cobalt	7440-48-4	LC	1.80E+01	1.2E+01	5.65E+00	2.1E-09	8.2E-03	1.7E-08	8.9E-03	8.3E-09	6.5E-03	9.3E-09	7.3E-02
AOI 24	SS-2-4	INORG	Copper	7440-50-8	D	2.10E+02	7.9E+01	1.31E+02	NC	5.6E-03	NC	4.7E-03	NC	2.2E-02	NC	5.1E-02
AOI 24	SS-2-4	INORG	Lead	7439-92-1	B2	1.80E+01		1.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-4	INORG	Mercury	7439-97-6	D	6.10E-02	3.6E-02	2.50E-02	NC	1.8E-03	NC	6.1E-04	NC	8.6E-04	NC	7.5E-03
AOI 24	SS-2-4	INORG	Molybdenum	7439-98-7		3.70E-01		3.70E-01	NC	3.2E-05	NC	2.6E-05	NC	1.3E-04	NC	2.9E-04

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 24	SS-2-4	INORG	Nickel	7440-02-0	A	4.20E+01	2.1E+01	2.06E+01	2.2E-10	9.7E-04	1.8E-09	4.2E-03	8.7E-10	2.9E-03	9.7E-10	8.0E-03
AOI 24	SS-2-4	INORG	Selenium	7782-49-2	D	7.90E-01		7.90E-01	NC	6.8E-05	NC	5.6E-05	NC	2.7E-04	NC	6.1E-04
AOI 24	SS-2-4	INORG	Thallium	7440-28-0	ID	1.40E-01		1.40E-01	NC	6.0E-03	NC	5.0E-03	NC	NC	NC	5.4E-02
AOI 24	SS-2-4	INORG	Vanadium	7440-62-2	ID	5.60E+01	1.6E+01	4.03E+01	NC	3.5E-03	NC	3.8E-03	NC	1.1E-02	NC	3.1E-02
AOI 24	SS-2-4	INORG	Zinc	7440-66-6	ID	7.00E+01	2.9E+01	4.08E+01	NC	5.8E-05	NC	4.9E-05	NC	2.3E-04	NC	5.3E-04
AOI 24	SS-2-5	INORG	Antimony	7440-36-0	ID	1.20E+00		1.20E+00	NC	1.3E-03	NC	1.1E-03	NC	5.1E-03	NC	1.2E-02
AOI 24	SS-2-5	INORG	Arsenic	7440-38-2	A	4.00E+00	3.2E+00	8.00E-01	**9.9E-07**	8.4E-02	**2.6E-07**	5.4E-02	1.2E-07	7.9E-04	**7.5E-06**	**6.1E-01**
AOI 24	SS-2-5	INORG	Barium	7440-39-3	NC	5.30E+02	1.9E+02	3.39E+02	NC	8.1E-04	NC	2.2E-03	NC	1.1E-02	NC	6.9E-03
AOI 24	SS-2-5	INORG	Beryllium	7440-41-7	B1	6.20E-01	2.9E-01	3.27E-01	3.3E-11	7.1E-04	2.7E-10	6.9E-04	1.3E-10	3.3E-03	1.4E-10	6.4E-03
AOI 24	SS-2-5	INORG	Cadmium	7440-43-9	B1	1.20E+00	6.6E-01	5.37E-01	9.4E-11	3.1E-04	7.7E-10	3.4E-04	3.7E-10	1.0E-03	4.1E-10	2.3E-03
AOI 24	SS-2-5	INORG	Chromium (total)	7440-47-3		2.90E+01	8.8E+00	2.02E+01	NC	6.2E-06	NC	1.4E-05	NC	6.9E-05	NC	5.4E-05
AOI 24	SS-2-5	INORG	Copper	7440-50-8	D	8.10E+01	7.9E+01	1.86E+00	NC	8.0E-05	NC	6.6E-05	NC	3.2E-04	NC	7.2E-04
AOI 24	SS-2-5	INORG	Lead	7439-92-1	B2	6.30E+01		6.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-5	INORG	Mercury	7439-97-6	D	4.20E-02	3.6E-02	6.00E-03	NC	4.2E-04	NC	1.5E-04	NC	2.1E-04	NC	1.8E-03
AOI 24	SS-2-5	INORG	Molybdenum	7439-98-7		1.10E+00		1.10E+00	NC	9.4E-05	NC	7.8E-05	NC	3.8E-04	NC	8.5E-04
AOI 24	SS-2-5	INORG	Nickel	7440-02-0	A	3.30E+01	2.1E+01	1.16E+01	1.3E-10	5.5E-04	1.0E-09	2.3E-03	4.9E-10	1.7E-03	5.5E-10	4.5E-03
AOI 24	SS-2-5	INORG	Selenium	7782-49-2	D	4.30E-01		4.30E-01	NC	3.7E-05	NC	3.1E-05	NC	1.5E-04	NC	3.3E-04
AOI 24	SS-2-5	INORG	Silver	7440-22-4	D	7.80E-02		7.80E-02	NC	7.6E-06	NC	2.4E-05	NC	1.2E-04	NC	6.4E-05
AOI 24	SS-2-5	INORG	Vanadium	7440-62-2	ID	5.40E+01	1.6E+01	3.83E+01	NC	3.3E-03	NC	3.6E-03	NC	1.1E-02	NC	3.0E-02
AOI 24	SS-2-5	INORG	Zinc	7440-66-6	ID	1.50E+02	2.9E+01	1.21E+02	NC	1.7E-04	NC	1.4E-04	NC	6.9E-04	NC	1.6E-03
AOI 24	SS-2-6	INORG	Antimony	7440-36-0	ID	1.40E+00		1.40E+00	NC	1.5E-03	NC	1.2E-03	NC	6.0E-03	NC	1.4E-02
AOI 24	SS-2-6	INORG	Barium	7440-39-3	NC	4.70E+02	1.9E+02	2.79E+02	NC	6.6E-04	NC	1.8E-03	NC	8.8E-03	NC	5.7E-03
AOI 24	SS-2-6	INORG	Beryllium	7440-41-7	B1	5.50E-01	2.9E-01	2.57E-01	2.6E-11	5.5E-04	2.1E-10	5.5E-04	1.0E-10	2.6E-03	1.1E-10	5.0E-03
AOI 24	SS-2-6	INORG	Cadmium	7440-43-9	B1	1.60E+00	6.6E-01	9.37E-01	1.6E-10	5.5E-04	1.3E-09	5.8E-04	6.4E-10	1.8E-03	7.2E-10	4.1E-03
AOI 24	SS-2-6	INORG	Chromium (total)	7440-47-3		3.00E+01	8.8E+00	2.12E+01	NC	6.6E-06	NC	1.5E-05	NC	7.3E-05	NC	5.7E-05
AOI 24	SS-2-6	INORG	Cobalt	7440-48-4	LC	1.30E+01	1.2E+01	6.50E-01	2.4E-10	9.4E-04	2.0E-09	1.0E-03	9.5E-10	7.4E-04	1.1E-09	8.4E-03
AOI 24	SS-2-6	INORG	Copper	7440-50-8	D	9.90E+01	7.9E+01	1.99E+01	NC	8.5E-04	NC	7.1E-04	NC	3.4E-03	NC	7.7E-03
AOI 24	SS-2-6	INORG	Lead	7439-92-1	B2	8.30E+01		8.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-6	INORG	Molybdenum	7439-98-7		4.00E-01		4.00E-01	NC	3.4E-05	NC	2.9E-05	NC	1.4E-04	NC	3.1E-04
AOI 24	SS-2-6	INORG	Nickel	7440-02-0	A	2.60E+01	2.1E+01	4.56E+00	4.9E-11	2.2E-04	4.0E-10	9.2E-04	1.9E-10	6.5E-04	2.2E-10	1.8E-03
AOI 24	SS-2-6	INORG	Selenium	7782-49-2	D	4.60E-01		4.60E-01	NC	3.9E-05	NC	3.3E-05	NC	1.6E-04	NC	3.6E-04
AOI 24	SS-2-6	INORG	Silver	7440-22-4	D	1.70E-01		1.70E-01	NC	1.7E-05	NC	5.3E-05	NC	2.5E-04	NC	1.4E-04
AOI 24	SS-2-6	INORG	Vanadium	7440-62-2	ID	4.80E+01	1.6E+01	3.23E+01	NC	2.8E-03	NC	3.0E-03	NC	9.2E-03	NC	2.5E-02
AOI 24	SS-2-6	INORG	Zinc	7440-66-6	ID	3.40E+02	2.9E+01	3.11E+02	NC	4.4E-04	NC	3.7E-04	NC	1.8E-03	NC	4.0E-03
AOI 24	SS-2-7	INORG	Antimony	7440-36-0	ID	1.40E+00		1.40E+00	NC	1.5E-03	NC	1.2E-03	NC	6.0E-03	NC	1.4E-02
AOI 24	SS-2-7	INORG	Barium	7440-39-3	NC	4.20E+02	1.9E+02	2.29E+02	NC	5.4E-04	NC	1.5E-03	NC	7.2E-03	NC	4.7E-03
AOI 24	SS-2-7	INORG	Beryllium	7440-41-7	B1	5.90E-01	2.9E-01	2.97E-01	3.0E-11	6.4E-04	2.4E-10	6.3E-04	1.2E-10	3.0E-03	1.3E-10	5.8E-03
AOI 24	SS-2-7	INORG	Cadmium	7440-43-9	B1	1.50E+00	6.6E-01	8.37E-01	1.5E-10	4.9E-04	1.2E-09	5.2E-04	5.7E-10	1.6E-03	6.4E-10	3.6E-03
AOI 24	SS-2-7	INORG	Chromium (total)	7440-47-3		1.00E+02	8.8E+00	9.12E+01	NC	2.8E-05	NC	6.5E-05	NC	3.1E-04	NC	2.4E-04
AOI 24	SS-2-7	INORG	Cobalt	7440-48-4	LC	1.40E+01	1.2E+01	1.65E+00	6.2E-10	2.4E-03	5.0E-09	2.6E-03	2.4E-09	1.9E-03	2.7E-09	2.1E-02
AOI 24	SS-2-7	INORG	Lead	7439-92-1	B2	3.80E+02		3.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-7	INORG	Mercury	7439-97-6	D	5.80E-02	3.6E-02	2.20E-02	NC	1.5E-03	NC	5.4E-04	NC	7.6E-04	NC	6.6E-03
AOI 24	SS-2-7	INORG	Molybdenum	7439-98-7		5.80E-01		5.80E-01	NC	5.0E-05	NC	4.1E-05	NC	2.0E-04	NC	4.5E-04
AOI 24	SS-2-7	INORG	Nickel	7440-02-0	A	2.60E+01	2.1E+01	4.56E+00	4.9E-11	2.2E-04	4.0E-10	9.2E-04	1.9E-10	6.5E-04	2.2E-10	1.8E-03
AOI 24	SS-2-7	INORG	Selenium	7782-49-2	D	6.30E-01		6.30E-01	NC	5.4E-05	NC	4.5E-05	NC	2.2E-04	NC	4.9E-04
AOI 24	SS-2-7	INORG	Silver	7440-22-4	D	3.10E-01		3.10E-01	NC	3.0E-05	NC	9.6E-05	NC	4.6E-04	NC	2.6E-04
AOI 24	SS-2-7	INORG	Thallium	7440-28-0	ID	1.10E-01		1.10E-01	NC	4.7E-03	NC	3.9E-03	NC	NC	NC	4.3E-02
AOI 24	SS-2-7	INORG	Vanadium	7440-62-2	ID	6.80E+01	1.6E+01	5.23E+01	NC	4.5E-03	NC	4.9E-03	NC	1.5E-02	NC	4.0E-02
AOI 24	SS-2-7	INORG	Zinc	7440-66-6	ID	3.20E+02	2.9E+01	2.91E+02	NC	4.2E-04	NC	3.5E-04	NC	1.7E-03	NC	3.8E-03
AOI 24	SS-2-8	INORG	Antimony	7440-36-0	ID	7.70E-01		7.70E-01	NC	8.2E-04	NC	6.9E-04	NC	3.3E-03	NC	7.5E-03
AOI 24	SS-2-8	INORG	Barium	7440-39-3	NC	4.00E+02	1.9E+02	2.09E+02	NC	5.0E-04	NC	1.4E-03	NC	6.6E-03	NC	4.3E-03

Table 3-5
Site-Related Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Background Conc (mg/kg)	Max Site-Related Conc from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Park Resident Outdoor Activities	
									Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 24	SS-2-8	INORG	Beryllium	7440-41-7	B1	4.40E-01	2.9E-01	1.47E-01	1.5E-11	3.2E-04	1.2E-10	3.1E-04	5.8E-11	1.5E-03	6.4E-11	2.9E-03
AOI 24	SS-2-8	INORG	Chromium (total)	7440-47-3		3.10E+01	8.8E+00	2.22E+01	NC	6.9E-06	NC	1.6E-05	NC	7.6E-05	NC	6.0E-05
AOI 24	SS-2-8	INORG	Lead	7439-92-1	B2	9.30E+01		9.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-8	INORG	Molybdenum	7439-98-7		3.80E-01		3.80E-01	NC	3.3E-05	NC	2.7E-05	NC	1.3E-04	NC	2.9E-04
AOI 24	SS-2-8	INORG	Selenium	7782-49-2	D	3.80E-01		3.80E-01	NC	3.3E-05	NC	2.7E-05	NC	1.3E-04	NC	2.9E-04
AOI 24	SS-2-8	INORG	Silver	7440-22-4	D	1.70E-01		1.70E-01	NC	1.7E-05	NC	5.3E-05	NC	2.5E-04	NC	1.4E-04
AOI 24	SS-2-8	INORG	Vanadium	7440-62-2	ID	4.60E+01	1.6E+01	3.03E+01	NC	2.6E-03	NC	2.9E-03	NC	8.6E-03	NC	2.3E-02
AOI 24	SS-2-8	INORG	Zinc	7440-66-6	ID	1.70E+02	2.9E+01	1.41E+02	NC	2.0E-04	NC	1.7E-04	NC	8.0E-04	NC	1.8E-03
AOI 25	SS-3-1	INORG	Lead	7439-92-1	B2	1.70E+02		1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3-2	PCB	PCBs (total)	1336-36-3	B2	1.20E-01		1.20E-01	9.0E-08	5.6E-03	1.7E-08	2.8E-03	9.6E-09	5.3E-03	**5.2E-07**	3.2E-02
AOI 25	SS-3-2	INORG	Lead	7439-92-1	B2	1.60E+02		1.60E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3A-1	INORG	Lead	7439-92-1	B2	4.70E+01		4.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3A-2	INORG	Lead	7439-92-1	B2	5.20E+01		5.20E+01	NC	NC	NC	NC	NC	NC	NC	NC

Notes:
Only chemicals detected at each location are shown.
Exposure concentrations conservatively calculated using the maximum detected soil concentrations observed at each location, regardless of depth.
Single-chemical cancer risk and HQ estimates in excess of 1/10 CalEPA's thresholds for cumulative cancer risk and HI of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HQ estimates were not calculated for detected chemicals with inadequate toxicity
or physical/chemical parameters or where chemical concentrations were non-detect.
The concentrations for all polychlorinated biphenyls (PCBs) Aroclors were summed to PCBs (total).
The concentrations for the Xylene isomers (m/p and o) were summed to Xylenes (total).
Single-chemical risks and hazard quotients are calculated using site-related concentrations, which are those in excess of site-specific background exposure concentrations for inorganics.
Chem Group - chemical group
Carc Class - USEPA Weight-of-Evidence Cancer Classification

Table 3-6

Upper-Bound Site-Related Sediment Cumulative Cancer Risks and Noncancer HIs

GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Maintenance Worker		Construction Worker	
		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI
AOI 14	CO-COMP	3E-07	8E-02	1E-07	7E-02

Notes:

Cumulative cancer risk and HI estimates in excess of 1E-6 and 1, respectively, are shaded and bold.

NC - Risk and HI estimates were not calculated for detected chemicals with inadequate toxicity or physical/chemical parameters or where chemical concentrations were non-detect.

Table 3-7
Site-Related Sediment Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

								Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities	
Area	**Location**	**Chem Group**	**Chemical**	**CASRN**	**Carc Class**	**Max Detect** (mg/kg)	**Background Conc** (mg/kg)	**Risk**	**HQ**	**Risk**	**HQ**
AOI 14	CO-COMP	PDIST	Diesel Range Organics	DRO		3.10E+01		NC	3.1E-03	NC	2.6E-02
AOI 14	CO-COMP	INORG	Antimony	7440-36-0	ID	3.70E+00		NC	3.3E-03	NC	1.6E-02
AOI 14	CO-COMP	INORG	Arsenic	7440-38-2	A	4.00E+00	3.2E+00	**2.6E-07**	5.4E-02	1.2E-07	7.9E-04
AOI 14	CO-COMP	INORG	Barium	7440-39-3	NC	3.40E+02	1.9E+02	NC	9.7E-04	NC	4.7E-03
AOI 14	CO-COMP	INORG	Cadmium	7440-43-9	B1	6.80E-01	6.6E-01	2.4E-11	1.1E-05	1.2E-11	3.2E-05
AOI 14	CO-COMP	INORG	Chromium (total)	7440-47-3		3.30E+01	8.8E+00	NC	1.7E-05	NC	8.3E-05
AOI 14	CO-COMP	INORG	Cobalt	7440-48-4	LC	1.50E+01	1.2E+01	8.1E-09	4.2E-03	3.9E-09	3.0E-03
AOI 14	CO-COMP	INORG	Copper	7440-50-8	D	8.20E+01	7.9E+01	NC	1.0E-04	NC	4.9E-04
AOI 14	CO-COMP	INORG	Lead	7439-92-1	B2	1.70E+02		NC	NC	NC	NC
AOI 14	CO-COMP	INORG	Mercury	7439-97-6	D	1.10E-01	3.6E-02	NC	1.8E-03	NC	2.5E-03
AOI 14	CO-COMP	INORG	Molybdenum	7439-98-7		1.70E+00		NC	1.2E-04	NC	5.8E-04
AOI 14	CO-COMP	INORG	Nickel	7440-02-0	A	3.50E+01	2.1E+01	1.2E-09	2.7E-03	5.7E-10	1.9E-03
AOI 14	CO-COMP	INORG	Vanadium	7440-62-2	ID	6.30E+01	1.6E+01	NC	4.5E-03	NC	1.3E-02
AOI 14	CO-COMP	INORG	Zinc	7440-66-6	ID	2.90E+02	2.9E+01	NC	3.1E-04	NC	1.5E-03

Notes:
Only chemicals detected at each location are shown.
Exposure concentrations conservatively calculated using the maximum detected soil concentrations observed at each location, regardless of depth.
Single-chemical cancer risk and HQ estimates in excess of 1/10 CalEPA's thresholds for cumulative cancer risk and HI of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HQ estimates were not calculated for detected chemicals with inadequate toxicity
or physical/chemical parameters or where chemical concentrations were non-detect.
Single-chemical risks and hazard quotients are calculated using site-related concentrations, which are those in excess of site-specific background exposure concentrations for inorganics.
Chem Group - chemical group
Carc Class - USEPA Weight-of-Evidence Cancer Classification

Table 3-8
Standing Water Screening Results
GGNRA Hawk Hill, Marin Headlands, CA

Area	Chem Group	Chemical	CASRN	Meas Basis	Carc Class	Analyzed	Detected	Max Detected (mg/L)	Drinking Water Screening Level (mg/L)		Ratio of Max Detect to Drinking Water Screening Level
AOI 14	INORG	Arsenic	7440-38-2	T	A	1	1	6.40E-04	1.0E-02	SM	6.4E-02
AOI 14	INORG	Barium	7440-39-3	T	NC	1	1	6.50E-02	1.0E+00	SM	6.5E-02
AOI 14	INORG	Cobalt	7440-48-4	T	LC	1	1	9.40E-04	6.0E-03	RSL-NC	1.6E-01
AOI 14	INORG	Copper	7440-50-8	T	D	1	1	1.20E-03	1.0E+00	SM	1.2E-03
AOI 14	INORG	Lead	7439-92-1	T	B2	1	1	4.20E-03	1.5E-02	SM	2.8E-01
AOI 14	INORG	Molybdenum	7439-98-7	T		1	1	5.30E-04	1.0E-01	RSL-NC	5.3E-03
AOI 14	INORG	Nickel	7440-02-0	T	A	1	1	3.20E-03	1.0E-01	SM	3.2E-02
AOI 14	INORG	Vanadium	7440-62-2	T	ID	1	1	1.50E-03	1.0E-01	RSL-NC	1.5E-02
AOI 14	INORG	Zinc	7440-66-6	T	ID	1	1	1.10E-02	5.0E+00	SM	2.2E-03

Notes:
Only chemicals detected in each area are shown.
The drinking water criteria are based on the following hierarchy: State MCL, Federal MCL, RSL Tap Water Ingestion value at the lower of the criteria calculated at either the target cancer risk of 1E-6 or target hazard quotient of 1.
The criteria for non-drinking water are the lower of the criteria at either the target cancer risk of 1E-6 or target hazard quotient of 1.
Ratios of concentration to the screening level greater than 1 are shaded in bold.

SM - The criterion is the State MCL.
FM - The criterion is the Federal MCL.
C - The criterion is based on cancer risk at the indicated cancer risk.
NC - The criterion is based on noncancer effects at the indicated hazard quotient.
Chem Group - chemical group
Meas Basis - measured basis; T = total, D = dissolved
Carc Class - USEPA Weight-of-Evidence Cancer Classification
RSL - Regional Screening Level
MCL - Maximum Contaminant Level

Table 3-9
Lead Soil Screening Summary
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Sample Name	Top Depth (ft)	Bottom Depth (ft)	Chem Group	Chemical	Conc (mg/kg)	Background (mg/kg)	Ratio of Conc to Background	DTSC Residential Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Residential Soil Screening Level	DTSC Com/Ind Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Com/Ind Soil Screening Level	USEPA Residential Regional Screening Levels (mg/kg)	Ratio of Conc to USEPA Residential RSLs
AOI 14	SS-14-1	SS-14-1-03	0.3	0.3	INORG	Lead	8.10E+01	4.50E+01	**1.8E+00**	8.0E+01	1.0E+00	3.2E+02	2.5E-01	4.0E+02	2.0E-01
AOI 14	SS-14-1	SS-14-1-12	1.0	1.0	INORG	Lead	1.30E+01	4.50E+01	2.9E-01	8.0E+01	1.6E-01	3.2E+02	4.1E-02	4.0E+02	3.3E-02
AOI 14	SS-15-1	SS-15-1-03	0.3	0.3	INORG	Lead	2.40E+02	4.50E+01	**5.3E+00**	8.0E+01	**3.0E+00**	3.2E+02	7.5E-01	4.0E+02	6.0E-01
AOI 14	SS-15-1	SS-15-1-12	1.0	1.0	INORG	Lead	3.90E+01	4.50E+01	8.7E-01	8.0E+01	4.9E-01	3.2E+02	1.2E-01	4.0E+02	9.8E-02
AOI 14	SS-15-2	SS-15-2-03	0.3	0.3	INORG	Lead	6.60E+01	4.50E+01	**1.5E+00**	8.0E+01	8.3E-01	3.2E+02	2.1E-01	4.0E+02	1.7E-01
AOI 14	SS-15-2	SS-15-2-12	1.0	1.0	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 14	SS-15A-1	SS-15A-1-03	0.3	0.3	INORG	Lead	4.70E+01	4.50E+01	1.0E+00	8.0E+01	5.9E-01	3.2E+02	1.5E-01	4.0E+02	1.2E-01
AOI 14	SS-15A-1	SS-15A-1-18	1.5	1.5	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 14	SS-15A-2	SS-15A-2-03	0.3	0.3	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 14	SS-15A-2	SS-15A-2-18	1.5	1.5	INORG	Lead	1.10E+01	4.50E+01	2.4E-01	8.0E+01	1.4E-01	3.2E+02	3.4E-02	4.0E+02	2.8E-02
AOI 15	SS-12-1	SS-12-1-06	0.5	0.5	INORG	Lead	1.60E+01	4.50E+01	3.6E-01	8.0E+01	2.0E-01	3.2E+02	5.0E-02	4.0E+02	4.0E-02
AOI 15	SS-12-1	SS-12-1-36	3.0	3.0	INORG	Lead	8.70E+00	4.50E+01	1.9E-01	8.0E+01	1.1E-01	3.2E+02	2.7E-02	4.0E+02	2.2E-02
AOI 15	SS-12-2	SS-12-2-06	0.5	0.5	INORG	Lead	1.30E+01	4.50E+01	2.9E-01	8.0E+01	1.6E-01	3.2E+02	4.1E-02	4.0E+02	3.3E-02
AOI 15	SS-12-2	SS-12-2-36	3.0	3.0	INORG	Lead	8.80E+00	4.50E+01	2.0E-01	8.0E+01	1.1E-01	3.2E+02	2.8E-02	4.0E+02	2.2E-02
AOI 15	SS-12-3	SS-12-3-06	0.5	0.5	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02
AOI 15	SS-12-3	SS-12-3-36	3.0	3.0	INORG	Lead	9.40E+00	4.50E+01	2.1E-01	8.0E+01	1.2E-01	3.2E+02	2.9E-02	4.0E+02	2.4E-02
AOI 15	SS-17-1	SS-17-1-03	0.3	0.3	INORG	Lead	1.00E+01	4.50E+01	2.2E-01	8.0E+01	1.3E-01	3.2E+02	3.1E-02	4.0E+02	2.5E-02
AOI 15	SS-17-2	SS-17-2-03	0.3	0.3	INORG	Lead	1.10E+01	4.50E+01	2.4E-01	8.0E+01	1.4E-01	3.2E+02	3.4E-02	4.0E+02	2.8E-02
AOI 15	SS-17-3	SS-17-3-03	0.3	0.3	INORG	Lead	8.40E+00	4.50E+01	1.9E-01	8.0E+01	1.1E-01	3.2E+02	2.6E-02	4.0E+02	2.1E-02
AOI 16	SS-13-1	SS-13-1-06	0.5	0.5	INORG	Lead	7.70E+00	4.50E+01	1.7E-01	8.0E+01	9.6E-02	3.2E+02	2.4E-02	4.0E+02	1.9E-02
AOI 16	SS-13-2	SS-13-2-06	0.5	0.5	INORG	Lead	1.00E+01	4.50E+01	2.2E-01	8.0E+01	1.3E-01	3.2E+02	3.1E-02	4.0E+02	2.5E-02
AOI 16	SS-16-1	SS-16-1-03	0.3	0.3	INORG	Lead	9.70E+01	4.50E+01	**2.2E+00**	8.0E+01	**1.2E+00**	3.2E+02	3.0E-01	4.0E+02	2.4E-01
AOI 16	SS-16-1	SS-16-1-12	1.0	1.0	INORG	Lead	5.10E+01	4.50E+01	**1.1E+00**	8.0E+01	6.4E-01	3.2E+02	1.6E-01	4.0E+02	1.3E-01
AOI 16	SS-16-2	SS-16-2-03	0.3	0.3	INORG	Lead	3.20E+01	4.50E+01	7.1E-01	8.0E+01	4.0E-01	3.2E+02	1.0E-01	4.0E+02	8.0E-02
AOI 16	SS-16-2	SS-16-2-12	1.0	1.0	INORG	Lead	2.00E+01	4.50E+01	4.4E-01	8.0E+01	2.5E-01	3.2E+02	6.3E-02	4.0E+02	5.0E-02
AOI 16	SS-16A-1	SS-16A-1-03	0.3	0.3	INORG	Lead	1.00E+02	4.50E+01	**2.2E+00**	8.0E+01	**1.3E+00**	3.2E+02	3.1E-01	4.0E+02	2.5E-01
AOI 16	SS-16A-1	SS-16A-1-18	1.5	1.5	INORG	Lead	2.40E+01	4.50E+01	5.3E-01	8.0E+01	3.0E-01	3.2E+02	7.5E-02	4.0E+02	6.0E-02
AOI 16	SS-16A-2	SS-16A-2-03	0.3	0.3	INORG	Lead	2.00E+01	4.50E+01	4.4E-01	8.0E+01	2.5E-01	3.2E+02	6.3E-02	4.0E+02	5.0E-02
AOI 16	SS-16A-2	SS-16A-2-18	1.5	1.5	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 16	SS-18-1	SS-18-1-03	0.3	0.3	INORG	Lead	1.90E+01	4.50E+01	4.2E-01	8.0E+01	2.4E-01	3.2E+02	5.9E-02	4.0E+02	4.8E-02
AOI 16	SS-18-1	SS-18-1-12	1.0	1.0	INORG	Lead	2.00E+01	4.50E+01	4.4E-01	8.0E+01	2.5E-01	3.2E+02	6.3E-02	4.0E+02	5.0E-02
AOI 16	SS-18-2	SS-18-2-03	0.3	0.3	INORG	Lead	7.30E+01	4.50E+01	**1.6E+00**	8.0E+01	9.1E-01	3.2E+02	2.3E-01	4.0E+02	1.8E-01
AOI 16	SS-18-2	SS-18-2-12	1.0	1.0	INORG	Lead	5.40E+01	4.50E+01	**1.2E+00**	8.0E+01	6.8E-01	3.2E+02	1.7E-01	4.0E+02	1.4E-01
AOI 17	SS-9-1	SS-9-1-12	1.0	1.0	INORG	Lead	6.70E+00	4.50E+01	1.5E-01	8.0E+01	8.4E-02	3.2E+02	2.1E-02	4.0E+02	1.7E-02
AOI 17	SS-9-1	SS-9-1-36	3.0	3.0	INORG	Lead	7.70E+00	4.50E+01	1.7E-01	8.0E+01	9.6E-02	3.2E+02	2.4E-02	4.0E+02	1.9E-02
AOI 17	SS-9-2	SS-9-2-12	1.0	1.0	INORG	Lead	2.30E+01	4.50E+01	5.1E-01	8.0E+01	2.9E-01	3.2E+02	7.2E-02	4.0E+02	5.8E-02
AOI 17	SS-9-3	SS-9-3-12	1.0	1.0	INORG	Lead	3.10E+01	4.50E+01	6.9E-01	8.0E+01	3.9E-01	3.2E+02	9.7E-02	4.0E+02	7.8E-02
AOI 17	SS-9-3	SS-9-3-36	3.0	3.0	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 18	SS-21-1	SS-21-1-03	0.3	0.3	INORG	Lead	1.30E+02	4.50E+01	**2.9E+00**	8.0E+01	**1.6E+00**	3.2E+02	4.1E-01	4.0E+02	3.3E-01
AOI 18	SS-21-1	SS-21-1-18	1.5	1.5	INORG	Lead	7.10E+01	4.50E+01	**1.6E+00**	8.0E+01	8.9E-01	3.2E+02	2.2E-01	4.0E+02	1.8E-01
AOI 18	SS-5-1	SS-5-1-03	0.3	0.3	INORG	Lead	1.00E+02	4.50E+01	**2.2E+00**	8.0E+01	**1.3E+00**	3.2E+02	3.1E-01	4.0E+02	2.5E-01
AOI 18	SS-5-1	SS-5-1-12	1.0	1.0	INORG	Lead	1.20E+01	4.50E+01	2.7E-01	8.0E+01	1.5E-01	3.2E+02	3.8E-02	4.0E+02	3.0E-02
AOI 18	SS-5-2	SS-5-2-03	0.3	0.3	INORG	Lead	5.90E+02	4.50E+01	**1.3E+01**	8.0E+01	**7.4E+00**	3.2E+02	**1.8E+00**	4.0E+02	**1.5E+00**
AOI 18	SS-5-2	SS-5-2-12	1.0	1.0	INORG	Lead	5.80E+02	4.50E+01	**1.3E+01**	8.0E+01	**7.3E+00**	3.2E+02	**1.8E+00**	4.0E+02	**1.5E+00**

Table 3-9
Lead Soil Screening Summary
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Sample Name	Top Depth (ft)	Bottom Depth (ft)	Chem Group	Chemical	Conc (mg/kg)	Background (mg/kg)	Ratio of Conc to Background	DTSC Residential Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Residential Soil Screening Level	DTSC Com/Ind Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Com/Ind Soil Screening Level	USEPA Residential Regional Screening Levels (mg/kg)	Ratio of Conc to USEPA Residential RSLs
AOI 18	SS-5-3	SS-5-3-03	0.3	0.3	INORG	Lead	7.80E+02	4.50E+01	**1.7E+01**	8.0E+01	**9.8E+00**	3.2E+02	**2.4E+00**	4.0E+02	**2.0E+00**
AOI 18	SS-5-3	SS-5-3-12	1.0	1.0	INORG	Lead	5.10E+01	4.50E+01	**1.1E+00**	8.0E+01	6.4E-01	3.2E+02	1.6E-01	4.0E+02	1.3E-01
AOI 18	SS-5A-1	SS-5A-1-03	0.3	0.3	INORG	Lead	8.70E+01	4.50E+01	**1.9E+00**	8.0E+01	**1.1E+00**	3.2E+02	2.7E-01	4.0E+02	2.2E-01
AOI 18	SS-5A-1	SS-5A-1-18	1.5	1.5	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02
AOI 18	SS-5A-2	SS-5A-2-03	0.3	0.3	INORG	Lead	1.50E+02	4.50E+01	**3.3E+00**	8.0E+01	**1.9E+00**	3.2E+02	4.7E-01	4.0E+02	3.8E-01
AOI 18	SS-5A-2	SS-5A-2-18	1.5	1.5	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 18	SS-5A-3	SS-5A-3-03	0.3	0.3	INORG	Lead	1.50E+02	4.50E+01	**3.3E+00**	8.0E+01	**1.9E+00**	3.2E+02	4.7E-01	4.0E+02	3.8E-01
AOI 18	SS-5A-3	SS-5A-3-18	1.5	1.5	INORG	Lead	2.80E+01	4.50E+01	6.2E-01	8.0E+01	3.5E-01	3.2E+02	8.8E-02	4.0E+02	7.0E-02
AOI 19	SS-19-1	SS-19-1-03	0.3	0.3	INORG	Lead	4.90E+02	4.50E+01	**1.1E+01**	8.0E+01	**6.1E+00**	3.2E+02	**1.5E+00**	4.0E+02	**1.2E+00**
AOI 19	SS-19-1	SS-19-1-18	1.5	1.5	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 19	SS-19-2	SS-19-2-03	0.3	0.3	INORG	Lead	7.00E+01	4.50E+01	**1.6E+00**	8.0E+01	8.8E-01	3.2E+02	2.2E-01	4.0E+02	1.8E-01
AOI 19	SS-19-2	SS-19-2-18	1.5	1.5	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 19	SS-19-3	SS-19-3-03	0.3	0.3	INORG	Lead	6.00E+01	4.50E+01	**1.3E+00**	8.0E+01	7.5E-01	3.2E+02	1.9E-01	4.0E+02	1.5E-01
AOI 19	SS-19-3	SS-19-3-18	1.5	1.5	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02
AOI 19	SS-19-4	SS-19-4-03	0.3	0.3	INORG	Lead	1.10E+02	4.50E+01	**2.4E+00**	8.0E+01	**1.4E+00**	3.2E+02	3.4E-01	4.0E+02	2.8E-01
AOI 19	SS-19-4	SS-19-4-18	1.5	1.5	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 19	SS-19-5	SS-19-5-03	0.3	0.3	INORG	Lead	2.00E+01	4.50E+01	4.4E-01	8.0E+01	2.5E-01	3.2E+02	6.3E-02	4.0E+02	5.0E-02
AOI 19	SS-19-5	SS-19-5-18	1.5	1.5	INORG	Lead	5.00E+00	4.50E+01	1.1E-01	8.0E+01	6.3E-02	3.2E+02	1.6E-02	4.0E+02	1.3E-02
AOI 19	SS-19-6	SS-19-6-03	0.3	0.3	INORG	Lead	5.60E+02	4.50E+01	**1.2E+01**	8.0E+01	**7.0E+00**	3.2E+02	**1.8E+00**	4.0E+02	**1.4E+00**
AOI 19	SS-19-6	SS-19-6-18	1.5	1.5	INORG	Lead	1.10E+01	4.50E+01	2.4E-01	8.0E+01	1.4E-01	3.2E+02	3.4E-02	4.0E+02	2.8E-02
AOI 20	BC-1	BC-1-3	0.3	0.3	INORG	Lead	2.80E+01	4.50E+01	6.2E-01	8.0E+01	3.5E-01	3.2E+02	8.8E-02	4.0E+02	7.0E-02
AOI 20	BC-1	BC-1-8	0.7	0.7	INORG	Lead	3.30E+01	4.50E+01	7.3E-01	8.0E+01	4.1E-01	3.2E+02	1.0E-01	4.0E+02	8.3E-02
AOI 20	BC-2	BC-2-3	0.3	0.3	INORG	Lead	2.20E+01	4.50E+01	4.9E-01	8.0E+01	2.8E-01	3.2E+02	6.9E-02	4.0E+02	5.5E-02
AOI 20	BC-2	BC-2-8	0.7	0.7	INORG	Lead	2.20E+01	4.50E+01	4.9E-01	8.0E+01	2.8E-01	3.2E+02	6.9E-02	4.0E+02	5.5E-02
AOI 20	BC-3	BC-3-3	0.3	0.3	INORG	Lead	6.30E+01	4.50E+01	**1.4E+00**	8.0E+01	7.9E-01	3.2E+02	2.0E-01	4.0E+02	1.6E-01
AOI 20	BC-3	BC-3-8	0.7	0.7	INORG	Lead	1.60E+01	4.50E+01	3.6E-01	8.0E+01	2.0E-01	3.2E+02	5.0E-02	4.0E+02	4.0E-02
AOI 20	BC-4	BC-4-3	0.3	0.3	INORG	Lead	1.70E+01	4.50E+01	3.8E-01	8.0E+01	2.1E-01	3.2E+02	5.3E-02	4.0E+02	4.3E-02
AOI 20	BC-4	BC-4-8	0.7	0.7	INORG	Lead	7.80E+00	4.50E+01	1.7E-01	8.0E+01	9.8E-02	3.2E+02	2.4E-02	4.0E+02	2.0E-02
AOI 20	BC-5	BC-5-3	0.3	0.3	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02
AOI 20	BC-5	BC-5-8	0.7	0.7	INORG	Lead	1.30E+01	4.50E+01	2.9E-01	8.0E+01	1.6E-01	3.2E+02	4.1E-02	4.0E+02	3.3E-02
AOI 20	BC-L-COMP	BC-L-COMP	0.0	0.0	INORG	Lead	3.00E+01	4.50E+01	6.7E-01	8.0E+01	3.8E-01	3.2E+02	9.4E-02	4.0E+02	7.5E-02
AOI 20	ID-U	ID-U	0.0	0.0	INORG	Lead	1.90E+03	4.50E+01	**4.2E+01**	8.0E+01	**2.4E+01**	3.2E+02	**5.9E+00**	4.0E+02	**4.8E+00**
AOI 20	SS-20-1	SS-20-1-03	0.3	0.3	INORG	Lead	4.90E+02	4.50E+01	**1.1E+01**	8.0E+01	**6.1E+00**	3.2E+02	**1.5E+00**	4.0E+02	**1.2E+00**
AOI 20	SS-20-1	SS-20-1-18	1.5	1.5	INORG	Lead	5.70E+01	4.50E+01	**1.3E+00**	8.0E+01	7.1E-01	3.2E+02	1.8E-01	4.0E+02	1.4E-01
AOI 21	SS-4-1	SS-4-1-03	0.3	0.3	INORG	Lead	6.80E+01	4.50E+01	**1.5E+00**	8.0E+01	8.5E-01	3.2E+02	2.1E-01	4.0E+02	1.7E-01
AOI 21	SS-4-1	SS-4-1-12	1.0	1.0	INORG	Lead	1.00E+02	4.50E+01	**2.2E+00**	8.0E+01	**1.3E+00**	3.2E+02	3.1E-01	4.0E+02	2.5E-01
AOI 21	SS-4-2	SS-4-2-03	0.3	0.3	INORG	Lead	6.80E+01	4.50E+01	**1.5E+00**	8.0E+01	8.5E-01	3.2E+02	2.1E-01	4.0E+02	1.7E-01
AOI 21	SS-4-2	SS-4-2-12	1.0	1.0	INORG	Lead	5.60E+01	4.50E+01	**1.2E+00**	8.0E+01	7.0E-01	3.2E+02	1.8E-01	4.0E+02	1.4E-01
AOI 21	SS-4-3	SS-4-3-03	0.3	0.3	INORG	Lead	1.70E+02	4.50E+01	**3.8E+00**	8.0E+01	**2.1E+00**	3.2E+02	5.3E-01	4.0E+02	4.3E-01
AOI 21	SS-4-3	SS-4-3-12	1.0	1.0	INORG	Lead	1.20E+02	4.50E+01	**2.7E+00**	8.0E+01	**1.5E+00**	3.2E+02	3.8E-01	4.0E+02	3.0E-01
AOI 21	SS-4-4	SS-4-4-03	0.3	0.3	INORG	Lead	2.80E+02	4.50E+01	**6.2E+00**	8.0E+01	**3.5E+00**	3.2E+02	8.8E-01	4.0E+02	7.0E-01
AOI 21	SS-4-4	SS-4-4-12	1.0	1.0	INORG	Lead	1.60E+02	4.50E+01	**3.6E+00**	8.0E+01	**2.0E+00**	3.2E+02	5.0E-01	4.0E+02	4.0E-01
AOI 21	SS-4-5	SS-4-5-03	0.3	0.3	INORG	Lead	8.80E+02	4.50E+01	**2.0E+01**	8.0E+01	**1.1E+01**	3.2E+02	**2.8E+00**	4.0E+02	**2.2E+00**
AOI 21	SS-4-5	SS-4-5-12	1.0	1.0	INORG	Lead	1.30E+02	4.50E+01	**2.9E+00**	8.0E+01	**1.6E+00**	3.2E+02	4.1E-01	4.0E+02	3.3E-01

Table 3-9
Lead Soil Screening Summary
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Sample Name	Top Depth (ft)	Bottom Depth (ft)	Chem Group	Chemical	Conc (mg/kg)	Background (mg/kg)	Ratio of Conc to Background	DTSC Residential Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Residential Soil Screening Level	DTSC Com/Ind Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Com/Ind Soil Screening Level	USEPA Residential Regional Screening Levels (mg/kg)	Ratio of Conc to USEPA Residential RSLs
AOI 21	SS-4-6	SS-4-6-03	0.3	0.3	INORG	Lead	3.70E+02	4.50E+01	**8.2E+00**	8.0E+01	**4.6E+00**	3.2E+02	**1.2E+00**	4.0E+02	9.3E-01
AOI 21	SS-4-6	SS-4-6-12	1.0	1.0	INORG	Lead	2.00E+01	4.50E+01	4.4E-01	8.0E+01	2.5E-01	3.2E+02	6.3E-02	4.0E+02	5.0E-02
AOI 21	SS-4-7	SS-4-7-03	0.3	0.3	INORG	Lead	1.20E+02	4.50E+01	**2.7E+00**	8.0E+01	**1.5E+00**	3.2E+02	3.8E-01	4.0E+02	3.0E-01
AOI 21	SS-4-7	SS-4-7-12	1.0	1.0	INORG	Lead	8.60E+01	4.50E+01	**1.9E+00**	8.0E+01	**1.1E+00**	3.2E+02	2.7E-01	4.0E+02	2.2E-01
AOI 21	SS-4-8	SS-4-8-03	0.3	0.3	INORG	Lead	6.40E+01	4.50E+01	**1.4E+00**	8.0E+01	8.0E-01	3.2E+02	2.0E-01	4.0E+02	1.6E-01
AOI 21	SS-4-8	SS-4-8-12	1.0	1.0	INORG	Lead	2.50E+01	4.50E+01	5.6E-01	8.0E+01	3.1E-01	3.2E+02	7.8E-02	4.0E+02	6.3E-02
AOI 21	SS-4A-1	SS-4A-1-03	0.3	0.3	INORG	Lead	2.10E+02	4.50E+01	**4.7E+00**	8.0E+01	**2.6E+00**	3.2E+02	6.6E-01	4.0E+02	5.3E-01
AOI 21	SS-4A-1	SS-4A-1-18	1.5	1.5	INORG	Lead	2.40E+01	4.50E+01	5.3E-01	8.0E+01	3.0E-01	3.2E+02	7.5E-02	4.0E+02	6.0E-02
AOI 21	SS-4A-2	SS-4A-2-03	0.3	0.3	INORG	Lead	6.80E+01	4.50E+01	**1.5E+00**	8.0E+01	8.5E-01	3.2E+02	2.1E-01	4.0E+02	1.7E-01
AOI 21	SS-4A-2	SS-4A-2-18	1.5	1.5	INORG	Lead	8.00E+01	4.50E+01	**1.8E+00**	8.0E+01	1.0E+00	3.2E+02	2.5E-01	4.0E+02	2.0E-01
AOI 21	SS-4A-3	SS-4A-3-03	0.3	0.3	INORG	Lead	1.70E+02	4.50E+01	**3.8E+00**	8.0E+01	**2.1E+00**	3.2E+02	5.3E-01	4.0E+02	4.3E-01
AOI 21	SS-4A-3	SS-4A-3-18	1.5	1.5	INORG	Lead	5.70E+01	4.50E+01	**1.3E+00**	8.0E+01	7.1E-01	3.2E+02	1.8E-01	4.0E+02	1.4E-01
AOI 21	SS-4A-4	SS-4A-4-03	0.3	0.3	INORG	Lead	4.70E+01	4.50E+01	1.0E+00	8.0E+01	5.9E-01	3.2E+02	1.5E-01	4.0E+02	1.2E-01
AOI 21	SS-4A-4	SS-4A-4-18	1.5	1.5	INORG	Lead	2.00E+01	4.50E+01	4.4E-01	8.0E+01	2.5E-01	3.2E+02	6.3E-02	4.0E+02	5.0E-02
AOI 21	SS-4A-5	SS-4A-5-03	0.3	0.3	INORG	Lead	7.20E+01	4.50E+01	**1.6E+00**	8.0E+01	9.0E-01	3.2E+02	2.3E-01	4.0E+02	1.8E-01
AOI 21	SS-4A-5	SS-4A-5-18	1.5	1.5	INORG	Lead	6.60E+01	4.50E+01	**1.5E+00**	8.0E+01	8.3E-01	3.2E+02	2.1E-01	4.0E+02	1.7E-01
AOI 21	SS-4A-6	SS-4A-6-03	0.3	0.3	INORG	Lead	2.40E+02	4.50E+01	**5.3E+00**	8.0E+01	**3.0E+00**	3.2E+02	7.5E-01	4.0E+02	6.0E-01
AOI 21	SS-4A-6	SS-4A-6-18	1.5	1.5	INORG	Lead	1.60E+01	4.50E+01	3.6E-01	8.0E+01	2.0E-01	3.2E+02	5.0E-02	4.0E+02	4.0E-02
AOI 21	SS-4A-7	SS-4A-7-03	0.3	0.3	INORG	Lead	3.40E+01	4.50E+01	7.6E-01	8.0E+01	4.3E-01	3.2E+02	1.1E-01	4.0E+02	8.5E-02
AOI 21	SS-4A-7	SS-4A-7-18	1.5	1.5	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 21	SS-4A-8	SS-4A-8-03	0.3	0.3	INORG	Lead	6.70E+01	4.50E+01	**1.5E+00**	8.0E+01	8.4E-01	3.2E+02	2.1E-01	4.0E+02	1.7E-01
AOI 21	SS-4A-8	SS-4A-8-18	1.5	1.5	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 22	SS-7-1	SS-7-1	0.1	0.1	INORG	Lead	3.10E+01	4.50E+01	6.9E-01	8.0E+01	3.9E-01	3.2E+02	9.7E-02	4.0E+02	7.8E-02
AOI 22	SS-7-2	SS-7-2	0.1	0.1	INORG	Lead	9.20E+01	4.50E+01	**2.0E+00**	8.0E+01	**1.2E+00**	3.2E+02	2.9E-01	4.0E+02	2.3E-01
AOI 22	SS-7-SED	SS-7-SED	0.1	0.1	INORG	Lead	5.40E+01	4.50E+01	**1.2E+00**	8.0E+01	6.8E-01	3.2E+02	1.7E-01	4.0E+02	1.4E-01
AOI 23	SS-8-1	SS-8-1-03	0.3	0.3	INORG	Lead	1.30E+03	4.50E+01	**2.9E+01**	8.0E+01	**1.6E+01**	3.2E+02	**4.1E+00**	4.0E+02	**3.3E+00**
AOI 23	SS-8-1	SS-8-1-12	1.0	1.0	INORG	Lead	7.40E+01	4.50E+01	**1.6E+00**	8.0E+01	9.3E-01	3.2E+02	2.3E-01	4.0E+02	1.9E-01
AOI 23	SS-8-2	SS-8-2-03	0.3	0.3	INORG	Lead	1.10E+03	4.50E+01	**2.4E+01**	8.0E+01	**1.4E+01**	3.2E+02	**3.4E+00**	4.0E+02	**2.8E+00**
AOI 23	SS-8-2	SS-8-2-12	1.0	1.0	INORG	Lead	2.10E+01	4.50E+01	4.7E-01	8.0E+01	2.6E-01	3.2E+02	6.6E-02	4.0E+02	5.3E-02
AOI 23	SS-8-3	SS-8-3-03	0.3	0.3	INORG	Lead	1.70E+02	4.50E+01	**3.8E+00**	8.0E+01	**2.1E+00**	3.2E+02	5.3E-01	4.0E+02	4.3E-01
AOI 23	SS-8-3	SS-8-3-12	1.0	1.0	INORG	Lead	1.10E+02	4.50E+01	**2.4E+00**	8.0E+01	**1.4E+00**	3.2E+02	3.4E-01	4.0E+02	2.8E-01
AOI 23	SS-8-4	SS-8-4-03	0.3	0.3	INORG	Lead	2.00E+02	4.50E+01	**4.4E+00**	8.0E+01	**2.5E+00**	3.2E+02	6.3E-01	4.0E+02	5.0E-01
AOI 23	SS-8-4	SS-8-4-12	1.0	1.0	INORG	Lead	1.10E+02	4.50E+01	**2.4E+00**	8.0E+01	**1.4E+00**	3.2E+02	3.4E-01	4.0E+02	2.8E-01
AOI 23	SS-8-5	SS-8-5-03	0.3	0.3	INORG	Lead	7.00E+02	4.50E+01	**1.6E+01**	8.0E+01	**8.8E+00**	3.2E+02	**2.2E+00**	4.0E+02	**1.8E+00**
AOI 23	SS-8-5	SS-8-5-12	1.0	1.0	INORG	Lead	1.90E+02	4.50E+01	**4.2E+00**	8.0E+01	**2.4E+00**	3.2E+02	5.9E-01	4.0E+02	4.8E-01
AOI 23	SS-8-6	SS-8-6-03	0.3	0.3	INORG	Lead	1.30E+02	4.50E+01	**2.9E+00**	8.0E+01	**1.6E+00**	3.2E+02	4.1E-01	4.0E+02	3.3E-01
AOI 23	SS-8-6	SS-8-6-12	1.0	1.0	INORG	Lead	1.40E+03	4.50E+01	**3.1E+01**	8.0E+01	**1.8E+01**	3.2E+02	**4.4E+00**	4.0E+02	**3.5E+00**
AOI 23	SS-8A-1	SS-8A-1-03	0.3	0.3	INORG	Lead	4.50E+01	4.50E+01	1.0E+00	8.0E+01	5.6E-01	3.2E+02	1.4E-01	4.0E+02	1.1E-01
AOI 23	SS-8A-1	SS-8A-1-18	1.5	1.5	INORG	Lead	3.00E+01	4.50E+01	6.7E-01	8.0E+01	3.8E-01	3.2E+02	9.4E-02	4.0E+02	7.5E-02
AOI 23	SS-8A-2	SS-8A-2-03	0.3	0.3	INORG	Lead	3.40E+01	4.50E+01	7.6E-01	8.0E+01	4.3E-01	3.2E+02	1.1E-01	4.0E+02	8.5E-02
AOI 23	SS-8A-2	SS-8A-2-18	1.5	1.5	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 23	SS-8A-3	SS-8A-3-03	0.3	0.3	INORG	Lead	6.40E+01	4.50E+01	**1.4E+00**	8.0E+01	8.0E-01	3.2E+02	2.0E-01	4.0E+02	1.6E-01
AOI 23	SS-8A-3	SS-8A-3-18	1.5	1.5	INORG	Lead	2.40E+01	4.50E+01	5.3E-01	8.0E+01	3.0E-01	3.2E+02	7.5E-02	4.0E+02	6.0E-02
AOI 23	SS-8A-4	SS-8A-4-03	0.3	0.3	INORG	Lead	3.30E+02	4.50E+01	**7.3E+00**	8.0E+01	**4.1E+00**	3.2E+02	1.0E+00	4.0E+02	8.3E-01

Table 3-9
Lead Soil Screening Summary
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Sample Name	Top Depth (ft)	Bottom Depth (ft)	Chem Group	Chemical	Conc (mg/kg)	Background (mg/kg)	Ratio of Conc to Background	DTSC Residential Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Residential Soil Screening Level	DTSC Com/Ind Soil Screening Level (mg/kg)	Ratio of Conc to DTSC Com/Ind Soil Screening Level	USEPA Residential Regional Screening Levels (mg/kg)	Ratio of Conc to USEPA Residential RSLs
AOI 23	SS-8A-4	SS-8A-4-18	1.5	1.5	INORG	Lead	8.60E+01	4.50E+01	**1.9E+00**	8.0E+01	**1.1E+00**	3.2E+02	2.7E-01	4.0E+02	2.2E-01
AOI 23	SS-8A-5	SS-8A-5-03	0.3	0.3	INORG	Lead	2.00E+02	4.50E+01	**4.4E+00**	8.0E+01	**2.5E+00**	3.2E+02	6.3E-01	4.0E+02	5.0E-01
AOI 23	SS-8A-5	SS-8A-5-18	1.5	1.5	INORG	Lead	5.80E+01	4.50E+01	**1.3E+00**	8.0E+01	7.3E-01	3.2E+02	1.8E-01	4.0E+02	1.5E-01
AOI 23	SS-8A-6	SS-8A-6-03	0.3	0.3	INORG	Lead	1.50E+02	4.50E+01	**3.3E+00**	8.0E+01	**1.9E+00**	3.2E+02	4.7E-01	4.0E+02	3.8E-01
AOI 23	SS-8A-6	SS-8A-6-18	1.5	1.5	INORG	Lead	6.20E+01	4.50E+01	**1.4E+00**	8.0E+01	7.8E-01	3.2E+02	1.9E-01	4.0E+02	1.6E-01
AOI 24	DO-1	DO-1-3	0.3	0.3	INORG	Lead	1.30E+02	4.50E+01	**2.9E+00**	8.0E+01	**1.6E+00**	3.2E+02	4.1E-01	4.0E+02	3.3E-01
AOI 24	DO-1	DO-1-8	0.7	0.7	INORG	Lead	7.40E+01	4.50E+01	**1.6E+00**	8.0E+01	9.3E-01	3.2E+02	2.3E-01	4.0E+02	1.9E-01
AOI 24	SS-2-1	SS-2-1-03	0.3	0.3	INORG	Lead	1.30E+02	4.50E+01	**2.9E+00**	8.0E+01	**1.6E+00**	3.2E+02	4.1E-01	4.0E+02	3.3E-01
AOI 24	SS-2-1	SS-2-1-08	0.7	0.7	INORG	Lead	7.00E+01	4.50E+01	**1.6E+00**	8.0E+01	8.8E-01	3.2E+02	2.2E-01	4.0E+02	1.8E-01
AOI 24	SS-2-1	SS-2-1-14	1.2	1.2	INORG	Lead	3.90E+01	4.50E+01	8.7E-01	8.0E+01	4.9E-01	3.2E+02	1.2E-01	4.0E+02	9.8E-02
AOI 24	SS-2-1	SS-2-1-20	1.7	1.7	INORG	Lead	1.20E+01	4.50E+01	2.7E-01	8.0E+01	1.5E-01	3.2E+02	3.8E-02	4.0E+02	3.0E-02
AOI 24	SS-2-2	SS-2-2-03	0.3	0.3	INORG	Lead	2.20E+02	4.50E+01	**4.9E+00**	8.0E+01	**2.8E+00**	3.2E+02	6.9E-01	4.0E+02	5.5E-01
AOI 24	SS-2-2	SS-2-2-08	0.7	0.7	INORG	Lead	1.70E+01	4.50E+01	3.8E-01	8.0E+01	2.1E-01	3.2E+02	5.3E-02	4.0E+02	4.3E-02
AOI 24	SS-2-2	SS-2-2-14	1.2	1.2	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02
AOI 24	SS-2-2	SS-2-2-20	1.7	1.7	INORG	Lead	1.30E+01	4.50E+01	2.9E-01	8.0E+01	1.6E-01	3.2E+02	4.1E-02	4.0E+02	3.3E-02
AOI 24	SS-2-3	SS-2-3-03	0.3	0.3	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 24	SS-2-3	SS-2-3-08	0.7	0.7	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02
AOI 24	SS-2-3	SS-2-3-14	1.2	1.2	INORG	Lead	1.10E+01	4.50E+01	2.4E-01	8.0E+01	1.4E-01	3.2E+02	3.4E-02	4.0E+02	2.8E-02
AOI 24	SS-2-3	SS-2-3-20	1.7	1.7	INORG	Lead	9.70E+00	4.50E+01	2.2E-01	8.0E+01	1.2E-01	3.2E+02	3.0E-02	4.0E+02	2.4E-02
AOI 24	SS-2-4	SS-2-4-03	0.3	0.3	INORG	Lead	1.80E+01	4.50E+01	4.0E-01	8.0E+01	2.3E-01	3.2E+02	5.6E-02	4.0E+02	4.5E-02
AOI 24	SS-2-4	SS-2-4-08	0.7	0.7	INORG	Lead	1.40E+01	4.50E+01	3.1E-01	8.0E+01	1.8E-01	3.2E+02	4.4E-02	4.0E+02	3.5E-02
AOI 24	SS-2-4	SS-2-4-14	1.2	1.2	INORG	Lead	9.90E+00	4.50E+01	2.2E-01	8.0E+01	1.2E-01	3.2E+02	3.1E-02	4.0E+02	2.5E-02
AOI 24	SS-2-4	SS-2-4-20	1.7	1.7	INORG	Lead	1.70E+01	4.50E+01	3.8E-01	8.0E+01	2.1E-01	3.2E+02	5.3E-02	4.0E+02	4.3E-02
AOI 24	SS-2-5	SS-2-5-03	0.3	0.3	INORG	Lead	6.30E+01	4.50E+01	**1.4E+00**	8.0E+01	7.9E-01	3.2E+02	2.0E-01	4.0E+02	1.6E-01
AOI 24	SS-2-5	SS-2-5-08	0.7	0.7	INORG	Lead	1.70E+01	4.50E+01	3.8E-01	8.0E+01	2.1E-01	3.2E+02	5.3E-02	4.0E+02	4.3E-02
AOI 24	SS-2-6	SS-2-6-03	0.3	0.3	INORG	Lead	8.30E+01	4.50E+01	**1.8E+00**	8.0E+01	1.0E+00	3.2E+02	2.6E-01	4.0E+02	2.1E-01
AOI 24	SS-2-6	SS-2-6-08	0.7	0.7	INORG	Lead	3.20E+01	4.50E+01	7.1E-01	8.0E+01	4.0E-01	3.2E+02	1.0E-01	4.0E+02	8.0E-02
AOI 24	SS-2-7	SS-2-7-03	0.3	0.3	INORG	Lead	3.80E+02	4.50E+01	**8.4E+00**	8.0E+01	**4.8E+00**	3.2E+02	**1.2E+00**	4.0E+02	9.5E-01
AOI 24	SS-2-7	SS-2-7-08	0.7	0.7	INORG	Lead	3.10E+01	4.50E+01	6.9E-01	8.0E+01	3.9E-01	3.2E+02	9.7E-02	4.0E+02	7.8E-02
AOI 24	SS-2-8	SS-2-8-03	0.3	0.3	INORG	Lead	9.30E+01	4.50E+01	**2.1E+00**	8.0E+01	**1.2E+00**	3.2E+02	2.9E-01	4.0E+02	2.3E-01
AOI 24	SS-2-8	SS-2-8-08	0.7	0.7	INORG	Lead	7.20E+01	4.50E+01	**1.6E+00**	8.0E+01	9.0E-01	3.2E+02	2.3E-01	4.0E+02	1.8E-01
AOI 25	SS-3-1	SS-3-1-03	0.3	0.3	INORG	Lead	1.70E+02	4.50E+01	**3.8E+00**	8.0E+01	**2.1E+00**	3.2E+02	5.3E-01	4.0E+02	4.3E-01
AOI 25	SS-3-1	SS-3-1-12	1.0	1.0	INORG	Lead	2.80E+01	4.50E+01	6.2E-01	8.0E+01	3.5E-01	3.2E+02	8.8E-02	4.0E+02	7.0E-02
AOI 25	SS-3-2	SS-3-2-03	0.3	0.3	INORG	Lead	1.60E+02	4.50E+01	**3.6E+00**	8.0E+01	**2.0E+00**	3.2E+02	5.0E-01	4.0E+02	4.0E-01
AOI 25	SS-3A-1	SS-3A-1-03	0.3	0.3	INORG	Lead	4.70E+01	4.50E+01	1.0E+00	8.0E+01	5.9E-01	3.2E+02	1.5E-01	4.0E+02	1.2E-01
AOI 25	SS-3A-1	SS-3A-1-18	1.5	1.5	INORG	Lead	3.10E+01	4.50E+01	6.9E-01	8.0E+01	3.9E-01	3.2E+02	9.7E-02	4.0E+02	7.8E-02
AOI 25	SS-3A-2	SS-3A-2-03	0.3	0.3	INORG	Lead	5.20E+01	4.50E+01	**1.2E+00**	8.0E+01	6.5E-01	3.2E+02	1.6E-01	4.0E+02	1.3E-01
AOI 25	SS-3A-2	SS-3A-2-18	1.5	1.5	INORG	Lead	1.50E+01	4.50E+01	3.3E-01	8.0E+01	1.9E-01	3.2E+02	4.7E-02	4.0E+02	3.8E-02

Notes:
Only chemicals detected in each area are shown.
Background threshold values are from the 2002 Erler & Kalinowski, Inc. *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water* .
These values represent estimates of the upper-end of the range of background concentrations, below which soil concentrations would reasonably be considered naturally occurring.
Ratios of concentration to the screening level greater than 1 are shaded in bold.

Table 3-10
Soil Ecological Screening and Baseline Summary
GGNRA Hawk Hill, Marin Headlands, CA

										NPS SLERA COPEC Selection				NPS Refined SLERA											Simple-BERA Refinements					
Area	Chem Group	Chemical	CASRN	Analyzed	Detected	Frequency Detected	Max Detected (mg/kg)	Background Threshold Value (BTV) (mg/kg)	Ratio of Max Detect to BTV	Ecological-Based Soil Screening Level (mg/kg)		Upper-Bound HQ	Retain as COPEC?	Basis	Terrestrial Plant ESV (mg/kg)	Terrestrial Plant HQ	Invertebrates ESV (mg/kg)	Invertebrates HQ	Birds ESV (mg/kg)	Birds HQ	Mammals ESV (mg/kg)	Mammals HQ	Retain for BERA?	Basis	Receptors Evaluated in BERA	HQ for Plants	HQ for Invertebrates	HQ for American Robin	HQ for Red-tailed Hawk	HQ for Deer Mouse	HQ for Red Fox
AOI 13	PCB	PCBs (total)	1336-36-3	4	3	75%	6.60E-02			8.8E-01	B/M	7.5E-02	Yes	Bioacc					8.8E-01	7.5E-02	1.0E+01	6.6E-03	Yes	Bioacc				3E-04	6E-10	5E-05	2E-09
AOI 14	INORG	Lead	7439-92-1	10	10	100%	2.40E+02	4.50E+01	**5.3E+00**	3.6E+01	B/M	**6.6E+00**	Yes	HQ≥1	1.2E+02	**2.0E+00**	1.7E+03	1.4E-01	9.2E+01	**2.6E+00**	5.6E+01	**4.3E+00**	Yes	HQ≥1	P, B, M	9E-01	6E-02	1E-01	1E-05	3E-01	6E-05
AOI 15	INORG	Antimony	7440-36-0	9	9	100%	4.60E-01	3.00E+00	1.5E-01	2.5E-01	B/M	**1.9E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Arsenic	7440-38-2	9	9	100%	4.10E+00	3.20E+00	**1.3E+00**	2.5E-01	B/M	**1.6E+01**	Yes	HQ≥1	1.8E+01	2.3E-01	6.0E+01	6.8E-02	4.3E+01	9.5E-02	4.6E+01	8.9E-02	No	HQ<1							
AOI 15	INORG	Barium	7440-39-3	9	9	100%	6.30E+02	9.00E+02	7.0E-01	1.7E+01	B/M	**3.7E+01**	No	Below BG									No	Below BG							
AOI 15	INORG	Beryllium	7440-41-7	9	9	100%	5.30E-01	7.20E-01	7.4E-01	2.4E+00	B/M	2.2E-01	No	Below BG									No	Below BG							
AOI 15	INORG	Cadmium	7440-43-9	9	5	56%	1.60E-01	1.70E+00	9.4E-02	2.7E-01	B/M	5.9E-01	No	Below BG									No	Below BG							
AOI 15	INORG	Chromium (total)	7440-47-3	9	9	100%	3.10E+01	4.10E+01	7.6E-01	3.4E-01	P/I	**9.1E+01**	No	Below BG									No	Below BG							
AOI 15	INORG	Cobalt	7440-48-4	9	9	100%	2.10E+01	3.70E+01	5.7E-01	1.3E+01	P/I	**1.6E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Copper	7440-50-8	9	9	100%	5.90E+01	3.60E+02	1.6E-01	1.4E+01	B/M	**4.2E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Lead	7439-92-1	9	9	100%	1.60E+01	4.50E+01	3.6E-01	3.6E+01	B/M	4.4E-01	No	Below BG									No	Below BG							
AOI 15	INORG	Mercury	7439-97-6	9	9	100%	5.20E-02	2.00E-01	2.6E-01	1.3E-02	B/M	**4.0E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Molybdenum	7439-98-7	9	9	100%	1.10E+00	2.00E+00	5.5E-01	5.2E-01	B/M	**2.1E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Nickel	7440-02-0	9	9	100%	3.70E+01	7.10E+01	5.2E-01	1.0E+01	B/M	**3.7E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Selenium	7782-49-2	9	9	100%	8.60E-01	5.00E-01	**1.7E+00**	3.3E-01	B/M	**2.6E+00**	Yes	HQ≥1	5.2E-01	**1.7E+00**	4.1E+00	2.1E-01	1.2E+00	7.2E-01	6.3E-01	**1.4E+00**	Yes	HQ≥1	P, M	7E-01	7E-02	3E-02	1E-05	1E-01	4E-05
AOI 15	INORG	Thallium	7440-28-0	9	8	89%	1.70E-01	1.00E+00	1.7E-01	2.7E-02	B/M	**6.3E+00**	No	Below BG									No	Below BG							
AOI 15	INORG	Vanadium	7440-62-2	9	9	100%	8.30E+01	6.10E+01	**1.4E+00**	7.1E-01	B/M	**1.2E+02**	Yes	HQ≥1	2.0E+00	**4.2E+01**			7.8E+00	**1.1E+01**	2.8E+02	3.0E-01	Yes	HQ≥1	P, B	1E+00		3E-01	2E-05	5E-02	2E-05
AOI 15	INORG	Zinc	7440-66-6	9	9	100%	5.20E+01	1.20E+02	4.3E-01	6.6E+00	P/I	**7.9E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Antimony	7440-36-0	8	8	100%	1.20E+01	3.00E+00	**4.0E+00**	2.5E-01	B/M	**4.8E+01**	Yes	HQ≥1	5.0E+00	**2.4E+00**	7.8E+01	1.5E-01			2.7E-01	**4.4E+01**	Yes	HQ≥1	P, M	5E-01	5E-02			**2E+00**	2E-04
AOI 16	INORG	Arsenic	7440-38-2	30	30	100%	5.60E+00	3.20E+00	**1.8E+00**	2.5E-01	B/M	**2.2E+01**	Yes	HQ≥1	1.8E+01	3.1E-01	6.0E+01	9.3E-02	4.3E+01	1.3E-01	4.6E+01	1.2E-01	No	HQ<1							
AOI 16	INORG	Barium	7440-39-3	8	8	100%	5.70E+02	9.00E+02	6.3E-01	1.7E+01	B/M	**3.3E+01**	No	Below BG									No	Below BG							
AOI 16	INORG	Beryllium	7440-41-7	8	8	100%	5.40E-01	7.20E-01	7.5E-01	2.4E+00	B/M	2.2E-01	No	Below BG									No	Below BG							
AOI 16	INORG	Cadmium	7440-43-9	8	6	75%	2.70E-01	1.70E+00	1.6E-01	2.7E-01	B/M	**1.0E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Chromium (total)	7440-47-3	8	8	100%	5.50E+01	4.10E+01	**1.3E+00**	3.4E-01	P/I	**1.6E+02**	Yes	HQ≥1	1.0E+00	**5.5E+01**	4.0E-01	**1.4E+02**	2.3E+01	**2.4E+00**	6.3E+01	8.7E-01	Yes	HQ≥1	P, I, B			7E-02	1E-05	7E-02	2E-05
AOI 16	INORG	Cobalt	7440-48-4	8	8	100%	1.70E+01	3.70E+01	4.6E-01	1.3E+01	P/I	**1.3E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Copper	7440-50-8	8	8	100%	8.90E+01	3.60E+02	2.5E-01	1.4E+01	B/M	**6.4E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Lead	7439-92-1	14	14	100%	1.00E+02	4.50E+01	**2.2E+00**	3.6E+01	B/M	**2.8E+00**	Yes	HQ≥1	1.2E+02	8.3E-01	1.7E+03	5.9E-02	9.2E+01	**1.1E+00**	5.6E+01	**1.8E+00**	Yes	HQ≥1	B, M	4E-01	3E-02	9E-02	1E-05	3E-01	6E-05
AOI 16	INORG	Mercury	7439-97-6	8	8	100%	3.00E-01	2.00E-01	**1.5E+00**	1.3E-02	B/M	**2.3E+01**	No	BG									No	BG							
AOI 16	INORG	Molybdenum	7439-98-7	8	8	100%	9.30E-01	2.00E+00	4.7E-01	5.2E-01	B/M	**1.8E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Nickel	7440-02-0	8	8	100%	6.30E+01	7.10E+01	8.9E-01	1.0E+01	B/M	**6.3E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Selenium	7782-49-2	8	8	100%	5.90E-01	5.00E-01	**1.2E+00**	3.3E-01	B/M	**1.8E+00**	Yes	HQ≥1	5.2E-01	**1.1E+00**	4.1E+00	1.4E-01	1.2E+00	4.9E-01	6.3E-01	9.4E-01	Yes	HQ≥1	P	5E-01	5E-02	4E-02	2E-05	2E-01	6E-05
AOI 16	INORG	Thallium	7440-28-0	8	5	63%	1.30E-01	1.00E+00	1.3E-01	2.7E-02	B/M	**4.8E+00**	No	Below BG									No	Below BG							
AOI 16	INORG	Vanadium	7440-62-2	8	8	100%	6.90E+01	6.10E+01	**1.1E+00**	7.1E-01	B/M	**9.7E+01**	Yes	HQ≥1	2.0E+00	**3.5E+01**			7.8E+00	**8.8E+00**	2.8E+02	2.5E-01	Yes	HQ≥1	P, B	1E+00		5E-01	3E-05	8E-02	3E-05
AOI 16	INORG	Zinc	7440-66-6	8	8	100%	2.20E+02	1.20E+02	**1.8E+00**	6.6E+00	P/I	**3.3E+01**	Yes	HQ≥1	1.6E+02	**1.4E+00**	1.2E+02	**1.8E+00**	4.6E+01	**4.8E+00**	7.9E+01	**2.8E+00**	Yes	HQ≥1	P, I, B, M	6E-01	2E-01	1E-01	2E-05	1E-01	2E-05
AOI 17	INORG	Antimony	7440-36-0	5	5	100%	5.80E-01	3.00E+00	1.9E-01	2.5E-01	B/M	**2.3E+00**	No	Below BG									No	Below BG							
AOI 17	INORG	Arsenic	7440-38-2	5	5	100%	3.40E+00	3.20E+00	**1.1E+00**	2.5E-01	B/M	**1.4E+01**	Yes	HQ≥1	1.8E+01	1.9E-01	6.0E+01	5.7E-02	4.3E+01	7.9E-02	4.6E+01	7.4E-02	No	HQ<1							
AOI 17	INORG	Barium	7440-39-3	5	5	100%	3.70E+02	9.00E+02	4.1E-01	1.7E+01	B/M	**2.2E+01**	No	Below BG									No	Below BG							
AOI 17	INORG	Beryllium	7440-41-7	5	5	100%	4.40E-01	7.20E-01	6.1E-01	2.4E+00	B/M	1.8E-01	No	Below BG									No	Below BG							
AOI 17	INORG	Cadmium	7440-43-9	5	2	40%	1.80E-01	1.70E+00	1.1E-01	2.7E-01	B/M	6.7E-01	No	Below BG									No	Below BG							
AOI 17	INORG	Chromium (total)	7440-47-3	5	5	100%	2.70E+01	4.10E+01	6.6E-01	3.4E-01	P/I	**7.9E+01**	No	Below BG									No	Below BG							
AOI 17	INORG	Cobalt	7440-48-4	5	5	100%	1.20E+01	3.70E+01	3.2E-01	1.3E+01	P/I	9.2E-01	No	Below BG									No	Below BG							
AOI 17	INORG	Copper	7440-50-8	5	5	100%	6.00E+01	3.60E+02	1.7E-01	1.4E+01	B/M	**4.3E+00**	No	Below BG									No	Below BG							
AOI 17	INORG	Lead	7439-92-1	5	5	100%	3.10E+01	4.50E+01	6.9E-01	3.6E+01	B/M	8.5E-01	No	Below BG									No	Below BG							
AOI 17	INORG	Mercury	7439-97-6	5	5	100%	6.40E-02	2.00E-01	3.2E-01	1.3E-02	B/M	**4.9E+00**	No	Below BG									No	Below BG							
AOI 17	INORG	Molybdenum	7439-98-7	5	5	100%	1.50E+00	2.00E+00	7.5E-01	5.2E-01	B/M	**2.9E+00**	No	Below BG									No	Below BG							
AOI 17	INORG	Nickel	7440-02-0	5	5	100%	2.50E+01	7.10E+01	3.5E-01	1.0E+01	B/M	**2.5E+00**	No	Below BG									No	Below BG							
AOI 17	INORG	Selenium	7782-49-2	5	5	100%	9.00E-01	5.00E-01	**1.8E+00**	3.3E-01	B/M	**2.7E+00**	Yes	HQ≥1	5.2E-01	**1.7E+00**	4.1E+00	2.2E-01	1.2E+00	7.5E-01	6.3E-01	**1.4E+00**	Yes	HQ≥1	P, M	7E-01	7E-02	7E-03	4E-06	3E-02	1E-05
AOI 17	INORG	Vanadium	7440-62-2	5	5	100%	5.20E+01	6.10E+01	8.5E-01	7.1E-01	B/M	**7.3E+01**	No	Below BG									No	Below BG							
AOI 17	INORG	Zinc	7440-66-6	5	5	100%	7.40E+01	1.20E+02	6.2E-01	6.6E+00	P/I	**1.1E+01**	No	Below BG									No	Below BG							
AOI 18	PCB	PCBs (total)	1336-36-3	2	2	100%	7.80E-02			8.8E-01	B/M	8.9E-02	Yes	Bioacc					8.8E-01	8.9E-02	1.0E+01	7.8E-03	Yes	Bioacc				1E-03	3E-09	3E-04	1E-08
AOI 18	INORG	Lead	7439-92-1	14	14	100%	7.80E+02	4.50E+01	**1.7E+01**	3.6E+01	B/M	**2.1E+01**	Yes	HQ≥1	1.2E+02	**6.5E+00**	1.7E+03	4.6E-01	9.2E+01	**8.5E+00**	5.6E+01	**1.4E+01**	Yes	HQ≥1	P, B, M	**3E+00**	2E-01	2E-01	1E-05	6E-01	1E-04
AOI 19	INORG	Lead	7439-92-1	12	12	100%	5.60E+02	4.50E+01	**1.2E+01**	3.6E+01	B/M	**1.5E+01**	Yes	HQ≥1	1.2E+02	**4.7E+00**	1.7E+03	3.3E-01	9.2E+01	**6.1E+00**	5.6E+01	**1.0E+01**	Yes	HQ≥1	P, B, M	**2E+00**	1E-01	1E-01	9E-06	3E-01	7E-05
AOI 20	PCB	PCBs (total)	1336-36-3	2	1	50%	1.30E-01			8.8E-01	B/M	1.5E-01	Yes	Bioacc					8.8E-01	1.5E-01	1.0E+01	1.3E-02	Yes	Bioacc				2E-03	5E-09	5E-04	2E-08
AOI 20	INORG	Lead	7439-92-1	14	14	100%	1.90E+03	4.50E+01	**4.2E+01**	3.6E+01	B/M	**5.2E+01**	Yes	HQ≥1	1.2E+02	**1.6E+01**	1.7E+03	**1.1E+00**	9.2E+01	**2.1E+01**	5.6E+01	**3.4E+01**	Yes	HQ≥1	P, I, B, M	**7E+00**	5E-01	4E-01	2E-05	1E+00	3E-04
AOI 21	PCB	PCBs (total)	1336-36-3	3	3	100%	7.80E-02			8.8E-01	B/M	8.9E-02	Yes	Bioacc					8.8E-01	8.9E-02	1.0E+01	7.8E-03	Yes	Bioacc				2E-03	4E-09	3E-04	1E-08
AOI 21	INORG	Lead	7439-92-1	32	32	100%	8.80E+02	4.50E+01	**2.0E+01**	3.6E+01	B/M	**2.4E+01**	Yes	HQ≥1	1.2E+02	**7.3E+00**	1.7E+03	5.2E-01	9.2E+01	**9.6E+00**	5.6E+01	**1.6E+01**	Yes	HQ≥1	P, B, M	**3E+00**	2E-01	3E-01	2E-05	7E-01	2E-04
AOI 22	INORG	Lead	7439-92-1	3	3	100%	9.20E+01	4.50E+01	**2.0E+00**	3.6E+01	B/M	**2.5E+00**	Yes	HQ≥1	1.2E+02	7.7E-01	1.7E+03	5.4E-02	9.2E+01	**1.0E+00**	5.6E+01	**1.6E+00**	Yes	HQ≥1	B, M	4E-01	2E-02	1E-02	2E-06	3E-02	7E-06
AOI 23	PCB	PCBs (total)	1336-36-3	1	1	100%	2.00E-01			8.8E-01	B/M	2.3E-01	Yes	Bioacc					8.8E-01	2.3E-01	1.0E+01	2.0E-02	Yes	Bioacc				2E-03	5E-09	4E-04	1E-08
AOI 23	INORG	Antimony	7440-36-0	2	2	100%	2.30E+00	3.00E+00	7.7E-01	2.5E-01	B/M	**9.3E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Arsenic	7440-38-2	2	2	100%	4.00E+00	3.20E+00	**1.3E+00**	2.5E-01	B/M	**1.6E+01**	Yes	HQ≥1	1.8E+01	2.2E-01	6.0E+01	6.7E-02	4.3E+01	9.3E-02	4.6E+01	8.7E-02	No	HQ<1							
AOI 23	INORG	Barium	7440-39-3	2	2	100%	3.70E+02	9.00E+02	4.1E-01	1.7E+01	B/M	**2.2E+01**	No	Below BG									No	Below BG							
AOI 23	INORG	Beryllium	7440-41-7	2	2	100%	5.30E-01	7.20E-01	7.4E-01	2.4E+00	B/M	2.2E-01	No	Below BG									No	Below BG							
AOI 23	INORG	Cadmium	7440-43-9	2	2	100%	5.20E-01	1.70E+00	3.1E-01	2.7E-01	B/M	**1.9E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Chromium (total)	7440-47-3	2	2	100%	6.20E+01	4.10E+01	**1.5E+00**	3.4E-01	P/I	**1.8E+02**	Yes	HQ≥1	1.0E+00	**6.2E+01**	4.0E-01	**1.6E+02**	2.3E+01	**2.7E+00**	6.3E+01	9.8E-01	Yes	HQ≥1	P, I, B			2E-02	3E-06	2E-02	4E-06
AOI 23	INORG	Cobalt	7440-48-4	2	2	100%	1.70E+01	3.70E+01	4.6E-01	1.3E+01	P/I	**1.3E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Copper	7440-50-8	2	2	100%	6.00E+01	3.60E+02	1.7E-01	1.4E+01	B/M	**4.3E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Lead	7439-92-1	24	24	100%	1.40E+03	4.50E+01	**3.1E+01**	3.6E+01	B/M	**3.9E+01**	Yes	HQ≥1	1.2E+02	**1.2E+01**	1.7E+03	8.2E-01	9.2E+01	**1.5E+01**	5.6E+01	**2.5E+01**	Yes	HQ≥1	P, B, M	**5E+00**	4E-01	2E-01	1E-05	6E-01	1E-04
AOI 23	INORG	Mercury	7439-97-6	2	2	100%	6.60E-02	2.00E-01	3.3E-01	1.3E-02	B/M	**5.1E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Molybdenum	7439-98-7	2	2	100%	1.20E+00	2.00E+00	6.0E-01	5.2E-01	B/M	**2.3E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Nickel	7440-02-0	2	2	100%	4.00E+01	7.10E+01	5.6E-01	1.0E+01	B/M	**4.0E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Selenium	7782-49-2	2	2	100%	5.90E-01	5.00E-01	**1.2E+00**	3.3E-01	B/M	**1.8E+00**	Yes	HQ≥1	5.2E-01	**1.1E+00**	4.1E+00	1.4E-01	1.2E+00	4.9E-01	6.3E-01	9.4E-01	Yes	HQ≥1	P	5E-01	5E-02	8E-03	5E-06	4E-02	1E-05
AOI 23	INORG	Silver	7440-22-4	2	1	50%	1.50E-01	1.00E+00	1.5E-01	2.0E+00	P/I	7.5E-02	No	Below BG									No	Below BG							
AOI 23	INORG	Thallium	7440-28-0	2	2	100%	1.20E-01	1.00E+00	1.2E-01	2.7E-02	B/M	**4.4E+00**	No	Below BG									No	Below BG							
AOI 23	INORG	Vanadium	7440-62-2	2	2	100%	6.60E+01	6.10E+01	**1.1E+00**	7.1E-01	B/M	**9.2E+01**	Yes	HQ≥1	2.0E+00	**3.3E+01**			7.8E+00	**8.5E+00**	2.8E+02	2.4E-01	Yes	HQ≥1	P, B	1E+00		1E-01	6E-06	2E-02	6E-06
AOI 23	INORG	Zinc	7440-66-6	2	2	100%	1.20E+02	1.20E+02	1.0E+00	6.6E+00	P/I	**1.8E+01**	No	Below BG									No	Below BG							
AOI 24	SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1	1	100%	4.60E+01						Yes	Detect But No SL									Yes	Detect But No SL							
AOI 24	PCB	PCBs (total)	1336-36-3	2	2	100%	1.50E+01			8.8E-01	B/M	**1.7E+01**	Yes	Bioacc					8.8E-01	**1.7E+01**	1.0E+01	**1.5E+00**	Yes	Bioacc	B, M			6E-02	1E-07	1E-02	4E-07
AOI 24	INORG	Antimony	7440-36-0	26	26	100%	3.40E+00	3.00E+00	**1.1E+00**	2.5E-01	B/M	**1.4E+01**	Yes	HQ≥1	5.0E+00	6.8E-01	7.8E+01	4.4E-02			2.7E-01	**1.3E+01**	Yes	HQ≥1	M	1E-01	1E-02			5E-02	4E-06
AOI 24	INORG	Arsenic	7440-38-2	26	26	100%	4.00E+00	3.20E+00	**1.3E+00**	2.5E-01	B/M	**1.6E+01**	Yes	HQ≥1	1.8E+01	2.2E-01	6.0E+01	6.7E-02	4.3E+01	9.3E-02	4.6E+01	8.7E-02	No	HQ<1							
AOI 24	INORG	Barium	7440-39-3	26	26	100%	1.30E+03	9.00E+02	**1.4E+00**	1.7E+01	B/M	**7.6E+01**	Yes	HQ≥1	5.0E+02	**2.6E+00**	3.3E+02	**3.9E+00**	7.2E+02	**1.8E+00**	2.0E+03	6.5E-01	Yes	HQ≥1	P, I, B	**3E+00**	1E+00	2E-02	2E-07	2E-02	4E-06
AOI 24	INORG	Beryllium	7440-41-7	26	25	96%	1.10E+00	7.20E-01	**1.5E+00**	2.4E+00	B/M	4.5E-01	No	HQ<1									No	HQ<1							
AOI 24	INORG	Cadmium	7440-43-9	32	30	94%	8.20E+00	1.70E+00	**4.8E+00**	2.7E-01	B/M	**3.0E+01**	Yes	HQ≥1	3.2E+01	2.6E-01	1.4E+02	5.9E-02	7.7E-01	**1.1E+01**	3.6E-01	**2.3E+01**	Yes	HQ≥1	B, M	1E-01	3E-02	2E-02	3E-07	4E-02	2E-06
AOI 24	INORG	Chromium (total)	7440-47-3	26	26	100%	1.00E+02	4.10E+01	**2.4E+00**	3.4E-01	P/I	**2.9E+02**	Yes	HQ≥1	1.0E+00	**1.0E+02**	4.0E-01	**2.5E+02**	2.3E+01	**4.3E+00**	6.3E+01	**1.6E+00**	Yes	HQ≥1	P, I, B, M			1E-02	1E-06	1E-02	2E-06
AOI 24	INORG	Cobalt	7440-48-4	26	26	100%	1.90E+01	3.70E+01	5.1E-01	1.3E+01	P/I	**1.5E+00**	No	Below BG									No	Below BG							
AOI 24	INORG	Copper	7440-50-8	26	26	100%	2.10E+02	3.60E+02	5.8E-01	1.4E+01	B/M	**1.5E+01**	No	Below BG									No	Below BG							
AOI 24	INORG	Lead	7439-92-1	26	26	100%	3.80E+02	4.50E+01	**8.4E+00**	3.6E+01	B/M	**1.0E+01**	Yes	HQ≥1	1.2E+02	**3.2E+00**	1.7E+03	2.2E-01	9.2E+01	**4.2E+00**	5.6E+01	**6.8E+00**	Yes	HQ≥1	P, B, M	1E+00	1E-01	2E-02	2E-06	6E-02	1E-05
AOI 24	INORG	Mercury	7439-97-6	26	26	100%	1.10E-01	2.00E-01	5.5E-01	1.3E-02	B/M	**8.5E+00**	No	Below BG									No	Below BG							
AOI 24	INORG	Molybdenum	7439-98-7	26	23	88%	1.10E+00	2.00E+00	5.5E-01	5.2E-01	B/M	**2.1E+00**	No	Below BG									No	Below BG							
AOI 24	INORG	Nickel	7440-02-0	26	26	100%	4.30E+01	7.10E+01	6.1E-01	1.0E+01	B/M	**4.3E+00**	No	Below BG									No	Below BG							
AOI 24	INORG	Selenium	7782-49-2	26	25	96%	7.90E-01	5.00E-01	**1.6E+00**	3.3E-01	B/M	**2.4E+00**	Yes	HQ≥1	5.2E-01	**1.5E+00**	4.1E+00	1.9E-01	1.2E+00	6.6E-01	6.3E-01	**1.3E+00**	Yes	HQ≥1	P, M	6E-01	6E-02	4E-03	2E-06	2E-02	5E-06
AOI 24	INORG	Silver	7440-22-4	26	12	46%	3.90E-01	1.00E+00	3.9E-01	2.0E+00	P/I	2.0E-01	No	Below BG									No	Below BG							
AOI 24	INORG	Thallium	7440-28-0	26	8	31%	1.50E-01	1.00E+00	1.5E-01	2.7E-02	B/M	**5.6E+00**	No	Below BG									No	Below BG							

Table 3-10
Soil Ecological Screening and Baseline Summary
GGNRA Hawk Hill, Marin Headlands, CA

										NPS SLERA COPEC Selection					NPS Refined SLERA											Simple-BERA Refinements					
Area	Chem Group	Chemical	CASRN	Analyzed	Detected	Frequency Detected	Max Detected (mg/kg)	Background Threshold Value (BTV) (mg/kg)	Ratio of Max Detect to BTV	Ecological-Based Soil Screening Level (mg/kg)		Upper-Bound HQ	Retain as COPEC?	Basis	Terrestrial Plant ESV (mg/kg)	Terrestrial Plant HQ	Invertebrates ESV (mg/kg)	Invertebrates HQ	Birds ESV (mg/kg)	Birds HQ	Mammals ESV (mg/kg)	Mammals HQ	Retain for BERA?	Basis	Receptors Evaluated in BERA	HQ for Plants	HQ for Invertebrates	HQ for American Robin	HQ for Red-tailed Hawk	HQ for Deer Mouse	HQ for Red Fox
AOI 24	INORG	Vanadium	7440-62-2	26	26	100%	1.10E+02	6.10E+01	**1.8E+00**	7.1E-01	B/M	**1.5E+02**	Yes	HQ≥1	2.0E+00	**5.5E+01**			7.8E+00	**1.4E+01**	2.8E+02	3.9E-01	Yes	HQ≥1	P, B	**2E+00**		6E-02	4E-06	1E-02	4E-06
AOI 24	INORG	Zinc	7440-66-6	32	32	100%	4.80E+03	1.20E+02	**4.0E+01**	6.6E+00	P/I	**7.3E+02**	Yes	HQ≥1	1.6E+02	**3.0E+01**	1.2E+02	**4.0E+01**	4.6E+01	**1.0E+02**	7.9E+01	**6.1E+01**	Yes	HQ≥1	P, I, B, M	**1E+01**	**5E+00**	3E-02	2E-06	4E-02	8E-06
AOI 25	PCB	PCBs (total)	1336-36-3	1	1	100%	1.20E-01			8.8E-01	B/M	1.4E-01	Yes	Bioacc					8.8E-01	1.4E-01	1.0E+01	1.2E-02	Yes	Bioacc				5E-04	1E-09	9E-05	3E-09
AOI 25	INORG	Lead	7439-92-1	7	7	100%	1.70E+02	4.50E+01	**3.8E+00**	3.6E+01	B/M	**4.7E+00**	Yes	HQ≥1	1.2E+02	**1.4E+00**	1.7E+03	1.0E-01	9.2E+01	**1.9E+00**	5.6E+01	**3.0E+00**	Yes	HQ≥1	P, B, M	7E-01	4E-02	1E-02	1E-06	3E-02	7E-06

Notes:
Only chemicals detected in each area are shown.
Background threshold values are from the 2002 Erler & Kalinowski, Inc. *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water* .
These values represent estimates of the upper-end of the range of background concentrations, below which soil concentrations would reasonably be considered naturally occurring.
Mercury is consistent with background and so was not retained as a COPEC.
The upper-bound HQ is the ratio of the maximum detected concentration to the SLERA COPEC Selection SL.
The receptor-specific HQs are the ratio of the maximum detected concentration to the Refined SLERA Ecological-Based Soil SL where the maximum detected concentration is above the BTV and SLERA COPEC Selection Ecological-Based Soil SL.
Ratios of concentration to the screening level greater than 1 are shaded in bold.
A blank cell indicates that a chemical was not evaluated further based on its retention in either the SLERA COPEC Selection or Refined SLERA [with the exceptions of 4,6 dinitro-2-methylphenol for which there is no readily available ESV, and chromium which was not evaluated in the simple BERA due to a lack of threshold values for Chromium (III)].

Chem Group - chemical group
SLERA - Screening-Level Ecological Risk Assessment
COPEC - Chemical of Potential Ecological Concern
Bioacc - Bioaccumulating
BTV - Background Threshold Value
HQ - Hazard Quotient
BG - Background
SL - Screening Level
SF ESL - San Francisco Regional Water Quality Control Board Environmental Screening Level

Basis of Ecological Screening Levels:
B/M - Birds and Mammals
P/I - Plants and Invertebrates

Areas of Interest (AOIs):
AOI 05 - Former Fuel Oil UST
AOI 13 - Former Transformer
AOI 14 - Casemate 1
AOI 15 - East Trail
AOI 16 - Casemate 2
AOI 17 - South Tunnel SE Portal
AOI 18 - Radar Pad 1
AOI 19 - Radar Platform
AOI 20 - Battery Commander Station
AOI 21 - East Retaining Wall
AOI 22 - Radar Pad 2
AOI 23 - NW Retaining Wall
AOI 24 - Drainage Outlet 1
AOI 25 - Radar Pad 3

Table 3-11
Standing Water Ecological Summary (Amphibians)
GGNRA Hawk Hill, Marin Headlands, CA

								NPS SLERA COPEC Selection				NPS Refined SLERA			
Area	**Chem Group**	**Chemical**	**CASRN**	**Meas Basis**	**Analyzed**	**Detected**	**Detected Conc** (mg/L)	**Ecological-Based Surface Water Screening Level for Amphibians** (mg/L)	**Upper-Bound HQ**	**Retain as COPEC?**	**Basis**	**Amphibian Chronic Exposure ESV** (mg/L)	**Chronic Exposure HQ**	**Retain for BERA?**	**Basis**
AOI 14	INORG	Arsenic	7440-38-2	T	1	1	6.40E-04	1.5E-01	4.3E-03	No	HQ<1			No	HQ<1
AOI 14	INORG	Barium	7440-39-3	T	1	1	6.50E-02			Yes	Detect But No SL			Yes	Detect But No SL
AOI 14	INORG	Cobalt	7440-48-4	T	1	1	9.40E-04	2.3E-02	4.1E-02	No	HQ<1			No	HQ<1
AOI 14	INORG	Copper	7440-50-8	T	1	1	1.20E-03	1.6E-03	7.5E-01	No	HQ<1			No	HQ<1
AOI 14	INORG	Lead	7439-92-1	T	1	1	4.20E-03	9.2E-04	**4.6E+00**	Yes	HQ>1	9.2E-04	**4.6E+00**	Yes	HQ>1
AOI 14	INORG	Molybdenum	7439-98-7	T	1	1	5.30E-04	3.7E-01	1.4E-03	No	HQ<1			No	HQ<1
AOI 14	INORG	Nickel	7440-02-0	T	1	1	3.20E-03	2.4E-02	1.3E-01	No	HQ<1			No	HQ<1
AOI 14	INORG	Vanadium	7440-62-2	T	1	1	1.50E-03			Yes	Detect But No SL			Yes	Detect But No SL
AOI 14	INORG	Zinc	7440-66-6	T	1	1	1.10E-02	5.4E-02	2.0E-01	No	HQ<1			No	HQ<1

Notes:
Only chemicals detected in each area are shown.
The upper-bound HQ is the ratio of the maximum detected concentration to the SLERA COPEC Selection SL.
The receptor-specific HQs are the ratio of the maximum detected concentration to the Refined SLERA Ecological-Based Soil SL where the maximum detected concentration is above the SLERA COPEC Selection Ecological-Based Soil SL.
Ratios of concentration to the screening level greater than 1 are shaded in bold.
A blank cell indicates that a chemical was not evaluated further based on its retention in either the SLERA COPEC Selection or Refined SLERA, or a screening level was not available.

Chem Group - chemical group
Meas Basis - measured basis; T = total, D = dissolved
SLERA - Screening-Level Ecological Risk Assessment
COPEC - Chemical of Potential Ecological Concern
BTV - Background Threshold Value
HQ - Hazard Quotient
BG - Background
SL - Screening Level

Areas of Interest (AOIs):
AOI 14 - Casemate 1

Table 3-12
Sediment Ecological Screening Summary (Amphibians)
GGNRA Hawk Hill, Marin Headlands, CA

									NPS Refined SLERA	
Area	**Chem Group**	**Chemical**	**CASRN**	**Analyzed**	**Detected**	**Detected Conc** (mg/kg)	**Background Threshold Value (BTV)** (mg/kg)	**Ratio of Detect Conc to BTV**	**Sub-Lethal Endpoint NOAEC for Amphibians** (mg/kg)	**Amphibian HQ**
AOI 14	PDIST	Diesel Range Organics	DRO	1	1	3.10E+01				
AOI 14	INORG	Antimony	7440-36-0	1	1	3.70E+00	3.0E+00	**1.2E+00**		
AOI 14	INORG	Arsenic	7440-38-2	1	1	4.00E+00	3.2E+00	**1.3E+00**		
AOI 14	INORG	Barium	7440-39-3	1	1	3.40E+02	9.0E+02	3.8E-01		
AOI 14	INORG	Cadmium	7440-43-9	1	1	6.80E-01	1.7E+00	4.0E-01		
AOI 14	INORG	Chromium (total)	7440-47-3	1	1	3.30E+01	4.1E+01	8.0E-01		
AOI 14	INORG	Cobalt	7440-48-4	1	1	1.50E+01	3.7E+01	4.1E-01		
AOI 14	INORG	Copper	7440-50-8	1	1	8.20E+01	3.6E+02	2.3E-01		
AOI 14	INORG	Lead	7439-92-1	1	1	1.70E+02	4.5E+01	**3.8E+00**	1.0E+02	**1.7E+00**
AOI 14	INORG	Mercury	7439-97-6	1	1	1.10E-01	2.0E-01	5.5E-01		
AOI 14	INORG	Molybdenum	7439-98-7	1	1	1.70E+00	2.0E+00	8.5E-01		
AOI 14	INORG	Nickel	7440-02-0	1	1	3.50E+01	7.1E+01	4.9E-01		
AOI 14	INORG	Vanadium	7440-62-2	1	1	6.30E+01	6.1E+01	1.0E+00		
AOI 14	INORG	Zinc	7440-66-6	1	1	2.90E+02	1.2E+02	**2.4E+00**		

Notes:
Only chemicals detected in each area are shown.
Background threshold values are from the 2002 Erler & Kalinowski, Inc. *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water* .
These values represent estimates of the upper-end of the range of background concentrations, below which soil concentrations would reasonably be considered naturally occurring.
The receptor-specific HQ is the ratio of the maximum detected concentration to the Refined SLERA Ecological-Based Soil SL where the maximum detected concentration is above the BTV.
The screening levels for Chromium (total) are the screening levels provided by the agency for Chromium VI, unless otherwise noted.
Ratios of concentration to the screening levels greater than 1 are shaded in bold.

Chem Group - chemical group
Carc Class - USEPA Weight-of-Evidence Cancer Classification
SLERA - Screening-Level Ecological Risk Assessment
BTV - Background Threshold Value
HQ - Hazard Quotient
BG - Background
SL - Screening Level

Areas of Interest (AOIs):
AOI 14 - Casemate 1

Table 3-13
Soil Samples Exceeding Terrestrial Plant and Soil Invertebrate Threshold Values
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Sample Name	Top Depth (ft)	Bottom Depth (ft)	Chem Group	Chemical	Conc (mg/kg)	Background (mg/kg)	Ratio of Conc to Background	Plants Threshold Value (mg/kg)	Ratio of Conc to Plants Threshold Value	Invertebrates Threshold Value (mg/kg)	Ratio of Conc to Invertebrates Threshold Value
AOI 18	SS-5-2	SS-5-2-03	0.3	0.3	INORG	Lead	5.90E+02	4.50E+01	**1.3E+01**	2.62E+02	**2E+00**	3.78E+03	2E-01
AOI 18	SS-5-2	SS-5-2-12	1.0	1.0	INORG	Lead	5.80E+02	4.50E+01	**1.3E+01**	2.62E+02	**2E+00**	3.78E+03	2E-01
AOI 18	SS-5-3	SS-5-3-03	0.3	0.3	INORG	Lead	7.80E+02	4.50E+01	**1.7E+01**	2.62E+02	**3E+00**	3.78E+03	2E-01
AOI 19	SS-19-1	SS-19-1-03	0.3	0.3	INORG	Lead	4.90E+02	4.50E+01	**1.1E+01**	2.62E+02	**2E+00**	3.78E+03	1E-01
AOI 19	SS-19-6	SS-19-6-03	0.3	0.3	INORG	Lead	5.60E+02	4.50E+01	**1.2E+01**	2.62E+02	**2E+00**	3.78E+03	1E-01
AOI 20	ID-U	ID-U	0.0	0.0	INORG	Lead	1.90E+03	4.50E+01	**4.2E+01**	2.62E+02	**7E+00**	3.78E+03	5E-01
AOI 20	SS-20-1	SS-20-1-03	0.3	0.3	INORG	Lead	4.90E+02	4.50E+01	**1.1E+01**	2.62E+02	**2E+00**	3.78E+03	1E-01
AOI 21	SS-4-5	SS-4-5-03	0.3	0.3	INORG	Lead	8.80E+02	4.50E+01	**2.0E+01**	2.62E+02	**3E+00**	3.78E+03	2E-01
AOI 23	SS-8-1	SS-8-1-03	0.3	0.3	INORG	Lead	1.30E+03	4.50E+01	**2.9E+01**	2.62E+02	**5E+00**	3.78E+03	3E-01
AOI 23	SS-8-2	SS-8-2-03	0.3	0.3	INORG	Lead	1.10E+03	4.50E+01	**2.4E+01**	2.62E+02	**4E+00**	3.78E+03	3E-01
AOI 23	SS-8-5	SS-8-5-03	0.3	0.3	INORG	Lead	7.00E+02	4.50E+01	**1.6E+01**	2.62E+02	**3E+00**	3.78E+03	2E-01
AOI 23	SS-8-6	SS-8-6-12	1.0	1.0	INORG	Lead	1.40E+03	4.50E+01	**3.1E+01**	2.62E+02	**5E+00**	3.78E+03	4E-01
AOI 24	DO-1	DO-1-3	0.3	0.3	INORG	Zinc	1.00E+03	1.20E+02	**8.3E+00**	3.60E+02	**3E+00**	1.06E+03	9E-01
AOI 24	DO-1	DO-1-8	0.7	0.7	INORG	Zinc	1.00E+03	1.20E+02	**8.3E+00**	3.60E+02	**3E+00**	1.06E+03	9E-01
AOI 24	SS-2-1	SS-2-1-03	0.3	0.3	INORG	Zinc	4.80E+03	1.20E+02	**4.0E+01**	3.60E+02	**1E+01**	1.06E+03	**5E+00**
AOI 24	SS-2-1	SS-2-1-08	0.7	0.7	INORG	Zinc	4.30E+03	1.20E+02	**3.6E+01**	3.60E+02	**1E+01**	1.06E+03	**4E+00**
AOI 24	SS-2-1	SS-2-1-14	1.2	1.2	INORG	Zinc	2.90E+03	1.20E+02	**2.4E+01**	3.60E+02	**8E+00**	1.06E+03	**3E+00**
AOI 24	SS-2-1	SS-2-1-20	1.7	1.7	INORG	Zinc	1.40E+03	1.20E+02	**1.2E+01**	3.60E+02	**4E+00**	1.06E+03	1E+00
AOI 24	SS-2-2	SS-2-2-20	1.7	1.7	INORG	Vanadium	1.10E+02	6.10E+01	**1.8E+00**	6.93E+01	**2E+00**		
AOI 24	SS-2-3	SS-2-3-14	1.2	1.2	INORG	Barium	1.30E+03	9.00E+02	**1.4E+00**	5.00E+02	**3E+00**	1.03E+03	1E+00
AOI 24	SS-2-4	SS-2-4-14	1.2	1.2	INORG	Barium	1.20E+03	9.00E+02	**1.3E+00**	5.00E+02	**2E+00**	1.03E+03	1E+00

Notes:
Only chemicals exceeding the plants or invertebrates threshold values are shown.
Background threshold values are from the 2002 Erler & Kalinowski, Inc. *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water* .
These values represent estimates of the upper-end of the range of background concentrations, below which soil concentrations would reasonably be considered naturally occurring.
Ratios of concentration to the screening level greater than 1 are shaded in bold.

Table 3-14
Human Health and Ecological Preliminary Risk-Based Removal Goals (PRGs)
GGNRA Hawk Hill, Marin Headlands, CA

			Background	Risk-Based Concentrations for Human Receptors				Risk-Based Concentrations for Ecological Receptors			CalEPA DTSC	Overall
Chem Group	**Chemical**	**CASRN**	**Background Threshold Value** (mg/kg)	**Park Resident** (mg/kg)	**Park Worker** (mg/kg)	**Maintenance Worker** (mg/kg)	**Human Health-Based Preliminary Removal Goal** (mg/kg)	**Terrestrial Plants** (mg/kg)	**Terrestrial Invertebrates** (mg/kg)	**Ecological-Based Preliminary Removal Goal** (mg/kg)	**CalEPA DTSC Arsenic Cleanup Goal** (mg/kg)	**Overall Proposed Preliminary Removal Goal** (mg/kg)
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	--	1.6E+01	--	--	1.6E+01	--	--	--	--	1.6E+01
PCB	PCBs (total)	1336-36-3	--	2.3E-01	1.3E+00	7.0E+00	2.3E-01	--	--	--	--	2.3E-01
INORG	Arsenic	7440-38-2	3.2E+00	1.1E-01	8.1E-01	3.1E+00	1.1E-01	--	--	--	4.7E+00	4.7E+00
INORG	Lead	7439-92-1	4.5E+01	8.0E+01	3.2E+02	3.2E+02	8.0E+01	2.6E+02	--	2.6E+02	--	8.0E+01
INORG	Zinc	7440-66-6	1.2E+02	--	--	--	--	3.6E+02	1.1E+03	3.6E+02	--	3.6E+02

Notes:
Background threshold values are from the 2002 Erler & Kalinowski, Inc. *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water*.
These values represent estimates of the upper-end of the range of background concentrations, below which soil concentrations would reasonably be considered naturally occurring
The overall preliminary removal goal (PRG) is equal to the lower of the human health or ecological risk-based concentrations, unless lower than the background threshold value (BTV). BTVs were used as the PRG in such cases.
-- No value calculated because the chemical was not determined to be a COC or CEC in the Human Health or Ecological Risk Assessments, respecitvely
With the exception of lead and arsenic, risk-based concentrations for human receptors are based upon the use of high-end exposure factors, a target cancer risk of $1C^{-6}$, and a target noncancer hazard quotient of 1.
The CalEPA DTSC Arsenic Cleanup Goal was calculated using methodologies presented in CalEPA DTSC's 2009 *Arsenic Strategies Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals*.
For lead, risk-based concentrations for park resident are equal to CalEPA DTSC's residential screening levels
For lead, risk-based concentrations for park worker and maintenance worker are equal to CalEPA DTSC's commercial/industrial screening levels
Risk-based concentrations for terrestrial plants and invertegbrates are equal to the geological mean of the NOAEC and LOAEC-based ecological soil screening levels from the LANL (2017) EcoRisk Database Release 4.1.

Table 6-1
Minimum Excavation and Confirmation Sample Quantities (Alternative 2)
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Location Description	Area (ft^2)	Depth (ft)	Volume (ft^3)	Volume (yd^3)	Excavation Perimeter (ft)	Chemicals Exceeding Remedial Goal	No. of Confirmation Samples
AOI 16	SS-18-2	Soil fill in Casemate 2 gunpit.	20	0.5	10	0.4	18	Arsenic	5
AOI 18	SS-5-2	Soil east of Radar Pad 1/painted curb, railing, and retaining wall.	104	1.5	156	6	62	Lead	5
	SS-5-3	Soil east of Radar Pad 1/painted curb, railing, and retaining wall.	90	1.0	90	3	51	Lead	
AOI 19	SS-19-1	Soil along the dripline of the elevated radar platform.	185	1.0	185	7	65	Lead	7
	SS-19-6	Soil along the dripline of the elevated radar platform.	232	1.0	232	9	78	Lead	
AOI 20	ID-U	Soil from internal drain in the upper room of the BCS.	302	0.0	0	0	72	Lead	5
	SS-20-1	Soil along the dripline of the painted concrete box at the southeast corner of the BCS.	198	1.0	198	7	56	Lead	
AOI 21	SS-4-4	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	197	1.5	295	11	69	Lead	9
	SS-4-5	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	157	1.5	236	9	58	Lead	
	SS-4-6	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	187	1.0	187	7	63	Lead	
AOI 23	SS-8-1	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	68	1.0	68	3	44	Lead	13
	SS-8-2	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	85	1.0	85	3	56	Lead	
	SS-8-5	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	83	1.5	125	5	59	Lead	
	SS-8-6	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	144	1.5	217	8	60	Lead	
	SS-8A-4	Step out samples of soil west of primary Hawk Hill retaining wall and railing (north of BCS).	166	1.5	249	9	64	Lead	
AOI 24	DO-1	Soil in drainage outlet northeast of BCS.	27	2.0	54	2	24	Lead, PCBs (total), Zinc	5
	SS-2-1	Stepout samples from drainage outlet, DO-1.	16	2.0	31	1	16	Lead, PCBs (total), Zinc, DNOC	
	SS-2-2	Stepout samples from drainage outlet, DO-1.	56	2.0	113	4	31	Lead, Zinc	
	SS-2-7	Stepout samples from drainage outlet, DO-1.	120	2.0	239	9	44	Lead	
		Minimum Total Quantities:	2436			103			49

Abbreviations:
BCS - Battery Commander Station
DO - drain outlet
DNOC - 4,6-Dinitro-2-methylphenol

Table 6-2
Minimum Excavation and Confirmation Sample Quantities (Alternative 3)
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Location Description	Area (ft^2)	Depth (ft)	Volume (ft^3)	Volume (yd^3)	Excavation Perimeter (ft)	Chemicals Exceeding Remedial Goal	No. of Confirmation Samples
AOI 14	SS-15-1	Soil around the dripline of the Casemate 1 roof and walls.	167	1.0	167	6	52	Lead	5
AOI 16	SS-16-1	Soil around the dripline of the Casemate 2 roof and walls.	321	1.0	321	12	73	Lead	10
	SS-16A-1	Step out samples of soil along from Casemate 2 walls.	621	1.0	621	23	105	Lead	
	SS-18-2	Soil fill in Casemate 2 gunpit.	20	0.5	10	0.4	18	Arsenic	
AOI 18	SS-21-1	Soil along the dripline of the painted concrete box at the northwest edge of Radar Pad 1.	417	1.0	417	15	107	Lead	24
	SS-5-1	Soil east of Radar Pad 1/painted curb, railing, and retaining wall.	154	1.0	154	6	80	Lead	
	SS-5-2	Soil east of Radar Pad 1/painted curb, railing, and retaining wall.	106	1.5	158	6	62	Lead	
	SS-5-3	Soil east of Radar Pad 1/painted curb, railing, and retaining wall.	82	1.0	82	3	51	Lead	
	SS-5A-1	Step out samples of soil east of Radar Pad 1/painted curb, railing, and retaining wall.	280	1.0	280	10	91	Lead	
	SS-5A-2	Step out samples of soil east of Radar Pad 1/painted curb, railing, and retaining wall.	226	1.0	226	8	81	Lead	
	SS-5A-3	Step out samples of soil east of Radar Pad 1/painted curb, railing, and retaining wall.	164	1.0	164	6	58	Lead	
AOI 19	SS-19-1	Soil along the dripline of the elevated radar platform.	183	1.0	183	7	65	Lead	10
	SS-19-4	Soil along the dripline of the elevated radar platform.	197	1.0	197	7	61	Lead	
	SS-19-6	Soil along the dripline of the elevated radar platform.	233	1.0	233	9	77	Lead	
AOI 20	ID-U	Soil from internal drain in the upper room of the BCS.	2	40.0	71	3	72	Lead	5
	SS-20-1	Soil along the dripline of the painted concrete box at the southeast corner of the BCS.	196	1.0	196	7	57	Lead	
AOI 21	SS-4-1	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	129	1.5	193	7	54	Lead	26
	SS-4-3	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	185	1.5	278	10	66	Lead	
	SS-4-4	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	197	1.5	295	11	69	Lead	
	SS-4-5	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	157	1.5	236	9	58	Lead	
	SS-4-6	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	187	1.0	187	7	63	Lead	
	SS-4-7	Soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	196	1.5	295	11	63	Lead	
	SS-4A-1	Step out samples of soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	183	1.0	183	7	60	Lead	
	SS-4A-3	Step out samples of soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	268	1.0	268	10	80	Lead	
	SS-4A-6	Step out samples of soil east of Radar Pads 2 and 3/painted curb, railing, and retaining wall.	198	1.0	198	7	64	Lead	
AOI 22	SS-7-2	Soil west of Radar Pad 2/painted curb, railing, and retaining wall.	240	1.0	240	9	64	Lead	5
AOI 23	SS-8-1	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	68	1.0	68	3	44	Lead	23
	SS-8-2	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	85	1.0	85	3	56	Lead	
	SS-8-3	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	75	1.5	112	4	55	Lead	
	SS-8-4	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	98	1.5	147	5	58	Lead	
	SS-8-5	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	83	1.5	125	5	59	Lead	
	SS-8-6	Soil west of primary Hawk Hill retaining wall and railing (north of BCS).	114	1.5	172	6	53	Lead	
	SS-8A-4	Step out samples of soil west of primary Hawk Hill retaining wall and railing (north of BCS).	166	1.5	249	9	64	Lead	
	SS-8A-5	Step out samples of soil west of primary Hawk Hill retaining wall and railing (north of BCS).	203	1.0	203	8	69	Lead	
	SS-8A-6	Step out samples of soil west of primary Hawk Hill retaining wall and railing (north of BCS).	205	1.0	205	8	70	Lead	
AOI 24	DO-1	Soil in drainage outlet northeast of BCS.	27	2.0	54	2	24	Lead, PCBs (total), Zinc	7
	SS-2-1	Stepout samples from drainage outlet, DO-1.	16	2.0	31	1	16	Lead, PCBs (total), Zinc, DNOC	
	SS-2-2	Stepout samples from drainage outlet, DO-1.	56	2.0	113	4	31	Lead, Zinc	
	SS-2-7	Stepout samples from drainage outlet, DO-1.	120	2.0	239	9	44	Lead	
	SS-2-8	Stepout samples from drainage outlet, DO-1.	81	2.0	163	6	42	Lead	
AOI 25	SS-3-1	Soil west of Radar Pad 3/painted retaining wall.	77	1.0	77	3	46	Lead	5
	SS-3-2	Soil west of Radar Pad 3/painted retaining wall.	83	1.0	83	3	46	Lead	
		Minimum Total Quantities:	6868			296			120

Abbreviations:
BCS - Battery Commander Station
DO - drain outlet
DNOC - 4,6-Dinitro-2-methylphenol

APPENDIX A
HUMAN HEALTH RISK ASSESSSMENT SUPPORTING INFORMATION

- Attachment 1 - Site-Specific Arsenic Assessment for Hawk Hill, Marin Headlands, California
- Table 1 – Toxicity Values
- Table 2 – Physical and Chemical Properties
- Table 3a – Dispersion Factor to Outdoor Air for Park Worker
- Table 3b – Soil PM10 Emission from Wind Erosion for Park Worker
- Table 3c – Vapor Flux from Soil to Outdoor Air for Park Worker
- Table 3d – Unit Cancer Risk Calculations for Exposure of Park Worker to Soil
- Table 3e – Unit Hazard Quotient Calculations for Exposure of Park Worker to Soil
- Table 4a – Dispersion Factor to Outdoor Air for Maintenance Worker
- Table 4b – Vapor Flux from Soil to Outdoor Air for Maintenance Worker
- Table 4c – Unit Cancer Risk Calculations for Exposure of Maintenance Worker to Soil
- Table 4d – Unit Hazard Quotient Calculations for Exposure of Maintenance Worker to Soil
- Table 5a – Dispersion Factor to Outdoor Air for Construction Worker
- Table 5b – Vapor Flux from Soil to Outdoor Air for Construction Worker
- Table 5c – Unit Cancer Risk Calculations for Exposure of Construction Worker to Soil
- Table 5d – Unit Hazard Quotient Calculations for Exposure of Construction Worker to Soil
- Table 6a – Dispersion Factor to Outdoor Air for Resident
- Table 6b – Soil PM10 Emission from Wind Erosion for Resident
- Table 6c – Vapor Flux from Soil to Outdoor Air for Resident
- Table 6d – Unit Cancer Risk Calculations for Exposure of Resident to Soil
- Table 6e – Unit Hazard Quotient Calculations for Exposure of Residents to Soil
- Table 7 – Upper-Bound Total Soil Cumulative Cancer Risks and Noncancer HIs
- Table 8 – Total Soil Single-Chemical Cancer Risk and Noncancer HQ
- Table 9 – Upper-Bound Total Sediment Cumulative Cancer Risks and Noncancer His
- Table 10 – Total Sediment Single-Chemical Cancer Risk and Noncancer HQ

Site-Specific Arsenic Assessment for Hawk Hill, Marin Headlands, California

Introduction

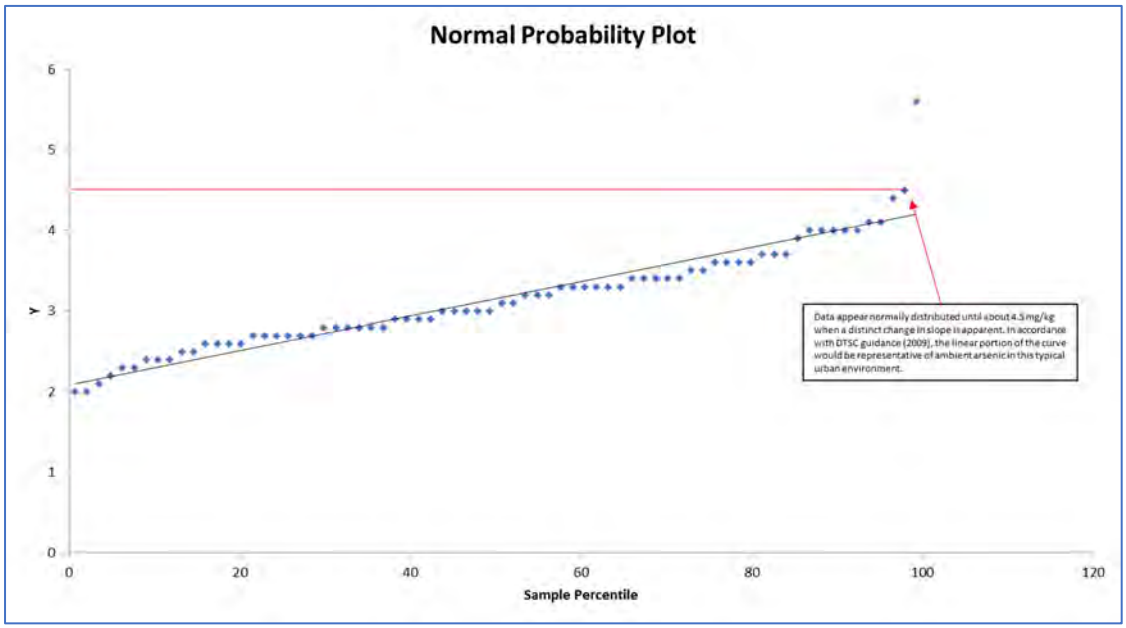
Arsenic soil sampling results were reviewed with consideration for the methodologies presented in CalEPA DTSC's January 2009 Arsenic Strategies Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals. This review suggests that a site cleanup goal of 4.7 mg/kg could be proposed for the Site. The following is a brief overview of the analysis performed and the associated results which support this proposed cleanup goal for arsenic. This included performing both a simple graphical determination as well as a statistical determination. The graphical determination resulted in an estimated cleanup goal for arsenic of 4.5 mg/kg. The statistical determination resulted in an estimated cleanup goal for arsenic of 4.7 mg/kg. Since both methodologies are supported by this guidance, the higher of these two results, 4.7 mg/kg, is recommended as the cleanup goal for arsenic.

Simple Graphical Determination

1. Calculated basic statistics for the arsenic data.

Statistic	Value	Units
Number of Samples	72	--
Min Conc	2	mg/kg
Max Conc	5.6	mg/kg
Mean Conc	3.2	mg/kg
Median Conc	3.1	mg/kg
Standard Deviation	0.6	--

2. Produced a normality plot of the raw arsenic data.



3. In accordance with the DTSC guidance, 4.5 mg/kg would represent the upper-bound of ambient arsenic in soil at the Site and could serve as the clean-up goal.

Statistical Determination

1. Identified statistically significant outliers in the data set. Overall, out of the 72 results, 1 was a statistically significant outlier, 5.6 mg/kg.

2. After removing the outlier, the data set was tested to determine if the underlying distribution (without outliers) was normally distributed. The results confirmed that the distribution was normally distributed.

3. Calculated the 95% upper confidence limit (UCL) on the 99th percentile for this data set = 4.7 mg/kg. In accordance with the DTSC guidance, 4.7 mg/kg would represent the upper-bound of the ambient arsenic in soil at the Site and could serve as the clean-up goal.

Appendix A
Table 1
Toxicity Values
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	Cancer Classification			ADAF			SF_{oral} $(mg/kg/d)^{-1}$			SF_{dermal} $(mg/kg/d)^{-1}$			URF $(mg/m^3)^{-1}$			RfD_{oral} (mg/kg/d)				RfD_{dermal} (mg/kg/d)				RfC (mg/m^3)			
			Group	Ref	Note	Y/N	f_{oral}	f_{inh}	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	UF	Ref	Notes	Value	UF	Ref	Notes	Value	UF	Ref	Notes
VOC	Benzene	71-43-2	A	1		N			1.0E-01	147		1.0E-01	125	104	2.9E-02	147		4.0E-03		147		4.0E-03		125	104	3.0E-03		147	
VOC	Ethyl Benzene	100-41-4	D	1		N												5.0E-02	1,000	126	116	5.0E-02	1,000	125	104	1.0E+00		147	
VOC	Toluene	108-88-3	ID	1		N												8.0E-02		147		8.0E-02		125	104	3.0E-01		147	
VOC	Xylenes (total)	1330-20-7	ID	1		N												2.0E-01		147		2.0E-01		125	104	1.0E-01		147	
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	126		N												8.0E-05		147		8.0E-05		125	104			126	90
PDIST	Diesel Range Organics	DRO				N												1.9E-02		999		1.9E-02		125	104	2.6E-01		999	
PCB	PCBs (total)	1336-36-3	B2	1		N			2.0E+00	147		2.0E+00	125	104	5.7E-01	147		2.0E-05		147	72	2.0E-05		125	104				
INORG	Antimony	7440-36-0	ID	126		N												4.0E-04		147		6.0E-05		125	104			126	90
INORG	Arsenic	7440-38-2	A	1		N			9.5E+00	147		9.5E+00	125	104	4.3E+00	147		3.5E-06		147		3.5E-06		125	104	1.5E-05		147	
INORG	Barium	7440-39-3	NC	1		N												2.0E-01		147		1.4E-02		125	104	5.0E-04		147	
INORG	Beryllium	7440-41-7	B1	1		N									2.4E+00	147		2.0E-04		147		1.4E-06		125	104	7.0E-06		147	
INORG	Cadmium	7440-43-9	B1	1		N									4.2E+00	147		1.0E-03	10	1	95	2.5E-05	10	125	104	1.0E-05		147	
INORG	Chromium (total)	7440-47-3				N												1.5E+00		147	8	2.0E-02		125	104	5.0E-03	90	129	8, 111, 166, 116
INORG	Cobalt	7440-48-4	LC	126		N									9.0E+00	147		3.0E-04		147		3.0E-04		125	104	6.0E-06		147	
INORG	Copper	7440-50-8	D	1		N												1.0E-02	3	129	111, 116	1.0E-02	3	125	104				
INORG	Lead	7439-92-1	B2	1		N																							
INORG	Mercury	7439-97-6	D	1		N												1.6E-04		147	51	1.1E-05		125	104	3.0E-05		147	
INORG	Molybdenum	7439-98-7				N												5.0E-03		147		5.0E-03		125	104				
INORG	Nickel	7440-02-0	A	1		N									2.6E-01	147		1.1E-02		147		4.4E-04		125	104	1.4E-05		147	
INORG	Selenium	7782-49-2	D	1		N												5.0E-03		147		5.0E-03		125	104	2.0E-02		147	
INORG	Silver	7440-22-4	D	1		N												5.0E-03		147		2.0E-04		125	104	1.0E-05	1,000	83	
INORG	Thallium	7440-28-0	ID	126		N												1.0E-05		147		1.0E-05		125	104			126	90
INORG	Vanadium	7440-62-2	ID	1		N												5.0E-03		147		1.3E-04		125	104	1.0E-04		147	
INORG	Zinc	7440-66-6	ID	1		N												3.0E-01		147		3.0E-01		125	104				

References:

1 USEPA. Integrated Risk Information System (IRIS). On-line database.
83 USEPA. NCEA. 1994. Risk Assessment Issue Paper for: Derivation of a Provisional RfC for Silver [CASRN 7440-22-4]. June 30.
125 USEPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. July.
126 Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV) Database.
129 ATSDR. 2018. Minimal Risk Levels. June.
141 NJDEP. 2009. Derivation of Ingestion-Based Soil Remediation Criteria for Cr+6 Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate. April.
147 CALEPA. DTSC. 2019. Human Health Risk Assessment Note 10 - Toxicity Criteria. February 25.
999 SFRWQCB. 2019. Environmental Screeening Levels.

Notes:

8 Used Chromium III [CASRN 16065-83-1] value from the indicated reference as a surrogate.
51 Terraphase used Mercuric Chloride [CASRN 7487-94-7] value from the indicated reference as a surrogate.
72 Terraphase used Aroclor 1254 [CASRN 11097-69-1] value from the indicated reference as a surrogate for PCBs [CASRN 1336-36-3].
90 Inadequate data exist to derive a toxicity value, according to the indicated reference.
95 This RfD is used to evaluate dietary exposures. A RfD of 0.0005 mg/kg/day is used to evaluate water ingestion exposures.
104 Dermal toxicity value is extrapolated from oral toxicity value in accordance with the referenced USEPA guidance.
111 Value as published is an MRL in the indicated reference.
116 Terraphase used subchronic value as a surrogate for the chronic value.
179 Terraphase used C9 through C10 Aromatic Hydrocarbons [CASRN C09-C10-AROM] value from the indicated reference as a surrogate.
180 Terraphase used C11 through C22 Aromatic Hydrocarbons [CASRN C11-C22-AROM] value from the indicated reference as a surrogate.
182 The only toxicity value available is from a PPRTV appendix. While EPA advises that such values should not be used as a primary basis for site cleanup decisions, this value may be used as applied to extractable petroleum hydrocarbon fractions.

Appendix A
Table 2
Physical and Chemical Properties
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	MW (g/mole)			K_{ow} (unitless)			K_{oc} (L/kg)			K_d (L/kg)			H (unitless)				s (mg/L)			VP (mm Hg)				D_{air} (m^2/d)			D_{water} (m^2/d)			K_p (cm/hr)			ABS_d (unitless)			FA (unitless)			DH_{vb} (cal/mol)			T_c (Kelvin)			T_B (Kelvin)			HENRY Ref Temp (°C)	VP Ref Temp (°C)
			Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Adjust	Ref	Notes	Value	Ref	Notes	Value	Adjust	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Value
VOC	Benzene	71-43-2	7.8E+01	50.3		1.3E+02	44		5.8E+01	44	111				2.3E-01	2.2E-01	44		1.8E+03	44		9.5E+01	1.2E+02	50.3		7.6E-01	44		8.5E-05	44		1.5E-02	44	115		62		1.0E+00	62		7.34E+03	44	118	5.62E+02	44	118	3.53E+02	44	118	2.5E+01	
VOC	Ethyl Benzene	100-41-4	1.1E+02	50.3		1.4E+03	44		3.7E+02	44	111				3.2E-01	3.1E-01	44		1.7E+02	44		9.6E+00	1.2E+01	50.3		6.5E-01	44		6.7E-05	44		4.8E-02	44	115		62		1.0E+00	62		8.50E+03	44	118	6.17E+02	44	118	4.09E+02	44	118	2.5E+01	
VOC	Toluene	108-88-3	9.2E+01	50.3		5.6E+02	44		1.8E+02	44	111				2.7E-01	2.6E-01	44		5.3E+02	44		2.8E+01	3.4E+01	50.3		7.5E-01	44		7.4E-05	44		3.2E-02	44	115		62		1.0E+00	62		7.93E+03	44	118	5.92E+02	44	118	3.84E+02	44	118	2.5E+01	
VOC	Xylenes (total)	1330-20-7	1.1E+02	50.3		1.5E+03	44		3.9E+02	44	111				2.8E-01	3.3E-01	44		1.7E+02	44		7.9E+00	9.6E+00	50.3		6.7E-01	44		7.6E-05	44		5.0E-02	44	115		62		1.0E+00	62	114							4.14E+02	44	118	2.5E+01	
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	2.0E+02	50.1		1.3E+02	69		3.2E+02	69	82				1.7E-05	2.6E-05	50.1	92, 123	2.0E+02	50.1	92	3.2E-04	4.9E-04	50.1	92	2.4E-01	69		6.0E-05	69		3.1E-03	69	115	1.0E-01	62		1.0E+00	62											2.0E+01	
PDIST	Diesel Range Organics	DRO	2.0E+02	999					1.5E+03	999					7.3E+01	7.3E+01	999		5.0E+00	999		5.0E-01	5.0E-01	999		5.2E-01	999		7.3E-05	999		6.9E-02	999			62		1.0E+00	999											
PCB	PCBs (total)	1336-36-3	3.3E+02	64	116	3.2E+06	64	116	2.5E+06	64	116, 82				8.2E-02	1.2E-01	64	116	1.2E-02	64	116	7.7E-05	1.2E-04	64	116	1.7E-01	69	116	4.3E-05	69	116	4.5E-01	64	116, 115	1.4E-01	62		7.0E-01	62	117, 110										2.5E+01	2.5E+01
INORG	Antimony	7440-36-0	1.2E+02	50.3								4.5E+01	44														40	48		40	48	1.0E-03	62			62															
INORG	Arsenic	7440-38-2	7.5E+01	50.3								2.9E+01	44	43													40	48		40	48	1.0E-03	62		3.0E-02	62															
INORG	Barium	7440-39-3	1.4E+02	50.3								4.1E+01	44	43													40	48		40	48	1.0E-03	62			62															
INORG	Beryllium	7440-41-7	9.0E+00	50.3								7.9E+02	44	43						1	61						40	48		40	48	1.0E-03	62			62															
INORG	Cadmium	7440-43-9	1.1E+02	50.3								7.5E+01	44	43						1	61						40	48		40	48	1.0E-03	62		1.0E-03	62															
INORG	Chromium (total)	7440-47-3	5.2E+01	50.3								1.8E+06	44	43, 45						1	61											1.0E-03	62	45		62															
INORG	Cobalt	7440-48-4	5.9E+01	50.3								4.5E+01	35							1	61											4.0E-04	62			62															
INORG	Copper	7440-50-8	6.4E+01	50.3								3.5E+01	35							1	61						40	48		40	48	1.0E-03	62			62															
INORG	Lead	7439-92-1	2.1E+02	50.3								9.0E+02	35							1	61						40	48		40	48	1.0E-04	62			62															
INORG	Mercury	7439-97-6	2.0E+02	67			1	48				1.0E+03	67		2.9E-01	4.1E-01	67	123	5.6E-02	1		2.0E-03	3.0E-03	50.3		2.7E-01	44		5.4E-05	44		1.0E-03	62			62					1.41E+04	44	118	1.75E+03	44	118	6.30E+02	44	118	2.0E+01	
INORG	Molybdenum	7439-98-7	9.6E+01	50.1								2.0E+01	35														40	48		40	48	1.0E-03	62			62															
INORG	Nickel	7440-02-0	5.9E+01	50.3								6.5E+01	44	43						1	61						40	48		40	48	2.0E-04	62			62															
INORG	Selenium	7782-49-2	7.9E+01	50.3								5.0E+00	44	43						40	48						40	48		40	48	1.0E-03	62			62															
INORG	Silver	7440-22-4	1.1E+02	50.3								8.3E+00	44	43						1	61						40	48		40	48	6.0E-04	62			62															
INORG	Thallium	7440-28-0	2.0E+02	50.3								7.1E+01	44	43						1	61						40	48		40	48	1.0E-03	62			62															
INORG	Vanadium	7440-62-2	5.1E+01	50.3								1.0E+03	44							1	61						40	48		40	48	1.0E-03	62			62															
INORG	Zinc	7440-66-6	6.5E+01	50.3								6.2E+01	44	43						1	61						40	48		40	48	6.0E-04	62			62															

References:

1 USEPA. 1992. Handbook of RCRA Ground-Water Monitoring Constituents. Chemical and Physical Properties (40 CFR Part 264, Appendix IX). EPA-530-R-92-022. September.
35 Baes III, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Released Radionuclides through Agriculture (AD-89-T-2-A-106) (formerly EPA078-D-X0304), Oak Ridge National Laboratory, ORNL-5786.
40 Research Triangle Institute, Center for Environmental Analysis. 1995. Supplemental Technical Support Document for Hazardous Waste Identification Rule: Risk Assessment for Human and Ecological Receptors--Volume 1, TABLE A-1. November 1995.
44 USEPA. 1996. Soil Screening Guidance: Technical Background Document and User Guide. Office of Emergency and Remedial Response. EPA/540/R-95/128. May.
50.1 USEPA. 1997. Superfund Chemical Data Matrix (SCDM). Office of Emergency and Remedial Response. September 12.
50.3 USEPA. 20014. Superfund Chemical Data Matrix (SCDM). Office of Superfund Remediation and Technology Innovation. June 20, 2014.
62 USEPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. July.
64 Agency for Toxic Substances and Disease Registry (ATSDR). November 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs).
67 USEPA. 1997. Mercury Study Report to Congress. EPA's Office of Air Quality Planning and Standards and Office of Research and Development. December.
69 USEPA. 2004. WATER9. Version 2.0.0. Office of Air Quality Planning and Standards. July.
999 SFRWQCB. 2019. Environmental Screeening Levels.

Notes:

43 The value is associated with pH 6.8.
45 Used the value for Chromium III [CASRN 16065-83-1] presented in indicated reference as a surrogate.
48 Not Available or Not Applicable
61 Insoluble
82 Used Equation (70) from Reference 44 to calculate Koc value using Log Kow value from indicated reference.
92 Indicated source cites CHEMFATE.
110 Used the value for 4-Chlorobiphenyl [CASRN 2051-62-9] from the indicated reference as a surrogate.
111 Used Equation (71) from Reference 44 to calculate Koc value using Log Kow value from indicated reference.
114 A value of 1 is conservatively used because EPA guidance does not provide a default value.
115 Calculated Kp value using equation 3.8 (p.3-7) in reference 62 with log Kow from the indicated reference and the MW presented in table.
116 Used the value for Aroclor-1254 [CASRN 11097-69-1] from the indicated reference as a surrogate.
117 Derived the FA based on Exhibit A-4 in the indicated reference.
118 From the 2001 Fact Sheet, "Correcting the Henry's Law Constant for Soil Temperature".
123 Value has been assigned a default reference temperature.

Appendix A
Table 3a
Dispersion Factor to Outdoor Air for Park Worker
GGNRA Hawk Hill, Marin Headlands, CA

Parameter	Units	Value
Correlation coefficient city		San Francisco
Correlation coefficient A		13.8139
Correlation coefficient B		20.1624
Correlation coefficient C		234.2869
Soil source area	acres	0.7
Soil C/Q averaging time		Annual Max
Conversion factor from 1-Hr Max for soil		0.19
C/Q for soil	$(kg/m^3)/(kg/m^2\text{-}s)$	**12.00**

Note:
C/Q is estimated using the empirical correlation in USEPA's Supplemental SSG (2002).

Appendix A
Table 3b
Soil PM10 Emission from Wind Erosion for Park Worker
GGNRA Hawk Hill, Marin Headlands, CA

Unlimited Reservoir Model			
Aerodynamic particle size multiplier			0.036
Ground cover fraction		**G**	0.5
Mode of aggregate size distribution	mm		0.50
Threshold friction velocity	m/s	$\mathbf{u'_t}$	0.50
Correction factor			1.25
Corrected friction velocity	m/s	$\mathbf{u^*_t}$	0.6252
Roughness height	m	$\mathbf{z_0}$	0.005
Anemometer height	m		10.0
Friction velocity at anemometer height	m/s	$\mathbf{u_t}$	11.88
Mean annual wind speed	mph	$\mathbf{u_m}$	10.5
Mean annual wind speed	m/s	$\mathbf{u_m}$	4.69
u_m/u_t			0.395
$x = 0.886\ u_t/u_m$			2.24
F(x)			0.138
Annual average PM_{10} flux	kg-soil/m^2-s	$\mathbf{J_{10,w}}$	**4.26E-11**

Appendix A
Table 3c
Vapor Flux from Soil to Outdoor Air for Park Worker
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	K_{oc} (L/kg)	K_d (L/kg)	H (unitless)	D_{air} (m^2/d)	D_{water} (m^2/d)	R_L (unitless)	D_G (m^2/d)	D_L (m^2/d)	D_E (m^2/d)	J_v (kg/m^2-s)
VOC	Benzene	71-43-2	5.82E+01		2.19E-01	7.60E-01	8.47E-05	3.17E-01	1.23E-01	3.42E-08	8.51E-02	1.48E-05
VOC	Ethyl Benzene	100-41-4	3.67E+02		3.06E-01	6.48E-01	6.74E-05	1.37E+00	1.05E-01	2.72E-08	2.35E-02	1.37E-05
VOC	Toluene	108-88-3	1.80E+02		2.59E-01	7.52E-01	7.43E-05	7.35E-01	1.22E-01	3.00E-08	4.30E-02	1.43E-05
VOC	Xylenes (total)	1330-20-7	3.86E+02		3.30E-01	6.74E-01	7.56E-05	1.44E+00	1.09E-01	3.05E-08	2.51E-02	1.38E-05
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.21E+02		2.61E-05	2.38E-01	5.97E-05	4.56E-01	3.87E-02	2.41E-08	2.27E-06	3.42E-07
PDIST	Diesel Range Organics	DRO	1.50E+03		7.30E+01	5.18E-01	7.26E-05	2.85E+01	8.41E-02	2.93E-08	2.15E-01	1.53E-05
PCB	PCBs (total)	1336-36-3	2.45E+06		1.22E-01	1.75E-01	4.32E-05	8.15E+03	2.83E-02	1.75E-08	4.26E-07	1.48E-07
INORG	Antimony	7440-36-0		4.50E+01								
INORG	Arsenic	7440-38-2		2.90E+01								
INORG	Barium	7440-39-3		4.10E+01								
INORG	Beryllium	7440-41-7		7.90E+02								
INORG	Cadmium	7440-43-9		7.50E+01								
INORG	Chromium (total)	7440-47-3		1.80E+06								
INORG	Cobalt	7440-48-4		4.50E+01								
INORG	Copper	7440-50-8		3.50E+01								
INORG	Lead	7439-92-1		9.00E+02								
INORG	Mercury	7439-97-6		1.00E+03	4.07E-01	2.65E-01	5.44E-05	1.66E+03	4.31E-02	2.20E-08	1.06E-05	7.38E-07
INORG	Molybdenum	7439-98-7		2.00E+01								
INORG	Nickel	7440-02-0		6.50E+01								
INORG	Selenium	7782-49-2		5.00E+00								
INORG	Silver	7440-22-4		8.30E+00								
INORG	Thallium	7440-28-0		7.10E+01								
INORG	Vanadium	7440-62-2		1.00E+03								
INORG	Zinc	7440-66-6		6.20E+01								

Notes:

Soil bulk density	kg/L	ρ_b	1.66
Soil porosity	L/L-soil	θ	0.38
Soil water content	L/L-soil	θ_w	0.05
Soil air-filled porosity	L/L-soil	θ_a	0.32
Soil organic carbon fraction	unitless	f_{oc}	0.002
Averaging period (Exposure Duration)	year	T	25
	days	T	9125
	s	T	7.9E+08
Molar Gas Constant	L-mmHg/ mole-°K	R	62.411
Temperature	°C	Temp	24
	K	Temp	297
Clean soil above source	m	Z_1	
Bottom of source depth	m	Z_2	7.62

The K_d for organic compounds is the K_{oc} times the foc.

Appendix A
Table 3d
Unit Cancer Risk Calculations for Exposure of Park Worker to Soil
GGNRA Hawk Hill, Marin Headlands, CA

					Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	Cancer Class	C_{soil} (mg/kg)	RBA	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	Risk	ABS_{derm}	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	Risk	C_{air} (mg/m^3)	URF (m^3/mg)	Risk	C_{air} (mg/m^3)	URF $(mg/m^3)^{-1}$	Risk	Risk
VOC	Benzene	71-43-2	A	1.00E+00		1.53E-07	1.0E-01	1.5E-08			1.0E-01		1.78E-04	2.9E-02	4.2E-07	5.11E-10	2.9E-02	1.2E-12	4.4E-07
VOC	Ethyl Benzene	100-41-4	D	1.00E+00		1.53E-07							1.65E-04			5.11E-10			
VOC	Toluene	108-88-3	ID	1.00E+00		1.53E-07							1.72E-04			5.11E-10			
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00		1.53E-07							1.65E-04			5.11E-10			
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	1.00E+00		1.53E-07			1.00E-01	1.29E-07			4.10E-06			5.11E-10			
PDIST	Diesel Range Organics	DRO		1.00E+00		1.53E-07							1.83E-04			5.11E-10			
PCB	PCBs (total)	1336-36-3	B2	1.00E+00		1.53E-07	2.0E+00	3.1E-07	1.40E-01	1.81E-07	2.0E+00	3.6E-07	1.78E-06	5.7E-01	8.3E-08	5.11E-10	5.7E-01	2.4E-11	7.5E-07
INORG	Antimony	7440-36-0	ID	1.00E+00		1.53E-07										5.11E-10			
INORG	Arsenic	7440-38-2	A	1.00E+00	0.6	1.53E-07	9.5E+00	8.7E-07	3.00E-02	3.88E-08	9.5E+00	3.7E-07		4.3E+00		5.11E-10	4.3E+00	1.8E-10	1.2E-06
INORG	Barium	7440-39-3	NC	1.00E+00		1.53E-07										5.11E-10			
INORG	Beryllium	7440-41-7	B1	1.00E+00		1.53E-07								2.4E+00		5.11E-10	2.4E+00	1.0E-10	1.0E-10
INORG	Cadmium	7440-43-9	B1	1.00E+00		1.53E-07			1.00E-03	1.29E-09				4.2E+00		5.11E-10	4.2E+00	1.7E-10	1.7E-10
INORG	Chromium (total)	7440-47-3		1.00E+00		1.53E-07										5.11E-10			
INORG	Cobalt	7440-48-4	LC	1.00E+00		1.53E-07								9.0E+00		5.11E-10	9.0E+00	3.7E-10	3.7E-10
INORG	Copper	7440-50-8	D	1.00E+00		1.53E-07										5.11E-10			
INORG	Lead	7439-92-1	B2	1.00E+00		1.53E-07										5.11E-10			
INORG	Mercury	7439-97-6	D	1.00E+00		1.53E-07							8.85E-06			5.11E-10			
INORG	Molybdenum	7439-98-7		1.00E+00		1.53E-07										5.11E-10			
INORG	Nickel	7440-02-0	A	1.00E+00		1.53E-07								2.6E-01		5.11E-10	2.6E-01	1.1E-11	1.1E-11
INORG	Selenium	7782-49-2	D	1.00E+00		1.53E-07										5.11E-10			
INORG	Silver	7440-22-4	D	1.00E+00		1.53E-07										5.11E-10			
INORG	Thallium	7440-28-0	ID	1.00E+00		1.53E-07										5.11E-10			
INORG	Vanadium	7440-62-2	ID	1.00E+00		1.53E-07										5.11E-10			
INORG	Zinc	7440-66-6	ID	1.00E+00		1.53E-07										5.11E-10			

Notes:
RBA - relative bioavailability factor

Appendix A
Table 3e
Unit Hazard Quotient Calculations for Exposure of Park Worker to Soil
GGNRA Hawk Hill, Marin Headlands, CA

				Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	C_{soil} (mg/kg)	RBA	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	HQ	ABS_{derm}	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	HQ
VOC	Benzene	71-43-2	1.00E+00		4.28E-07	4.0E-03	1.1E-04			4.0E-03		1.78E-04	3.0E-03	1.4E-02	5.11E-10	3.0E-03	3.9E-08	1.4E-02
VOC	Ethyl Benzene	100-41-4	1.00E+00		4.28E-07	5.0E-02	8.6E-06			5.0E-02		1.65E-04	1.0E+00	3.8E-05	5.11E-10	1.0E+00	1.2E-10	4.6E-05
VOC	Toluene	108-88-3	1.00E+00		4.28E-07	8.0E-02	5.4E-06			8.0E-02		1.72E-04	3.0E-01	1.3E-04	5.11E-10	3.0E-01	3.9E-10	1.4E-04
VOC	Xylenes (total)	1330-20-7	1.00E+00		4.28E-07	2.0E-01	2.1E-06			2.0E-01		1.65E-04	1.0E-01	3.8E-04	5.11E-10	1.0E-01	1.2E-09	3.8E-04
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.00E+00		4.28E-07	8.0E-05	5.4E-03	1.00E-01	3.62E-07	8.0E-05	4.5E-03	4.10E-06			5.11E-10			9.9E-03
PDIST	Diesel Range Organics	DRO	1.00E+00		4.28E-07	1.9E-02	2.3E-05			1.9E-02		1.83E-04	2.6E-01	1.6E-04	5.11E-10	2.6E-01	4.5E-10	1.8E-04
PCB	PCBs (total)	1336-36-3	1.00E+00		4.28E-07	2.0E-05	2.1E-02	1.40E-01	5.07E-07	2.0E-05	2.5E-02	1.78E-06			5.11E-10			4.7E-02
INORG	Antimony	7440-36-0	1.00E+00		4.28E-07	4.0E-04	1.1E-03			6.0E-05					5.11E-10			1.1E-03
INORG	Arsenic	7440-38-2	1.00E+00	0.6	4.28E-07	3.5E-06	7.3E-02	3.00E-02	1.09E-07	3.5E-06	3.1E-02		1.5E-05		5.11E-10	1.5E-05	7.8E-06	1.0E-01
INORG	Barium	7440-39-3	1.00E+00		4.28E-07	2.0E-01	2.1E-06			1.4E-02			5.0E-04		5.11E-10	5.0E-04	2.3E-07	2.4E-06
INORG	Beryllium	7440-41-7	1.00E+00		4.28E-07	2.0E-04	2.1E-03			1.4E-06			7.0E-06		5.11E-10	7.0E-06	1.7E-05	2.2E-03
INORG	Cadmium	7440-43-9	1.00E+00		4.28E-07	1.0E-03	4.3E-04	1.00E-03	3.62E-09	2.5E-05	1.4E-04		1.0E-05		5.11E-10	1.0E-05	1.2E-05	5.8E-04
INORG	Chromium (total)	7440-47-3	1.00E+00		4.28E-07	1.5E+00	2.9E-07			2.0E-02			5.0E-03		5.11E-10	5.0E-03	2.3E-08	3.1E-07
INORG	Cobalt	7440-48-4	1.00E+00		4.28E-07	3.0E-04	1.4E-03			3.0E-04			6.0E-06		5.11E-10	6.0E-06	1.9E-05	1.4E-03
INORG	Copper	7440-50-8	1.00E+00		4.28E-07	1.0E-02	4.3E-05			1.0E-02					5.11E-10			4.3E-05
INORG	Lead	7439-92-1	1.00E+00		4.28E-07										5.11E-10			
INORG	Mercury	7439-97-6	1.00E+00		4.28E-07	1.6E-04	2.7E-03			1.1E-05		8.85E-06	3.0E-05	6.7E-02	5.11E-10	3.0E-05	3.9E-06	7.0E-02
INORG	Molybdenum	7439-98-7	1.00E+00		4.28E-07	5.0E-03	8.6E-05			5.0E-03					5.11E-10			8.6E-05
INORG	Nickel	7440-02-0	1.00E+00		4.28E-07	1.1E-02	3.9E-05			4.4E-04			1.4E-05		5.11E-10	1.4E-05	8.3E-06	4.7E-05
INORG	Selenium	7782-49-2	1.00E+00		4.28E-07	5.0E-03	8.6E-05			5.0E-03			2.0E-02		5.11E-10	2.0E-02	5.8E-09	8.6E-05
INORG	Silver	7440-22-4	1.00E+00		4.28E-07	5.0E-03	8.6E-05			2.0E-04			1.0E-05		5.11E-10	1.0E-05	1.2E-05	9.7E-05
INORG	Thallium	7440-28-0	1.00E+00		4.28E-07	1.0E-05	4.3E-02			1.0E-05					5.11E-10			4.3E-02
INORG	Vanadium	7440-62-2	1.00E+00		4.28E-07	5.0E-03	8.5E-05			1.3E-04			1.0E-04		5.11E-10	1.0E-04	1.2E-06	8.6E-05
INORG	Zinc	7440-66-6	1.00E+00		4.28E-07	3.0E-01	1.4E-06			3.0E-01					5.11E-10			1.4E-06

Notes:
RBA - relative bioavailability factor

Appendix A
Table 4a
Dispersion Factor to Outdoor Air for Maintenance Worker
GGNRA Hawk Hill, Marin Headlands, CA

Parameter	Units	Value
Correlation coefficient city		San Francisco
Correlation coefficient A		13.8139
Correlation coefficient B		20.1624
Correlation coefficient C		234.2869
Soil source area	acres	0.7
Soil C/Q averaging time		Annual Max
Conversion factor from 1-Hr Max for soil		0.19
C/Q for soil	$(kg/m^3)/(kg/m^2\text{-}s)$	**12.00**

Note:
C/Q is estimated using the empirical correlation in USEPA's Supplemental SSG (2002).

Appendix A
Table 4b
Vapor Flux from Soil to Outdoor Air for Maintenance Worker
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	K_{oc} (L/kg)	K_d (L/kg)	H (unitless)	D_{air} (m^2/d)	D_{water} (m^2/d)	R_L (unitless)	D_G (m^2/d)	D_L (m^2/d)	D_E (m^2/d)	J_v (kg/m^2-s)
VOC	Benzene	71-43-2	5.82E+01		2.19E-01	7.60E-01	8.47E-05	3.17E-01	1.23E-01	3.42E-08	8.51E-02	3.53E-05
VOC	Ethyl Benzene	100-41-4	3.67E+02		3.06E-01	6.48E-01	6.74E-05	1.37E+00	1.05E-01	2.72E-08	2.35E-02	3.11E-05
VOC	Toluene	108-88-3	1.80E+02		2.59E-01	7.52E-01	7.43E-05	7.35E-01	1.22E-01	3.00E-08	4.30E-02	3.33E-05
VOC	Xylenes (total)	1330-20-7	3.86E+02		3.30E-01	6.74E-01	7.56E-05	1.44E+00	1.09E-01	3.05E-08	2.51E-02	3.13E-05
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.21E+02		2.61E-05	2.38E-01	5.97E-05	4.56E-01	3.87E-02	2.41E-08	2.27E-06	5.41E-07
PDIST	Diesel Range Organics	DRO	1.50E+03		7.30E+01	5.18E-01	7.26E-05	2.85E+01	8.41E-02	2.93E-08	2.15E-01	3.70E-05
PCB	PCBs (total)	1336-36-3	2.45E+06		1.22E-01	1.75E-01	4.32E-05	8.15E+03	2.83E-02	1.75E-08	4.26E-07	2.34E-07
INORG	Antimony	7440-36-0		4.50E+01								
INORG	Arsenic	7440-38-2		2.90E+01								
INORG	Barium	7440-39-3		4.10E+01								
INORG	Beryllium	7440-41-7		7.90E+02								
INORG	Cadmium	7440-43-9		7.50E+01								
INORG	Chromium (total)	7440-47-3		1.80E+06								
INORG	Cobalt	7440-48-4		4.50E+01								
INORG	Copper	7440-50-8		3.50E+01								
INORG	Lead	7439-92-1		9.00E+02								
INORG	Mercury	7439-97-6		1.00E+03	4.07E-01	2.65E-01	5.44E-05	1.66E+03	4.31E-02	2.20E-08	1.06E-05	1.17E-06
INORG	Molybdenum	7439-98-7		2.00E+01								
INORG	Nickel	7440-02-0		6.50E+01								
INORG	Selenium	7782-49-2		5.00E+00								
INORG	Silver	7440-22-4		8.30E+00								
INORG	Thallium	7440-28-0		7.10E+01								
INORG	Vanadium	7440-62-2		1.00E+03								
INORG	Zinc	7440-66-6		6.20E+01								

Notes:

Soil bulk density	kg/L	ρ_b	1.66
Soil porosity	L/L-soil	θ	0.38
Soil water content	L/L-soil	θ_w	0.05
Soil air-filled porosity	L/L-soil	θ_a	0.32
Soil organic carbon fraction	unitless	f_{oc}	0.002
Averaging period (Exposure Duration)	year	**T**	10
	days	**T**	3650
	s	**T**	3.2E+08
Molar Gas Constant	L-mmHg/ mole-°K	**R**	62.411
Temperature	°C	**Temp**	24
	K	**Temp**	297
Clean soil above source	m	Z_1	
Bottom of source depth	m	Z_2	7.62

The K_d for organic compounds is the K_{oc} times the foc.

Appendix A
Table 4c
Unit Cancer Risk Calculations for Exposure of Maintenance Worker to Soil
GGNRA Hawk Hill, Marin Headlands, CA

					Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	Cancer Class	C_{soil} (mg/kg)	RBA	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	Risk	ABS_{derm}	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	Risk	C_{air} (mg/m^3)	URF (m^3/mg)	Risk	C_{air} (mg/m^3)	URF $(mg/m^3)^{-1}$	Risk	Risk
VOC	Benzene	71-43-2	A	1.00E+00		5.09E-08	1.0E-01	5.1E-09			1.0E-01		4.23E-04	2.9E-02	8.3E-08	5.00E-08	2.9E-02	9.8E-12	8.8E-08
VOC	Ethyl Benzene	100-41-4	D	1.00E+00		5.09E-08							3.73E-04			5.00E-08			
VOC	Toluene	108-88-3	ID	1.00E+00		5.09E-08							4.00E-04			5.00E-08			
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00		5.09E-08							3.76E-04			5.00E-08			
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	1.00E+00		5.09E-08			1.00E-01	1.08E-08			6.49E-06			5.00E-08			
PDIST	Diesel Range Organics	DRO		1.00E+00		5.09E-08							4.45E-04			5.00E-08			
PCB	PCBs (total)	1336-36-3	B2	1.00E+00		5.09E-08	2.0E+00	1.0E-07	1.40E-01	1.51E-08	2.0E+00	3.0E-08	2.81E-06	5.7E-01	1.1E-08	5.00E-08	5.7E-01	1.9E-10	1.4E-07
INORG	Antimony	7440-36-0	ID	1.00E+00		5.09E-08										5.00E-08			
INORG	Arsenic	7440-38-2	A	1.00E+00	0.6	5.09E-08	9.5E+00	2.9E-07	3.00E-02	3.23E-09	9.5E+00	3.1E-08		4.3E+00		5.00E-08	4.3E+00	1.5E-09	3.2E-07
INORG	Barium	7440-39-3	NC	1.00E+00		5.09E-08										5.00E-08			
INORG	Beryllium	7440-41-7	B1	1.00E+00		5.09E-08								2.4E+00		5.00E-08	2.4E+00	8.1E-10	8.1E-10
INORG	Cadmium	7440-43-9	B1	1.00E+00		5.09E-08			1.00E-03	1.08E-10				4.2E+00		5.00E-08	4.2E+00	1.4E-09	1.4E-09
INORG	Chromium (total)	7440-47-3		1.00E+00		5.09E-08										5.00E-08			
INORG	Cobalt	7440-48-4	LC	1.00E+00		5.09E-08								9.0E+00		5.00E-08	9.0E+00	3.1E-09	3.1E-09
INORG	Copper	7440-50-8	D	1.00E+00		5.09E-08										5.00E-08			
INORG	Lead	7439-92-1	B2	1.00E+00		5.09E-08										5.00E-08			
INORG	Mercury	7439-97-6	D	1.00E+00		5.09E-08							1.40E-05			5.00E-08			
INORG	Molybdenum	7439-98-7		1.00E+00		5.09E-08										5.00E-08			
INORG	Nickel	7440-02-0	A	1.00E+00		5.09E-08								2.6E-01		5.00E-08	2.6E-01	8.8E-11	8.8E-11
INORG	Selenium	7782-49-2	D	1.00E+00		5.09E-08										5.00E-08			
INORG	Silver	7440-22-4	D	1.00E+00		5.09E-08										5.00E-08			
INORG	Thallium	7440-28-0	ID	1.00E+00		5.09E-08										5.00E-08			
INORG	Vanadium	7440-62-2	ID	1.00E+00		5.09E-08										5.00E-08			
INORG	Zinc	7440-66-6	ID	1.00E+00		5.09E-08										5.00E-08			

Notes:
The concentration of particulates in the air is assumed to be no more than the former annual National Ambient Air Quality Standards (NAAQS) for PM_{10} of 50 ug/m^3.
RBA - relative bioavailability factor

Appendix A
Table 4d
Unit Hazard Quotient Calculations for Exposure of Maintenance Worker to Soil
GGNRA Hawk Hill, Marin Headlands, CA

				Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	C_{soil} (mg/kg)	RBA	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	HQ	ABS_{derm}	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	HQ
VOC	Benzene	71-43-2	1.00E+00		3.56E-07	4.0E-03	8.9E-05			4.0E-03		4.23E-04	3.0E-03	6.7E-03	5.00E-08	3.0E-03	7.9E-07	6.8E-03
VOC	Ethyl Benzene	100-41-4	1.00E+00		3.56E-07	5.0E-02	7.1E-06			5.0E-02		3.73E-04	1.0E+00	1.8E-05	5.00E-08	1.0E+00	2.4E-09	2.5E-05
VOC	Toluene	108-88-3	1.00E+00		3.56E-07	8.0E-02	4.5E-06			8.0E-02		4.00E-04	3.0E-01	6.3E-05	5.00E-08	3.0E-01	7.9E-09	6.8E-05
VOC	Xylenes (total)	1330-20-7	1.00E+00		3.56E-07	2.0E-01	1.8E-06			2.0E-01		3.76E-04	1.0E-01	1.8E-04	5.00E-08	1.0E-01	2.4E-08	1.8E-04
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.00E+00		3.56E-07	8.0E-05	4.5E-03	1.00E-01	7.54E-08	8.0E-05	9.4E-04	6.49E-06			5.00E-08			5.4E-03
PDIST	Diesel Range Organics	DRO	1.00E+00		3.56E-07	1.9E-02	1.9E-05			1.9E-02		4.45E-04	2.6E-01	8.1E-05	5.00E-08	2.6E-01	9.1E-09	1.0E-04
PCB	PCBs (total)	1336-36-3	1.00E+00		3.56E-07	2.0E-05	1.8E-02	1.40E-01	1.06E-07	2.0E-05	5.3E-03	2.81E-06			5.00E-08			2.3E-02
INORG	Antimony	7440-36-0	1.00E+00		3.56E-07	4.0E-04	8.9E-04			6.0E-05					5.00E-08			8.9E-04
INORG	Arsenic	7440-38-2	1.00E+00	0.6	3.56E-07	3.5E-06	6.1E-02	3.00E-02	2.26E-08	3.5E-06	6.5E-03		1.5E-05		5.00E-08	1.5E-05	1.6E-04	6.8E-02
INORG	Barium	7440-39-3	1.00E+00		3.56E-07	2.0E-01	1.8E-06			1.4E-02			5.0E-04		5.00E-08	5.0E-04	4.7E-06	6.5E-06
INORG	Beryllium	7440-41-7	1.00E+00		3.56E-07	2.0E-04	1.8E-03			1.4E-06			7.0E-06		5.00E-08	7.0E-06	3.4E-04	2.1E-03
INORG	Cadmium	7440-43-9	1.00E+00		3.56E-07	1.0E-03	3.6E-04	1.00E-03	7.54E-10	2.5E-05	3.0E-05		1.0E-05		5.00E-08	1.0E-05	2.4E-04	6.2E-04
INORG	Chromium (total)	7440-47-3	1.00E+00		3.56E-07	1.5E+00	2.4E-07			2.0E-02			5.0E-03		5.00E-08	5.0E-03	4.7E-07	7.1E-07
INORG	Cobalt	7440-48-4	1.00E+00		3.56E-07	3.0E-04	1.2E-03			3.0E-04			6.0E-06		5.00E-08	6.0E-06	4.0E-04	1.6E-03
INORG	Copper	7440-50-8	1.00E+00		3.56E-07	1.0E-02	3.6E-05			1.0E-02					5.00E-08			3.6E-05
INORG	Lead	7439-92-1	1.00E+00		3.56E-07										5.00E-08			
INORG	Mercury	7439-97-6	1.00E+00		3.56E-07	1.6E-04	2.2E-03			1.1E-05		1.40E-05	3.0E-05	2.2E-02	5.00E-08	3.0E-05	7.9E-05	2.4E-02
INORG	Molybdenum	7439-98-7	1.00E+00		3.56E-07	5.0E-03	7.1E-05			5.0E-03					5.00E-08			7.1E-05
INORG	Nickel	7440-02-0	1.00E+00		3.56E-07	1.1E-02	3.2E-05			4.4E-04			1.4E-05		5.00E-08	1.4E-05	1.7E-04	2.0E-04
INORG	Selenium	7782-49-2	1.00E+00		3.56E-07	5.0E-03	7.1E-05			5.0E-03			2.0E-02		5.00E-08	2.0E-02	1.2E-07	7.1E-05
INORG	Silver	7440-22-4	1.00E+00		3.56E-07	5.0E-03	7.1E-05			2.0E-04			1.0E-05		5.00E-08	1.0E-05	2.4E-04	3.1E-04
INORG	Thallium	7440-28-0	1.00E+00		3.56E-07	1.0E-05	3.6E-02			1.0E-05					5.00E-08			3.6E-02
INORG	Vanadium	7440-62-2	1.00E+00		3.56E-07	5.0E-03	7.1E-05			1.3E-04			1.0E-04		5.00E-08	1.0E-04	2.4E-05	9.4E-05
INORG	Zinc	7440-66-6	1.00E+00		3.56E-07	3.0E-01	1.2E-06			3.0E-01					5.00E-08			1.2E-06

Notes:
The concentration of particulates in the air is assumed to be no more than the former annual National Ambient Air Quality Standards (NAAQS) for PM_{10} of 50 ug/m^3.
RBA - relative bioavailability factor

Appendix A
Table 5a
Dispersion Factor to Outdoor Air for Construction Worker
GGNRA Hawk Hill, Marin Headlands, CA

Parameter	Units	Value
Correlation coefficient city		San Francisco
Correlation coefficient A		13.8139
Correlation coefficient B		20.1624
Correlation coefficient C		234.2869
Soil source area	acres	0.7
Soil C/Q averaging time		Annual Max
Conversion factor from 1-Hr Max for soil		0.19
C/Q for soil	$(kg/m^3)/(kg/m^2\text{-}s)$	**12.00**

Note:
C/Q is estimated using the empirical correlation in USEPA's Supplemental SSG (2002).

Appendix A
Table 5b
Vapor Flux from Soil to Outdoor Air for Construction Worker
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	K_{oc} (L/kg)	K_d (L/kg)	H (unitless)	D_{air} (m^2/d)	D_{water} (m^2/d)	R_L (unitless)	D_G (m^2/d)	D_L (m^2/d)	D_E (m^2/d)	J_v (kg/m^2-s)
VOC	Benzene	71-43-2	5.82E+01		2.19E-01	7.60E-01	8.47E-05	3.17E-01	1.23E-01	3.42E-08	8.51E-02	2.57E-04
VOC	Ethyl Benzene	100-41-4	3.67E+02		3.06E-01	6.48E-01	6.74E-05	1.37E+00	1.05E-01	2.72E-08	2.35E-02	1.68E-04
VOC	Toluene	108-88-3	1.80E+02		2.59E-01	7.52E-01	7.43E-05	7.35E-01	1.22E-01	3.00E-08	4.30E-02	2.12E-04
VOC	Xylenes (total)	1330-20-7	3.86E+02		3.30E-01	6.74E-01	7.56E-05	1.44E+00	1.09E-01	3.05E-08	2.51E-02	1.73E-04
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.21E+02		2.61E-05	2.38E-01	5.97E-05	4.56E-01	3.87E-02	2.41E-08	2.27E-06	1.71E-06
PDIST	Diesel Range Organics	DRO	1.50E+03		7.30E+01	5.18E-01	7.26E-05	2.85E+01	8.41E-02	2.93E-08	2.15E-01	3.07E-04
PCB	PCBs (total)	1336-36-3	2.45E+06		1.22E-01	1.75E-01	4.32E-05	8.15E+03	2.83E-02	1.75E-08	4.26E-07	7.40E-07
INORG	Antimony	7440-36-0		4.50E+01								
INORG	Arsenic	7440-38-2		2.90E+01								
INORG	Barium	7440-39-3		4.10E+01								
INORG	Beryllium	7440-41-7		7.90E+02								
INORG	Cadmium	7440-43-9		7.50E+01								
INORG	Chromium (total)	7440-47-3		1.80E+06								
INORG	Cobalt	7440-48-4		4.50E+01								
INORG	Copper	7440-50-8		3.50E+01								
INORG	Lead	7439-92-1		9.00E+02								
INORG	Mercury	7439-97-6		1.00E+03	4.07E-01	2.65E-01	5.44E-05	1.66E+03	4.31E-02	2.20E-08	1.06E-05	3.69E-06
INORG	Molybdenum	7439-98-7		2.00E+01								
INORG	Nickel	7440-02-0		6.50E+01								
INORG	Selenium	7782-49-2		5.00E+00								
INORG	Silver	7440-22-4		8.30E+00								
INORG	Thallium	7440-28-0		7.10E+01								
INORG	Vanadium	7440-62-2		1.00E+03								
INORG	Zinc	7440-66-6		6.20E+01								

Notes:

Soil bulk density	kg/L	ρ_b	1.66
Soil porosity	L/L-soil	θ	0.38
Soil water content	L/L-soil	θ_w	0.05
Soil air-filled porosity	L/L-soil	θ_a	0.32
Soil organic carbon fraction	unitless	f_{oc}	0.002
Averaging period (Exposure Duration)	year	**T**	1
	days	**T**	365
	s	**T**	3.2E+07
Molar Gas Constant	L-mmHg/ mole-°K	**R**	62.411
Temperature	°C	**Temp**	24
	K	**Temp**	297
Clean soil above source	m	Z_1	
Bottom of source depth	m	Z_2	7.62

The K_d for organic compounds is the K_{oc} times the foc.

Appendix A
Table 5c
Unit Cancer Risk Calculations for Exposure of Construction Worker to Soil
GGNRA Hawk Hill, Marin Headlands, CA

					Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	Cancer Class	C_{soil} (mg/kg)	RBA	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	Risk	ABS_{derm}	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	Risk	C_{air} (mg/m^3)	URF (m^3/mg)	Risk	C_{air} (mg/m^3)	URF $(mg/m^3)^{-1}$	Risk	Risk
VOC	Benzene	71-43-2	A	1.00E+00		2.45E-08	1.0E-01	2.4E-09			1.0E-01		3.09E-03	2.9E-02	2.9E-07	5.00E-08	2.9E-02	4.7E-12	2.9E-07
VOC	Ethyl Benzene	100-41-4	D	1.00E+00		2.45E-08							2.02E-03			5.00E-08			
VOC	Toluene	108-88-3	ID	1.00E+00		2.45E-08							2.54E-03			5.00E-08			
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00		2.45E-08							2.08E-03			5.00E-08			
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	1.00E+00		2.45E-08			1.00E-01	5.18E-09			2.05E-05			5.00E-08			
PDIST	Diesel Range Organics	DRO		1.00E+00		2.45E-08							3.68E-03			5.00E-08			
PCB	PCBs (total)	1336-36-3	B2	1.00E+00		2.45E-08	2.0E+00	4.9E-08	1.40E-01	7.25E-09	2.0E+00	1.4E-08	8.89E-06	5.7E-01	1.7E-08	5.00E-08	5.7E-01	9.3E-11	8.0E-08
INORG	Antimony	7440-36-0	ID	1.00E+00		2.45E-08										5.00E-08			
INORG	Arsenic	7440-38-2	A	1.00E+00	0.6	2.45E-08	9.5E+00	1.4E-07	3.00E-02	1.55E-09	9.5E+00	1.5E-08		4.3E+00		5.00E-08	4.3E+00	7.0E-10	1.5E-07
INORG	Barium	7440-39-3	NC	1.00E+00		2.45E-08										5.00E-08			
INORG	Beryllium	7440-41-7	B1	1.00E+00		2.45E-08								2.4E+00		5.00E-08	2.4E+00	3.9E-10	3.9E-10
INORG	Cadmium	7440-43-9	B1	1.00E+00		2.45E-08			1.00E-03	5.18E-11				4.2E+00		5.00E-08	4.2E+00	6.8E-10	6.8E-10
INORG	Chromium (total)	7440-47-3		1.00E+00		2.45E-08										5.00E-08			
INORG	Cobalt	7440-48-4	LC	1.00E+00		2.45E-08								9.0E+00		5.00E-08	9.0E+00	1.5E-09	1.5E-09
INORG	Copper	7440-50-8	D	1.00E+00		2.45E-08										5.00E-08			
INORG	Lead	7439-92-1	B2	1.00E+00		2.45E-08										5.00E-08			
INORG	Mercury	7439-97-6	D	1.00E+00		2.45E-08							4.43E-05			5.00E-08			
INORG	Molybdenum	7439-98-7		1.00E+00		2.45E-08										5.00E-08			
INORG	Nickel	7440-02-0	A	1.00E+00		2.45E-08								2.6E-01		5.00E-08	2.6E-01	4.2E-11	4.2E-11
INORG	Selenium	7782-49-2	D	1.00E+00		2.45E-08										5.00E-08			
INORG	Silver	7440-22-4	D	1.00E+00		2.45E-08										5.00E-08			
INORG	Thallium	7440-28-0	ID	1.00E+00		2.45E-08										5.00E-08			
INORG	Vanadium	7440-62-2	ID	1.00E+00		2.45E-08										5.00E-08			
INORG	Zinc	7440-66-6	ID	1.00E+00		2.45E-08										5.00E-08			

Notes:
The concentration of particulates in the air is assumed to be no more than the former annual National Ambient Air Quality Standards (NAAQS) for PM_{10} of 50 ug/m^3.
RBA - relative bioavailability factor

Appendix A
Table 5d
Unit Hazard Quotient Calculations for Exposure of Construction Worker to Soil
GGNRA Hawk Hill, Marin Headlands, CA

				Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	C_{soil} (mg/kg)	RBA	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	HQ	ABS_{derm}	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	HQ
VOC	Benzene	71-43-2	1.00E+00		1.71E-06	1.0E-02	1.7E-04			1.0E-02		3.09E-03	9.0E-02	7.8E-03	5.00E-08	9.0E-02	1.3E-07	8.0E-03
VOC	Ethyl Benzene	100-41-4	1.00E+00		1.71E-06	5.0E-02	3.4E-05			5.0E-02		2.02E-03	9.0E+00	5.1E-05	5.00E-08	9.0E+00	1.3E-09	8.5E-05
VOC	Toluene	108-88-3	1.00E+00		1.71E-06	8.0E-01	2.1E-06			8.0E-01		2.54E-03	5.0E+00	1.2E-04	5.00E-08	5.0E+00	2.3E-09	1.2E-04
VOC	Xylenes (total)	1330-20-7	1.00E+00		1.71E-06	2.0E-01	8.6E-06			2.0E-01		2.08E-03	3.0E-01	1.6E-03	5.00E-08	3.0E-01	3.8E-08	1.6E-03
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.00E+00		1.71E-06	8.0E-04	2.1E-03	1.00E-01	3.62E-07	8.0E-04	4.5E-04	2.05E-05			5.00E-08			2.6E-03
PDIST	Diesel Range Organics	DRO	1.00E+00		1.71E-06	3.0E-01	5.7E-06			3.0E-01		3.68E-03	1.0E+00	8.4E-04	5.00E-08	1.0E+00	1.1E-08	8.5E-04
PCB	PCBs (total)	1336-36-3	1.00E+00		1.71E-06	5.0E-05	3.4E-02	1.40E-01	5.07E-07	5.0E-05	1.0E-02	8.89E-06			5.00E-08			4.4E-02
INORG	Antimony	7440-36-0	1.00E+00		1.71E-06	4.0E-04	4.3E-03			6.0E-05					5.00E-08			4.3E-03
INORG	Arsenic	7440-38-2	1.00E+00	0.6	1.71E-06	5.0E-03	2.1E-04	3.00E-02	1.09E-07	5.0E-03	2.2E-05		1.5E-05		5.00E-08	1.5E-05	7.6E-04	9.9E-04
INORG	Barium	7440-39-3	1.00E+00		1.71E-06	2.0E-01	8.6E-06			1.4E-02			5.0E-04		5.00E-08	5.0E-04	2.3E-05	3.1E-05
INORG	Beryllium	7440-41-7	1.00E+00		1.71E-06	2.0E-04	8.6E-03			1.4E-06			7.0E-06		5.00E-08	7.0E-06	1.6E-03	1.0E-02
INORG	Cadmium	7440-43-9	1.00E+00		1.71E-06	1.0E-03	1.7E-03	1.00E-03	3.62E-09	2.5E-05	1.4E-04		9.0E-04		5.00E-08	9.0E-04	1.3E-05	1.9E-03
INORG	Chromium (total)	7440-47-3	1.00E+00		1.71E-06	1.5E+00	1.1E-06			2.0E-02			5.0E-03		5.00E-08	5.0E-03	2.3E-06	3.4E-06
INORG	Cobalt	7440-48-4	1.00E+00		1.71E-06	3.0E-03	5.7E-04			3.0E-03			2.0E-05		5.00E-08	2.0E-05	5.7E-04	1.1E-03
INORG	Copper	7440-50-8	1.00E+00		1.71E-06	1.0E-02	1.7E-04			1.0E-02					5.00E-08			1.7E-04
INORG	Lead	7439-92-1	1.00E+00		1.71E-06										5.00E-08			
INORG	Mercury	7439-97-6	1.00E+00		1.71E-06	3.0E-03	5.7E-04			2.1E-04		4.43E-05	3.0E-04	3.4E-02	5.00E-08	3.0E-04	3.8E-05	3.4E-02
INORG	Molybdenum	7439-98-7	1.00E+00		1.71E-06	5.0E-03	3.4E-04			5.0E-03					5.00E-08			3.4E-04
INORG	Nickel	7440-02-0	1.00E+00		1.71E-06	2.0E-02	8.6E-05			8.0E-04			2.0E-04		5.00E-08	2.0E-04	5.7E-05	1.4E-04
INORG	Selenium	7782-49-2	1.00E+00		1.71E-06	5.0E-03	3.4E-04			5.0E-03			2.0E-02		5.00E-08	2.0E-02	5.7E-07	3.4E-04
INORG	Silver	7440-22-4	1.00E+00		1.71E-06	5.0E-03	3.4E-04			2.0E-04			1.0E-05		5.00E-08	1.0E-05	1.1E-03	1.5E-03
INORG	Thallium	7440-28-0	1.00E+00		1.71E-06										5.00E-08			
INORG	Vanadium	7440-62-2	1.00E+00		1.71E-06	1.0E-02	1.7E-04			2.6E-04			1.0E-04		5.00E-08	1.0E-04	1.1E-04	2.9E-04
INORG	Zinc	7440-66-6	1.00E+00		1.71E-06	3.0E-01	5.7E-06			3.0E-01					5.00E-08			5.7E-06

Notes:
The concentration of particulates in the air is assumed to be no more than the former annual National Ambient Air Quality Standards (NAAQS) for PM_{10} of 50 ug/m^3.
RBA - relative bioavailability factor

Appendix A
Table 6a
Dispersion Factor to Outdoor Air for Resident
GGNRA Hawk Hill, Marin Headlands, CA

Parameter	Units	Value
Correlation coefficient city		San Francisco
Correlation coefficient A		13.8139
Correlation coefficient B		20.1624
Correlation coefficient C		234.2869
Soil source area	acres	0.7
Soil C/Q averaging time		Annual Max
Conversion factor from 1-Hr Max for soil		0.19
C/Q for soil	$(kg/m^3)/(kg/m^2\text{-}s)$	**12.00**

Note:
C/Q is estimated using the empirical correlation in USEPA's Supplemental SSG (2002).

Appendix A
Table 6b
Soil PM10 Emission from Wind Erosion for Resident
GGNRA Hawk Hill, Marin Headlands, CA

Unlimited Reservoir Model			
Aerodynamic particle size multiplier			0.036
Ground cover fraction		**G**	0.5
Mode of aggregate size distribution	mm		0.50
Threshold friction velocity	m/s	u'_t	0.50
Correction factor			1.25
Corrected friction velocity	m/s	u^*_t	0.6252
Roughness height	m	z_0	0.005
Anemometer height	m		10.0
Friction velocity at anemometer height	m/s	u_t	11.88
Mean annual wind speed	mph	u_m	10.5
Mean annual wind speed	m/s	u_m	4.69
u_m/u_t			0.395
$x = 0.886\ u_t/u_m$			2.24
F(x)			0.138
Annual average PM_{10} flux	kg-soil/m^2-s	$J_{10,w}$	**4.26E-11**

Appendix A
Table 6c
Vapor Flux from Soil to Outdoor Air for Resident
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	K_{oc} (L/kg)	K_d (L/kg)	H (unitless)	D_{air} (m^2/d)	D_{water} (m^2/d)	R_L (unitless)	D_G (m^2/d)	D_L (m^2/d)	D_E (m^2/d)	J_v (kg/m^2-s)
VOC	Benzene	71-43-2	5.82E+01		2.19E-01	7.60E-01	8.47E-05	3.17E-01	1.23E-01	3.42E-08	8.51E-02	1.43E-05
VOC	Ethyl Benzene	100-41-4	3.67E+02		3.06E-01	6.48E-01	6.74E-05	1.37E+00	1.05E-01	2.72E-08	2.35E-02	1.32E-05
VOC	Toluene	108-88-3	1.80E+02		2.59E-01	7.52E-01	7.43E-05	7.35E-01	1.22E-01	3.00E-08	4.30E-02	1.38E-05
VOC	Xylenes (total)	1330-20-7	3.86E+02		3.30E-01	6.74E-01	7.56E-05	1.44E+00	1.09E-01	3.05E-08	2.51E-02	1.33E-05
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.21E+02		2.61E-05	2.38E-01	5.97E-05	4.56E-01	3.87E-02	2.41E-08	2.27E-06	3.35E-07
PDIST	Diesel Range Organics	DRO	1.50E+03		7.30E+01	5.18E-01	7.26E-05	2.85E+01	8.41E-02	2.93E-08	2.15E-01	1.47E-05
PCB	PCBs (total)	1336-36-3	2.45E+06		1.22E-01	1.75E-01	4.32E-05	8.15E+03	2.83E-02	1.75E-08	4.26E-07	1.45E-07
INORG	Antimony	7440-36-0		4.50E+01								
INORG	Arsenic	7440-38-2		2.90E+01								
INORG	Barium	7440-39-3		4.10E+01								
INORG	Beryllium	7440-41-7		7.90E+02								
INORG	Cadmium	7440-43-9		7.50E+01								
INORG	Chromium (total)	7440-47-3		1.80E+06								
INORG	Cobalt	7440-48-4		4.50E+01								
INORG	Copper	7440-50-8		3.50E+01								
INORG	Lead	7439-92-1		9.00E+02								
INORG	Mercury	7439-97-6		1.00E+03	4.07E-01	2.65E-01	5.44E-05	1.66E+03	4.31E-02	2.20E-08	1.06E-05	7.23E-07
INORG	Molybdenum	7439-98-7		2.00E+01								
INORG	Nickel	7440-02-0		6.50E+01								
INORG	Selenium	7782-49-2		5.00E+00								
INORG	Silver	7440-22-4		8.30E+00								
INORG	Thallium	7440-28-0		7.10E+01								
INORG	Vanadium	7440-62-2		1.00E+03								
INORG	Zinc	7440-66-6		6.20E+01								

Notes:

Soil bulk density	kg/L	ρ_b	1.66
Soil porosity	L/L-soil	θ	0.38
Soil water content	L/L-soil	θ_w	0.05
Soil air-filled porosity	L/L-soil	θ_a	0.32
Soil organic carbon fraction	unitless	f_{oc}	0.002
Averaging period (Exposure Duration)	year	T	26
	days	T	9490
	s	T	8.2E+08
Molar Gas Constant	L-mmHg/ mole-°K	R	62.411
Temperature	°C	Temp	24
	K	Temp	297
Clean soil above source	m	Z_1	
Bottom of source depth	m	Z_2	7.62

The K_d for organic compounds is the K_{oc} times the foc.

Appendix A
Table 6d
Unit Cancer Risk Calculations for Exposure of Resident to Soil
GGNRA Hawk Hill, Marin Headlands, CA

					Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	Cancer Class	C_{soil} (mg/kg)	RBA	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	Risk	ABS_{derm}	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	Risk	C_{air} (mg/m^3)	URF (m^3/mg)	Risk	C_{air} (mg/m^3)	URF $(mg/m^3)^{-1}$	Risk	Risk
VOC	Benzene	71-43-2	A	1.00E+00		1.44E-06	1.0E-01	1.4E-07			1.0E-01		1.71E-04	2.9E-02	1.8E-06	5.11E-10	2.9E-02	5.3E-12	1.9E-06
VOC	Ethyl Benzene	100-41-4	D	1.00E+00		1.44E-06							1.59E-04			5.11E-10			
VOC	Toluene	108-88-3	ID	1.00E+00		1.44E-06							1.66E-04			5.11E-10			
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00		1.44E-06							1.60E-04			5.11E-10			
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	1.00E+00		1.44E-06			1.00E-01	4.05E-07			4.02E-06			5.11E-10			
PDIST	Diesel Range Organics	DRO		1.00E+00		1.44E-06							1.76E-04			5.11E-10			
PCB	PCBs (total)	1336-36-3	B2	1.00E+00		1.44E-06	2.0E+00	2.9E-06	1.40E-01	5.67E-07	2.0E+00	1.1E-06	1.74E-06	5.7E-01	3.5E-07	5.11E-10	5.7E-01	1.0E-10	4.4E-06
INORG	Antimony	7440-36-0	ID	1.00E+00		1.44E-06										5.11E-10			
INORG	Arsenic	7440-38-2	A	1.00E+00	0.6	1.44E-06	9.5E+00	8.2E-06	3.00E-02	1.21E-07	9.5E+00	1.2E-06		4.3E+00		5.11E-10	4.3E+00	7.8E-10	9.4E-06
INORG	Barium	7440-39-3	NC	1.00E+00		1.44E-06										5.11E-10			
INORG	Beryllium	7440-41-7	B1	1.00E+00		1.44E-06								2.4E+00		5.11E-10	2.4E+00	4.4E-10	4.4E-10
INORG	Cadmium	7440-43-9	B1	1.00E+00		1.44E-06			1.00E-03	4.05E-09				4.2E+00		5.11E-10	4.2E+00	7.6E-10	7.6E-10
INORG	Chromium (total)	7440-47-3		1.00E+00		1.44E-06										5.11E-10			
INORG	Cobalt	7440-48-4	LC	1.00E+00		1.44E-06								9.0E+00		5.11E-10	9.0E+00	1.6E-09	1.6E-09
INORG	Copper	7440-50-8	D	1.00E+00		1.44E-06										5.11E-10			
INORG	Lead	7439-92-1	B2	1.00E+00		1.44E-06										5.11E-10			
INORG	Mercury	7439-97-6	D	1.00E+00		1.44E-06							8.68E-06			5.11E-10			
INORG	Molybdenum	7439-98-7		1.00E+00		1.44E-06										5.11E-10			
INORG	Nickel	7440-02-0	A	1.00E+00		1.44E-06								2.6E-01		5.11E-10	2.6E-01	4.7E-11	4.7E-11
INORG	Selenium	7782-49-2	D	1.00E+00		1.44E-06										5.11E-10			
INORG	Silver	7440-22-4	D	1.00E+00		1.44E-06										5.11E-10			
INORG	Thallium	7440-28-0	ID	1.00E+00		1.44E-06										5.11E-10			
INORG	Vanadium	7440-62-2	ID	1.00E+00		1.44E-06										5.11E-10			
INORG	Zinc	7440-66-6	ID	1.00E+00		1.44E-06										5.11E-10			

Notes:
f_{oral} and f_{inh} are the fraction of the oral and inhalation toxicity values, respectively, that USEPA identified as having a mutagenic mode of action.
RBA - relative bioavailability factor

Appendix A
Table 6e
Unit Hazard Quotient Calculations for Exposure of Resident to Soil
GGNRA Hawk Hill, Marin Headlands, CA

				Soil Ingestion				Soil Dermal Contact				Soil Vapor Inhalation			Soil Particulate Inhalation			All Routes
Chem Group	Chemical	CASRN	C_{soil} (mg/kg)	RBA	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	HQ	ABS_{derm}	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	C_{air} (mg/m^3)	RfC (mg/m^3)	HQ	HQ
VOC	Benzene	71-43-2	1.00E+00		3.87E-06	4.0E-03	9.7E-04			4.0E-03		1.71E-04	3.0E-03	5.5E-02	5.11E-10	3.0E-03	1.6E-07	5.6E-02
VOC	Ethyl Benzene	100-41-4	1.00E+00		3.87E-06	5.0E-02	7.7E-05			5.0E-02		1.59E-04	1.0E+00	1.5E-04	5.11E-10	1.0E+00	4.9E-10	2.3E-04
VOC	Toluene	108-88-3	1.00E+00		3.87E-06	8.0E-02	4.8E-05			8.0E-02		1.66E-04	3.0E-01	5.3E-04	5.11E-10	3.0E-01	1.6E-09	5.8E-04
VOC	Xylenes (total)	1330-20-7	1.00E+00		3.87E-06	2.0E-01	1.9E-05			2.0E-01		1.60E-04	1.0E-01	1.5E-03	5.11E-10	1.0E-01	4.9E-09	1.5E-03
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.00E+00		3.87E-06	8.0E-05	4.8E-02	1.00E-01	1.09E-06	8.0E-05	1.4E-02	4.02E-06			5.11E-10			6.2E-02
PDIST	Diesel Range Organics	DRO	1.00E+00		3.87E-06	1.9E-02	2.0E-04			1.9E-02		1.76E-04	2.6E-01	6.5E-04	5.11E-10	2.6E-01	1.9E-09	8.5E-04
PCB	PCBs (total)	1336-36-3	1.00E+00		3.87E-06	2.0E-05	1.9E-01	1.40E-01	1.53E-06	2.0E-05	7.6E-02	1.74E-06			5.11E-10			2.7E-01
INORG	Antimony	7440-36-0	1.00E+00		3.87E-06	4.0E-04	9.7E-03			6.0E-05					5.11E-10			9.7E-03
INORG	Arsenic	7440-38-2	1.00E+00	0.6	3.87E-06	3.5E-06	6.6E-01	3.00E-02	3.27E-07	3.5E-06	9.3E-02		1.5E-05		5.11E-10	1.5E-05	3.3E-05	7.6E-01
INORG	Barium	7440-39-3	1.00E+00		3.87E-06	2.0E-01	1.9E-05			1.4E-02			5.0E-04		5.11E-10	5.0E-04	9.8E-07	2.0E-05
INORG	Beryllium	7440-41-7	1.00E+00		3.87E-06	2.0E-04	1.9E-02			1.4E-06			7.0E-06		5.11E-10	7.0E-06	7.0E-05	1.9E-02
INORG	Cadmium	7440-43-9	1.00E+00		3.87E-06	1.0E-03	3.9E-03	1.00E-03	1.09E-08	2.5E-05	4.4E-04		1.0E-05		5.11E-10	1.0E-05	4.9E-05	4.4E-03
INORG	Chromium (total)	7440-47-3	1.00E+00		3.87E-06	1.5E+00	2.6E-06			2.0E-02			5.0E-03		5.11E-10	5.0E-03	9.8E-08	2.7E-06
INORG	Cobalt	7440-48-4	1.00E+00		3.87E-06	3.0E-04	1.3E-02			3.0E-04			6.0E-06		5.11E-10	6.0E-06	8.2E-05	1.3E-02
INORG	Copper	7440-50-8	1.00E+00		3.87E-06	1.0E-02	3.9E-04			1.0E-02					5.11E-10			3.9E-04
INORG	Lead	7439-92-1	1.00E+00		3.87E-06										5.11E-10			
INORG	Mercury	7439-97-6	1.00E+00		3.87E-06	1.6E-04	2.4E-02			1.1E-05		8.68E-06	3.0E-05	2.8E-01	5.11E-10	3.0E-05	1.6E-05	3.0E-01
INORG	Molybdenum	7439-98-7	1.00E+00		3.87E-06	5.0E-03	7.7E-04			5.0E-03					5.11E-10			7.7E-04
INORG	Nickel	7440-02-0	1.00E+00		3.87E-06	1.1E-02	3.5E-04			4.4E-04			1.4E-05		5.11E-10	1.4E-05	3.5E-05	3.9E-04
INORG	Selenium	7782-49-2	1.00E+00		3.87E-06	5.0E-03	7.7E-04			5.0E-03			2.0E-02		5.11E-10	2.0E-02	2.4E-08	7.7E-04
INORG	Silver	7440-22-4	1.00E+00		3.87E-06	5.0E-03	7.7E-04			2.0E-04			1.0E-05		5.11E-10	1.0E-05	4.9E-05	8.2E-04
INORG	Thallium	7440-28-0	1.00E+00		3.87E-06	1.0E-05	3.9E-01			1.0E-05					5.11E-10			3.9E-01
INORG	Vanadium	7440-62-2	1.00E+00		3.87E-06	5.0E-03	7.7E-04			1.3E-04			1.0E-04		5.11E-10	1.0E-04	4.9E-06	7.7E-04
INORG	Zinc	7440-66-6	1.00E+00		3.87E-06	3.0E-01	1.3E-05			3.0E-01					5.11E-10			1.3E-05

Notes:
RBA - relative bioavailability factor

Appendix A
Table 7
Upper-Bound Total Soil Cumulative Cancer Risks and Noncancer HIs
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Park Worker		Maintenance Worker		Construction Worker		Resident	
		Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI	Risk	HI	Risk	HI
AOI 05	AOI5-SS-01	NC	3E-01	NC	1E-01	NC	1E+00	NC	1E+00
AOI 05	F9-SB01	NC	1E-02	NC	7E-03	NC	6E-02	NC	6E-02
AOI 05	F9-SB02	NC	1E-07	NC	7E-08	NC	1E-07	NC	6E-07
AOI 05	F9-SB03	NC	1E-07	NC	6E-08	NC	1E-07	NC	5E-07
AOI 05	F9-SB04	NC	2E-07	NC	7E-08	NC	1E-07	NC	6E-07
AOI 05	F9-SB05	2E-10	8E-01	4E-11	4E-01	1E-10	**3E+00**	8E-10	**4E+00**
AOI 05	F9-SB06	NC	NC	NC	NC	NC	NC	NC	NC
AOI 05	F9-SB07	3E-10	8E-06	5E-11	4E-06	2E-10	5E-06	1E-09	3E-05
AOI 05	F9-SB08	NC	NC	NC	NC	NC	NC	NC	NC
AOI 13	AOI13-SS-01	4E-08	3E-03	8E-09	1E-03	4E-09	2E-03	2E-07	1E-02
AOI 13	AOI13-SS-02	5E-08	3E-03	9E-09	2E-03	5E-09	3E-03	3E-07	2E-02
AOI 13	AOI13-SS-03	1E-08	6E-04	2E-09	3E-04	1E-09	6E-04	6E-08	4E-03
AOI 13	AOI13-SS-04	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-14-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-1	**5E-06**	5E-01	1E-06	3E-01	7E-07	7E-02	**4E-05**	**3E+00**
AOI 15	SS-12-2	**5E-06**	5E-01	1E-06	3E-01	6E-07	9E-02	**4E-05**	**3E+00**
AOI 15	SS-12-3	**4E-06**	4E-01	1E-06	3E-01	5E-07	9E-02	**3E-05**	**3E+00**
AOI 15	SS-17-1	**4E-06**	4E-01	1E-06	3E-01	6E-07	9E-02	**3E-05**	**3E+00**
AOI 15	SS-17-2	**5E-06**	4E-01	1E-06	3E-01	6E-07	9E-02	**3E-05**	**3E+00**
AOI 15	SS-17-3	**4E-06**	4E-01	1E-06	3E-01	5E-07	8E-02	**3E-05**	**3E+00**
AOI 16	SS-13-1	**3E-06**	3E-01	9E-07	2E-01	4E-07	7E-02	**2E-05**	**2E+00**
AOI 16	SS-13-2	**3E-06**	3E-01	9E-07	2E-01	4E-07	7E-02	**3E-05**	**2E+00**
AOI 16	SS-16-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16-2	**5E-06**	5E-01	1E-06	3E-01	7E-07	1E-01	**4E-05**	**4E+00**
AOI 16	SS-16A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-1	**5E-06**	5E-01	1E-06	3E-01	6E-07	8E-02	**4E-05**	**3E+00**
AOI 16	SS-18-10	**4E-06**	3E-01	1E-06	2E-01	5E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-11	**4E-06**	3E-01	1E-06	2E-01	5E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-12	**6E-06**	5E-01	1E-06	3E-01	7E-07	4E-03	**4E-05**	**3E+00**
AOI 16	SS-18-13	**3E-06**	3E-01	9E-07	2E-01	4E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-14	**3E-06**	3E-01	9E-07	2E-01	4E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-2	**7E-06**	6E-01	**2E-06**	4E-01	9E-07	1E-01	**5E-05**	**5E+00**
AOI 16	SS-18-2-A1	**3E-06**	3E-01	8E-07	2E-01	4E-07	2E-03	**2E-05**	**2E+00**
AOI 16	SS-18-2-B1	**4E-06**	3E-01	9E-07	2E-01	4E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-2-B2	**5E-06**	4E-01	1E-06	3E-01	6E-07	4E-03	**3E-05**	**3E+00**
AOI 16	SS-18-2-C1	**3E-06**	3E-01	9E-07	2E-01	4E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-2-C2	**4E-06**	3E-01	1E-06	2E-01	5E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-2-C3	**3E-06**	2E-01	7E-07	2E-01	4E-07	2E-03	**2E-05**	**2E+00**
AOI 16	SS-18-2-D1	**3E-06**	3E-01	8E-07	2E-01	4E-07	3E-03	**2E-05**	**2E+00**
AOI 16	SS-18-2-D2	**4E-06**	3E-01	1E-06	2E-01	5E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-3	**5E-06**	4E-01	1E-06	3E-01	6E-07	4E-03	**4E-05**	**3E+00**
AOI 16	SS-18-4	**5E-06**	4E-01	1E-06	3E-01	6E-07	4E-03	**3E-05**	**3E+00**
AOI 16	SS-18-5	**4E-06**	3E-01	1E-06	2E-01	5E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-6	**4E-06**	4E-01	1E-06	2E-01	6E-07	4E-03	**3E-05**	**3E+00**
AOI 16	SS-18-7	**4E-06**	3E-01	1E-06	2E-01	5E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-8	**4E-06**	3E-01	9E-07	2E-01	4E-07	3E-03	**3E-05**	**2E+00**
AOI 16	SS-18-9	**3E-06**	3E-01	8E-07	2E-01	4E-07	2E-03	**2E-05**	**2E+00**
AOI 17	SS-9-1	**4E-06**	3E-01	1E-06	2E-01	5E-07	5E-02	**3E-05**	**2E+00**
AOI 17	SS-9-2	**4E-06**	4E-01	1E-06	3E-01	5E-07	6E-02	**3E-05**	**3E+00**
AOI 17	SS-9-3	**3E-06**	3E-01	8E-07	2E-01	4E-07	6E-02	**2E-05**	**2E+00**
AOI 18	SS-21-1	6E-08	4E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 18	SS-5-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-2	4E-08	3E-03	8E-09	1E-03	5E-09	3E-03	3E-07	2E-02
AOI 18	SS-5-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-3	NC	NC	NC	NC	NC	NC	NC	NC

Appendix A
Table 7
Upper-Bound Total Soil Cumulative Cancer Risks and Noncancer HIs
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Park Worker		Maintenance Worker		Construction Worker		Resident	
		Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI	Risk	HI	Risk	HI
AOI 19	SS-19-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-L-COMP	NC	1E-03	NC	6E-04	NC	5E-03	NC	5E-03
AOI 20	ID-U	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	SS-20-1	5E-08	3E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 21	SS-4-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-3	6E-08	4E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 21	SS-4-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-5	6E-08	4E-03	1E-08	2E-03	6E-09	3E-03	3E-07	2E-02
AOI 21	SS-4-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-7	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-8	5E-08	3E-03	9E-09	1E-03	5E-09	3E-03	3E-07	2E-02
AOI 21	SS-4A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-7	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-8	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-SED	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-2	2E-07	9E-03	3E-08	5E-03	2E-08	9E-03	9E-07	5E-02
AOI 23	SS-8-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-5	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-2	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-3	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-4	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-5	**5E-06**	5E-01	1E-06	3E-01	6E-07	9E-02	**4E-05**	**3E+00**
AOI 23	SS-8A-6	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	DO-1	**5E-06**	5E-01	1E-06	3E-01	7E-07	2E-01	**4E-05**	**3E+00**
AOI 24	SS-2-1	**2E-05**	**2E+00**	**3E-06**	9E-01	**2E-06**	1E+00	**1E-04**	**1E+01**
AOI 24	SS-2-2	**4E-06**	4E-01	1E-06	3E-01	5E-07	1E-01	**3E-05**	**3E+00**
AOI 24	SS-2-3	**4E-06**	4E-01	1E-06	3E-01	6E-07	1E-01	**3E-05**	**3E+00**
AOI 24	SS-2-4	**4E-06**	4E-01	1E-06	3E-01	6E-07	1E-01	**3E-05**	**3E+00**
AOI 24	SS-2-5	**5E-06**	5E-01	1E-06	3E-01	6E-07	9E-02	**4E-05**	**3E+00**
AOI 24	SS-2-6	**3E-06**	3E-01	9E-07	2E-01	5E-07	8E-02	**3E-05**	**2E+00**
AOI 24	SS-2-7	**3E-06**	3E-01	1E-06	2E-01	5E-07	9E-02	**3E-05**	**3E+00**
AOI 24	SS-2-8	**3E-06**	3E-01	8E-07	2E-01	4E-07	7E-02	**2E-05**	**2E+00**
AOI 25	SS-3-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3-2	9E-08	6E-03	2E-08	3E-03	1E-08	5E-03	5E-07	3E-02
AOI 25	SS-3A-1	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3A-2	NC	NC	NC	NC	NC	NC	NC	NC
Unassigned	SS-23-1	NC	NC	NC	NC	NC	NC	NC	NC

Notes:
Cumulative cancer risk and HI estimates in excess of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HI estimates were not calculated for detected chemicals with inadequate toxicity or physical/chemical parameters or where chemical concentrations were non-detect.

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Resident Outdoor Activities	
							Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 05	AOI5-SS-01	PDIST	Diesel Range Organics	DRO		1.40E+03	NC	**2.6E-01**	NC	1.4E-01	NC	**1.2E+00**	NC	**1.2E+00**
AOI 05	F9-SB01	VOC	Toluene	108-88-3	ID	1.60E-03	NC	2.2E-07	NC	1.1E-07	NC	1.9E-07	NC	9.2E-07
AOI 05	F9-SB01	PDIST	Diesel Range Organics	DRO		6.55E+01	NC	1.2E-02	NC	6.5E-03	NC	5.5E-02	NC	5.6E-02
AOI 05	F9-SB02	VOC	Toluene	108-88-3	ID	1.00E-03	NC	1.4E-07	NC	6.8E-08	NC	1.2E-07	NC	5.8E-07
AOI 05	F9-SB03	VOC	Toluene	108-88-3	ID	9.40E-04	NC	1.3E-07	NC	6.4E-08	NC	1.1E-07	NC	5.4E-07
AOI 05	F9-SB04	VOC	Toluene	108-88-3	ID	1.10E-03	NC	1.5E-07	NC	7.5E-08	NC	1.3E-07	NC	6.4E-07
AOI 05	F9-SB05	VOC	Benzene	71-43-2	A	4.40E-04	1.9E-10	6.0E-06	3.9E-11	3.0E-06	1.3E-10	3.5E-06	8.4E-10	2.5E-05
AOI 05	F9-SB05	VOC	Ethyl Benzene	100-41-4	D	3.00E-03	NC	1.4E-07	NC	7.5E-08	NC	2.6E-07	NC	6.9E-07
AOI 05	F9-SB05	VOC	Toluene	108-88-3	ID	1.10E-03	NC	1.5E-07	NC	7.5E-08	NC	1.3E-07	NC	6.4E-07
AOI 05	F9-SB05	VOC	Xylenes (total)	1330-20-7	ID	1.50E-02	NC	5.7E-06	NC	2.7E-06	NC	2.4E-05	NC	2.3E-05
AOI 05	F9-SB05	PDIST	Diesel Range Organics	DRO		4.10E+03	NC	**7.5E-01**	NC	**4.1E-01**	NC	**3.5E+00**	NC	**3.5E+00**
AOI 05	F9-SB07	VOC	Benzene	71-43-2	A	5.80E-04	2.5E-10	7.9E-06	5.1E-11	3.9E-06	1.7E-10	4.7E-06	1.1E-09	3.2E-05
AOI 13	AOI13-SS-01	PCB	PCBs (total)	1336-36-3	B2	5.40E-02	4.1E-08	2.5E-03	7.7E-09	1.2E-03	4.3E-09	2.4E-03	**2.4E-07**	1.5E-02
AOI 13	AOI13-SS-02	PCB	PCBs (total)	1336-36-3	B2	6.60E-02	5.0E-08	3.1E-03	9.4E-09	1.5E-03	5.3E-09	2.9E-03	**2.9E-07**	1.8E-02
AOI 13	AOI13-SS-03	PCB	PCBs (total)	1336-36-3	B2	1.30E-02	9.8E-09	6.1E-04	1.9E-09	3.0E-04	1.0E-09	5.8E-04	5.7E-08	3.5E-03
AOI 14	SS-14-1	INORG	Lead	7439-92-1	B2	8.10E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-1	INORG	Lead	7439-92-1	B2	2.40E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15-2	INORG	Lead	7439-92-1	B2	6.60E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-1	INORG	Lead	7439-92-1	B2	4.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	SS-15A-2	INORG	Lead	7439-92-1	B2	1.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-1	INORG	Antimony	7440-36-0	ID	4.30E-01	NC	4.6E-04	NC	3.8E-04	NC	1.8E-03	NC	4.2E-03
AOI 15	SS-12-1	INORG	Arsenic	7440-38-2	A	4.10E+00	**5.1E-06**	**4.3E-01**	**1.3E-06**	**2.8E-01**	**6.4E-07**	4.1E-03	**3.8E-05**	**3.1E+00**
AOI 15	SS-12-1	INORG	Barium	7440-39-3	NC	4.10E+02	NC	9.7E-04	NC	2.7E-03	NC	1.3E-02	NC	8.3E-03
AOI 15	SS-12-1	INORG	Beryllium	7440-41-7	B1	3.70E-01	3.7E-11	8.0E-04	3.0E-10	7.8E-04	1.5E-10	3.8E-03	1.6E-10	7.2E-03
AOI 15	SS-12-1	INORG	Cadmium	7440-43-9	B1	9.30E-02	1.6E-11	5.4E-05	1.3E-10	5.8E-05	6.4E-11	1.7E-04	7.1E-11	4.1E-04
AOI 15	SS-12-1	INORG	Chromium (total)	7440-47-3		2.80E+01	NC	8.6E-06	NC	2.0E-05	NC	9.6E-05	NC	7.5E-05
AOI 15	SS-12-1	INORG	Cobalt	7440-48-4	LC	1.60E+01	6.0E-09	2.3E-02	4.9E-08	2.5E-02	2.4E-08	1.8E-02	2.6E-08	**2.1E-01**
AOI 15	SS-12-1	INORG	Copper	7440-50-8	D	4.10E+01	NC	1.8E-03	NC	1.5E-03	NC	7.0E-03	NC	1.6E-02
AOI 15	SS-12-1	INORG	Lead	7439-92-1	B2	1.60E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-1	INORG	Mercury	7439-97-6	D	5.20E-02	NC	3.6E-03	NC	1.3E-03	NC	1.8E-03	NC	1.6E-02
AOI 15	SS-12-1	INORG	Molybdenum	7439-98-7		1.10E+00	NC	9.4E-05	NC	7.8E-05	NC	3.8E-04	NC	8.5E-04
AOI 15	SS-12-1	INORG	Nickel	7440-02-0	A	2.30E+01	2.5E-10	1.1E-03	2.0E-09	4.6E-03	9.8E-10	3.3E-03	1.1E-09	8.9E-03
AOI 15	SS-12-1	INORG	Selenium	7782-49-2	D	7.90E-01	NC	6.8E-05	NC	5.6E-05	NC	2.7E-04	NC	6.1E-04
AOI 15	SS-12-1	INORG	Thallium	7440-28-0	ID	1.70E-01	NC	7.3E-03	NC	6.1E-03	NC	NC	NC	6.6E-02
AOI 15	SS-12-1	INORG	Vanadium	7440-62-2	ID	5.20E+01	NC	4.5E-03	NC	4.9E-03	NC	1.5E-02	NC	4.0E-02
AOI 15	SS-12-1	INORG	Zinc	7440-66-6	ID	3.80E+01	NC	5.4E-05	NC	4.5E-05	NC	2.2E-04	NC	4.9E-04
AOI 15	SS-12-2	INORG	Antimony	7440-36-0	ID	3.80E-01	NC	4.1E-04	NC	3.4E-04	NC	1.6E-03	NC	3.7E-03
AOI 15	SS-12-2	INORG	Arsenic	7440-38-2	A	4.00E+00	**5.0E-06**	**4.2E-01**	**1.3E-06**	**2.7E-01**	**6.2E-07**	4.0E-03	**3.7E-05**	**3.0E+00**
AOI 15	SS-12-2	INORG	Barium	7440-39-3	NC	4.90E+02	NC	1.2E-03	NC	3.2E-03	NC	1.5E-02	NC	1.0E-02
AOI 15	SS-12-2	INORG	Beryllium	7440-41-7	B1	4.80E-01	4.8E-11	1.0E-03	3.9E-10	1.0E-03	1.9E-10	4.9E-03	2.1E-10	9.3E-03
AOI 15	SS-12-2	INORG	Cadmium	7440-43-9	B1	1.60E-01	2.8E-11	9.4E-05	2.3E-10	1.0E-04	1.1E-10	3.0E-04	1.2E-10	7.0E-04
AOI 15	SS-12-2	INORG	Chromium (total)	7440-47-3		3.10E+01	NC	9.6E-06	NC	2.2E-05	NC	1.1E-04	NC	8.3E-05
AOI 15	SS-12-2	INORG	Cobalt	7440-48-4	LC	1.90E+01	7.1E-09	2.7E-02	5.8E-08	3.0E-02	2.8E-08	2.2E-02	3.1E-08	**2.5E-01**
AOI 15	SS-12-2	INORG	Copper	7440-50-8	D	5.50E+01	NC	2.4E-03	NC	2.0E-03	NC	9.4E-03	NC	2.1E-02
AOI 15	SS-12-2	INORG	Lead	7439-92-1	B2	1.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-2	INORG	Mercury	7439-97-6	D	4.40E-02	NC	3.1E-03	NC	1.1E-03	NC	1.5E-03	NC	1.3E-02
AOI 15	SS-12-2	INORG	Molybdenum	7439-98-7		8.10E-01	NC	6.9E-05	NC	5.8E-05	NC	2.8E-04	NC	6.3E-04
AOI 15	SS-12-2	INORG	Nickel	7440-02-0	A	3.00E+01	3.3E-10	1.4E-03	2.7E-09	6.1E-03	1.3E-09	4.3E-03	1.4E-09	1.2E-02
AOI 15	SS-12-2	INORG	Selenium	7782-49-2	D	8.60E-01	NC	7.4E-05	NC	6.1E-05	NC	3.0E-04	NC	6.7E-04
AOI 15	SS-12-2	INORG	Thallium	7440-28-0	ID	1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-12-2	INORG	Vanadium	7440-62-2	ID	8.30E+01	NC	7.1E-03	NC	7.8E-03	NC	2.4E-02	NC	6.4E-02

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 15	SS-12-2	INORG	Zinc	7440-66-6	ID	5.00E+01	NC	7.1E-05	NC	5.9E-05	NC	2.9E-04	NC	6.5E-04
AOI 15	SS-12-3	INORG	Antimony	7440-36-0	ID	4.50E-01	NC	4.8E-04	NC	4.0E-04	NC	1.9E-03	NC	4.4E-03
AOI 15	SS-12-3	INORG	Arsenic	7440-38-2	A	3.30E+00	**4.1E-06**	**3.4E-01**	**1.1E-06**	**2.2E-01**	**5.1E-07**	3.3E-03	**3.1E-05**	**2.5E+00**
AOI 15	SS-12-3	INORG	Barium	7440-39-3	NC	6.30E+02	NC	1.5E-03	NC	4.1E-03	NC	2.0E-02	NC	1.3E-02
AOI 15	SS-12-3	INORG	Beryllium	7440-41-7	B1	5.30E-01	5.3E-11	1.1E-03	4.3E-10	1.1E-03	2.1E-10	5.4E-03	2.3E-10	1.0E-02
AOI 15	SS-12-3	INORG	Cadmium	7440-43-9	B1	1.30E-01	2.3E-11	7.6E-05	1.9E-10	8.1E-05	8.9E-11	2.4E-04	9.9E-11	5.7E-04
AOI 15	SS-12-3	INORG	Chromium (total)	7440-47-3		2.90E+01	NC	9.0E-06	NC	2.1E-05	NC	9.9E-05	NC	7.8E-05
AOI 15	SS-12-3	INORG	Cobalt	7440-48-4	LC	2.10E+01	7.9E-09	3.0E-02	6.4E-08	3.3E-02	3.1E-08	2.4E-02	3.4E-08	**2.7E-01**
AOI 15	SS-12-3	INORG	Copper	7440-50-8	D	5.70E+01	NC	2.4E-03	NC	2.0E-03	NC	9.8E-03	NC	2.2E-02
AOI 15	SS-12-3	INORG	Lead	7439-92-1	B2	1.50E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-12-3	INORG	Mercury	7439-97-6	D	4.40E-02	NC	3.1E-03	NC	1.1E-03	NC	1.5E-03	NC	1.3E-02
AOI 15	SS-12-3	INORG	Molybdenum	7439-98-7		8.40E-01	NC	7.2E-05	NC	6.0E-05	NC	2.9E-04	NC	6.5E-04
AOI 15	SS-12-3	INORG	Nickel	7440-02-0	A	2.90E+01	3.1E-10	1.4E-03	2.6E-09	5.9E-03	1.2E-09	4.1E-03	1.4E-09	1.1E-02
AOI 15	SS-12-3	INORG	Selenium	7782-49-2	D	5.30E-01	NC	4.5E-05	NC	3.8E-05	NC	1.8E-04	NC	4.1E-04
AOI 15	SS-12-3	INORG	Thallium	7440-28-0	ID	1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-12-3	INORG	Vanadium	7440-62-2	ID	8.30E+01	NC	7.1E-03	NC	7.8E-03	NC	2.4E-02	NC	6.4E-02
AOI 15	SS-12-3	INORG	Zinc	7440-66-6	ID	5.20E+01	NC	7.4E-05	NC	6.2E-05	NC	3.0E-04	NC	6.7E-04
AOI 15	SS-17-1	INORG	Antimony	7440-36-0	ID	4.60E-01	NC	4.9E-04	NC	4.1E-04	NC	2.0E-03	NC	4.5E-03
AOI 15	SS-17-1	INORG	Arsenic	7440-38-2	A	3.50E+00	**4.3E-06**	**3.7E-01**	**1.1E-06**	**2.4E-01**	**5.4E-07**	3.5E-03	**3.3E-05**	**2.7E+00**
AOI 15	SS-17-1	INORG	Barium	7440-39-3	NC	5.40E+02	NC	1.3E-03	NC	3.5E-03	NC	1.7E-02	NC	1.1E-02
AOI 15	SS-17-1	INORG	Beryllium	7440-41-7	B1	4.90E-01	4.9E-11	1.1E-03	4.0E-10	1.0E-03	1.9E-10	5.0E-03	2.1E-10	9.5E-03
AOI 15	SS-17-1	INORG	Cadmium	7440-43-9	B1	6.50E-02	1.1E-11	3.8E-05	9.3E-11	4.1E-05	4.5E-11	1.2E-04	5.0E-11	2.8E-04
AOI 15	SS-17-1	INORG	Chromium (total)	7440-47-3		2.70E+01	NC	8.3E-06	NC	1.9E-05	NC	9.3E-05	NC	7.2E-05
AOI 15	SS-17-1	INORG	Cobalt	7440-48-4	LC	2.00E+01	7.5E-09	2.9E-02	6.1E-08	3.2E-02	2.9E-08	2.3E-02	3.3E-08	**2.6E-01**
AOI 15	SS-17-1	INORG	Copper	7440-50-8	D	5.90E+01	NC	2.5E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 15	SS-17-1	INORG	Lead	7439-92-1	B2	1.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-17-1	INORG	Mercury	7439-97-6	D	3.40E-02	NC	2.4E-03	NC	8.3E-04	NC	1.2E-03	NC	1.0E-02
AOI 15	SS-17-1	INORG	Molybdenum	7439-98-7		9.20E-01	NC	7.9E-05	NC	6.6E-05	NC	3.2E-04	NC	7.1E-04
AOI 15	SS-17-1	INORG	Nickel	7440-02-0	A	3.70E+01	4.0E-10	1.7E-03	3.3E-09	7.5E-03	1.6E-09	5.3E-03	1.8E-09	1.4E-02
AOI 15	SS-17-1	INORG	Selenium	7782-49-2	D	5.60E-01	NC	4.8E-05	NC	4.0E-05	NC	1.9E-04	NC	4.3E-04
AOI 15	SS-17-1	INORG	Thallium	7440-28-0	ID	1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-17-1	INORG	Vanadium	7440-62-2	ID	6.40E+01	NC	5.5E-03	NC	6.0E-03	NC	1.8E-02	NC	4.9E-02
AOI 15	SS-17-1	INORG	Zinc	7440-66-6	ID	3.90E+01	NC	5.6E-05	NC	4.6E-05	NC	2.2E-04	NC	5.0E-04
AOI 15	SS-17-2	INORG	Antimony	7440-36-0	ID	4.20E-01	NC	4.5E-04	NC	3.7E-04	NC	1.8E-03	NC	4.1E-03
AOI 15	SS-17-2	INORG	Arsenic	7440-38-2	A	3.70E+00	**4.6E-06**	**3.9E-01**	**1.2E-06**	**2.5E-01**	**5.7E-07**	3.7E-03	**3.5E-05**	**2.8E+00**
AOI 15	SS-17-2	INORG	Barium	7440-39-3	NC	5.60E+02	NC	1.3E-03	NC	3.7E-03	NC	1.8E-02	NC	1.1E-02
AOI 15	SS-17-2	INORG	Beryllium	7440-41-7	B1	5.00E-01	5.0E-11	1.1E-03	4.1E-10	1.1E-03	2.0E-10	5.1E-03	2.2E-10	9.7E-03
AOI 15	SS-17-2	INORG	Chromium (total)	7440-47-3		2.90E+01	NC	9.0E-06	NC	2.1E-05	NC	9.9E-05	NC	7.8E-05
AOI 15	SS-17-2	INORG	Cobalt	7440-48-4	LC	2.00E+01	7.5E-09	2.9E-02	6.1E-08	3.2E-02	2.9E-08	2.3E-02	3.3E-08	**2.6E-01**
AOI 15	SS-17-2	INORG	Copper	7440-50-8	D	5.90E+01	NC	2.5E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 15	SS-17-2	INORG	Lead	7439-92-1	B2	1.10E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-17-2	INORG	Mercury	7439-97-6	D	3.00E-02	NC	2.1E-03	NC	7.3E-04	NC	1.0E-03	NC	9.1E-03
AOI 15	SS-17-2	INORG	Molybdenum	7439-98-7		8.00E-01	NC	6.9E-05	NC	5.7E-05	NC	2.7E-04	NC	6.2E-04
AOI 15	SS-17-2	INORG	Nickel	7440-02-0	A	2.90E+01	3.1E-10	1.4E-03	2.6E-09	5.9E-03	1.2E-09	4.1E-03	1.4E-09	1.1E-02
AOI 15	SS-17-2	INORG	Selenium	7782-49-2	D	5.00E-01	NC	4.3E-05	NC	3.6E-05	NC	1.7E-04	NC	3.9E-04
AOI 15	SS-17-2	INORG	Thallium	7440-28-0	ID	1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 15	SS-17-2	INORG	Vanadium	7440-62-2	ID	7.00E+01	NC	6.0E-03	NC	6.6E-03	NC	2.0E-02	NC	5.4E-02
AOI 15	SS-17-2	INORG	Zinc	7440-66-6	ID	3.80E+01	NC	5.4E-05	NC	4.5E-05	NC	2.2E-04	NC	4.9E-04
AOI 15	SS-17-3	INORG	Antimony	7440-36-0	ID	3.50E-01	NC	3.8E-04	NC	3.1E-04	NC	1.5E-03	NC	3.4E-03
AOI 15	SS-17-3	INORG	Arsenic	7440-38-2	A	3.20E+00	**4.0E-06**	**3.3E-01**	**1.0E-06**	**2.2E-01**	**5.0E-07**	3.2E-03	**3.0E-05**	**2.4E+00**
AOI 15	SS-17-3	INORG	Barium	7440-39-3	NC	5.80E+02	NC	1.4E-03	NC	3.8E-03	NC	1.8E-02	NC	1.2E-02

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Resident Outdoor Activities	
							Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 15	SS-17-3	INORG	Beryllium	7440-41-7	B1	4.40E-01	4.4E-11	9.5E-04	3.6E-10	9.3E-04	1.7E-10	4.5E-03	1.9E-10	8.6E-03
AOI 15	SS-17-3	INORG	Chromium (total)	7440-47-3		2.90E+01	NC	9.0E-06	NC	2.1E-05	NC	9.9E-05	NC	7.8E-05
AOI 15	SS-17-3	INORG	Cobalt	7440-48-4	LC	1.70E+01	6.4E-09	2.5E-02	5.2E-08	2.7E-02	2.5E-08	1.9E-02	2.8E-08	**2.2E-01**
AOI 15	SS-17-3	INORG	Copper	7440-50-8	D	5.80E+01	NC	2.5E-03	NC	2.1E-03	NC	9.9E-03	NC	2.2E-02
AOI 15	SS-17-3	INORG	Lead	7439-92-1	B2	8.40E+00	NC	NC	NC	NC	NC	NC	NC	NC
AOI 15	SS-17-3	INORG	Mercury	7439-97-6	D	4.00E-02	NC	2.8E-03	NC	9.8E-04	NC	1.4E-03	NC	1.2E-02
AOI 15	SS-17-3	INORG	Molybdenum	7439-98-7		6.60E-01	NC	5.7E-05	NC	4.7E-05	NC	2.3E-04	NC	5.1E-04
AOI 15	SS-17-3	INORG	Nickel	7440-02-0	A	2.80E+01	3.0E-10	1.3E-03	2.5E-09	5.7E-03	1.2E-09	4.0E-03	1.3E-09	1.1E-02
AOI 15	SS-17-3	INORG	Selenium	7782-49-2	D	4.00E-01	NC	3.4E-05	NC	2.9E-05	NC	1.4E-04	NC	3.1E-04
AOI 15	SS-17-3	INORG	Thallium	7440-28-0	ID	1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 15	SS-17-3	INORG	Vanadium	7440-62-2	ID	6.60E+01	NC	5.7E-03	NC	6.2E-03	NC	1.9E-02	NC	5.1E-02
AOI 15	SS-17-3	INORG	Zinc	7440-66-6	ID	3.60E+01	NC	5.1E-05	NC	4.3E-05	NC	2.1E-04	NC	4.7E-04
AOI 16	SS-13-1	INORG	Antimony	7440-36-0	ID	7.40E-01	NC	7.9E-04	NC	6.6E-04	NC	3.2E-03	NC	7.2E-03
AOI 16	SS-13-1	INORG	Arsenic	7440-38-2	A	2.50E+00	**3.1E-06**	**2.6E-01**	**8.1E-07**	**1.7E-01**	**3.9E-07**	2.5E-03	**2.3E-05**	**1.9E+00**
AOI 16	SS-13-1	INORG	Barium	7440-39-3	NC	4.40E+02	NC	1.0E-03	NC	2.9E-03	NC	1.4E-02	NC	9.0E-03
AOI 16	SS-13-1	INORG	Beryllium	7440-41-7	B1	4.30E-01	4.3E-11	9.3E-04	3.5E-10	9.1E-04	1.7E-10	4.4E-03	1.9E-10	8.4E-03
AOI 16	SS-13-1	INORG	Chromium (total)	7440-47-3		2.00E+01	NC	6.2E-06	NC	1.4E-05	NC	6.9E-05	NC	5.4E-05
AOI 16	SS-13-1	INORG	Cobalt	7440-48-4	LC	1.70E+01	6.4E-09	2.5E-02	5.2E-08	2.7E-02	2.5E-08	1.9E-02	2.8E-08	**2.2E-01**
AOI 16	SS-13-1	INORG	Copper	7440-50-8	D	5.90E+01	NC	2.5E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 16	SS-13-1	INORG	Lead	7439-92-1	B2	7.70E+00	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-13-1	INORG	Mercury	7439-97-6	D	2.10E-02	NC	1.5E-03	NC	5.1E-04	NC	7.2E-04	NC	6.3E-03
AOI 16	SS-13-1	INORG	Molybdenum	7439-98-7		8.20E-01	NC	7.0E-05	NC	5.8E-05	NC	2.8E-04	NC	6.4E-04
AOI 16	SS-13-1	INORG	Nickel	7440-02-0	A	2.00E+01	2.2E-10	9.5E-04	1.8E-09	4.0E-03	8.5E-10	2.9E-03	9.5E-10	7.7E-03
AOI 16	SS-13-1	INORG	Selenium	7782-49-2	D	3.90E-01	NC	3.3E-05	NC	2.8E-05	NC	1.3E-04	NC	3.0E-04
AOI 16	SS-13-1	INORG	Thallium	7440-28-0	ID	1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-13-1	INORG	Vanadium	7440-62-2	ID	4.70E+01	NC	4.0E-03	NC	4.4E-03	NC	1.3E-02	NC	3.6E-02
AOI 16	SS-13-1	INORG	Zinc	7440-66-6	ID	2.80E+01	NC	4.0E-05	NC	3.3E-05	NC	1.6E-04	NC	3.6E-04
AOI 16	SS-13-2	INORG	Antimony	7440-36-0	ID	5.00E-01	NC	5.4E-04	NC	4.5E-04	NC	2.1E-03	NC	4.8E-03
AOI 16	SS-13-2	INORG	Arsenic	7440-38-2	A	2.70E+00	**3.4E-06**	**2.8E-01**	**8.7E-07**	**1.8E-01**	**4.2E-07**	2.7E-03	**2.5E-05**	**2.0E+00**
AOI 16	SS-13-2	INORG	Barium	7440-39-3	NC	4.60E+02	NC	1.1E-03	NC	3.0E-03	NC	1.4E-02	NC	9.4E-03
AOI 16	SS-13-2	INORG	Beryllium	7440-41-7	B1	4.20E-01	4.2E-11	9.1E-04	3.4E-10	8.9E-04	1.6E-10	4.3E-03	1.8E-10	8.2E-03
AOI 16	SS-13-2	INORG	Chromium (total)	7440-47-3		2.10E+01	NC	6.5E-06	NC	1.5E-05	NC	7.2E-05	NC	5.6E-05
AOI 16	SS-13-2	INORG	Cobalt	7440-48-4	LC	1.60E+01	6.0E-09	2.3E-02	4.9E-08	2.5E-02	2.4E-08	1.8E-02	2.6E-08	**2.1E-01**
AOI 16	SS-13-2	INORG	Copper	7440-50-8	D	6.00E+01	NC	2.6E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 16	SS-13-2	INORG	Lead	7439-92-1	B2	1.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-13-2	INORG	Mercury	7439-97-6	D	1.50E-02	NC	1.1E-03	NC	3.7E-04	NC	5.1E-04	NC	4.5E-03
AOI 16	SS-13-2	INORG	Molybdenum	7439-98-7		8.30E-01	NC	7.1E-05	NC	5.9E-05	NC	2.8E-04	NC	6.4E-04
AOI 16	SS-13-2	INORG	Nickel	7440-02-0	A	2.20E+01	2.4E-10	1.0E-03	1.9E-09	4.4E-03	9.3E-10	3.1E-03	1.0E-09	8.5E-03
AOI 16	SS-13-2	INORG	Selenium	7782-49-2	D	3.90E-01	NC	3.3E-05	NC	2.8E-05	NC	1.3E-04	NC	3.0E-04
AOI 16	SS-13-2	INORG	Thallium	7440-28-0	ID	1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-13-2	INORG	Vanadium	7440-62-2	ID	5.10E+01	NC	4.4E-03	NC	4.8E-03	NC	1.5E-02	NC	3.9E-02
AOI 16	SS-13-2	INORG	Zinc	7440-66-6	ID	3.20E+01	NC	4.6E-05	NC	3.8E-05	NC	1.8E-04	NC	4.1E-04
AOI 16	SS-16-1	INORG	Lead	7439-92-1	B2	9.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16-2	PDIST	Diesel Range Organics	DRO		3.60E+00	NC	6.6E-04	NC	3.6E-04	NC	3.0E-03	NC	3.1E-03
AOI 16	SS-16-2	INORG	Antimony	7440-36-0	ID	1.20E+01	NC	1.3E-02	NC	1.1E-02	NC	5.1E-02	NC	1.2E-01
AOI 16	SS-16-2	INORG	Arsenic	7440-38-2	A	4.10E+00	**5.1E-06**	**4.3E-01**	**1.3E-06**	**2.8E-01**	**6.4E-07**	4.1E-03	**3.8E-05**	**3.1E+00**
AOI 16	SS-16-2	INORG	Barium	7440-39-3	NC	3.70E+02	NC	8.8E-04	NC	2.4E-03	NC	1.2E-02	NC	7.5E-03
AOI 16	SS-16-2	INORG	Beryllium	7440-41-7	B1	4.40E-01	4.4E-11	9.5E-04	3.6E-10	9.3E-04	1.7E-10	4.5E-03	1.9E-10	8.6E-03
AOI 16	SS-16-2	INORG	Cadmium	7440-43-9	B1	2.70E-01	4.7E-11	1.6E-04	3.9E-10	1.7E-04	1.9E-10	5.1E-04	2.1E-10	1.2E-03
AOI 16	SS-16-2	INORG	Chromium (total)	7440-47-3		2.60E+01	NC	8.0E-06	NC	1.9E-05	NC	8.9E-05	NC	7.0E-05
AOI 16	SS-16-2	INORG	Cobalt	7440-48-4	LC	1.10E+01	4.1E-09	1.6E-02	3.4E-08	1.7E-02	1.6E-08	1.3E-02	1.8E-08	1.4E-01

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 16	SS-16-2	INORG	Copper	7440-50-8	D	5.90E+01	NC	2.5E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 16	SS-16-2	INORG	Lead	7439-92-1	B2	3.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16-2	INORG	Mercury	7439-97-6	D	6.00E-02	NC	4.2E-03	NC	1.5E-03	NC	2.1E-03	NC	1.8E-02
AOI 16	SS-16-2	INORG	Molybdenum	7439-98-7		9.10E-01	NC	7.8E-05	NC	6.5E-05	NC	3.1E-04	NC	7.1E-04
AOI 16	SS-16-2	INORG	Nickel	7440-02-0	A	2.00E+01	2.2E-10	9.5E-04	1.8E-09	4.0E-03	8.5E-10	2.9E-03	9.5E-10	7.7E-03
AOI 16	SS-16-2	INORG	Selenium	7782-49-2	D	5.90E-01	NC	5.1E-05	NC	4.2E-05	NC	2.0E-04	NC	4.6E-04
AOI 16	SS-16-2	INORG	Thallium	7440-28-0	ID	1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-16-2	INORG	Vanadium	7440-62-2	ID	4.70E+01	NC	4.0E-03	NC	4.4E-03	NC	1.3E-02	NC	3.6E-02
AOI 16	SS-16-2	INORG	Zinc	7440-66-6	ID	2.20E+02	NC	3.1E-04	NC	2.6E-04	NC	1.3E-03	NC	2.8E-03
AOI 16	SS-16A-1	INORG	Lead	7439-92-1	B2	1.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-16A-2	INORG	Lead	7439-92-1	B2	2.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-1	PDIST	Diesel Range Organics	DRO		2.00E+00	NC	3.7E-04	NC	2.0E-04	NC	1.7E-03	NC	1.7E-03
AOI 16	SS-18-1	INORG	Antimony	7440-36-0	ID	1.00E+00	NC	1.1E-03	NC	8.9E-04	NC	4.3E-03	NC	9.7E-03
AOI 16	SS-18-1	INORG	Arsenic	7440-38-2	A	4.00E+00	**5.0E-06**	**4.2E-01**	**1.3E-06**	**2.7E-01**	**6.2E-07**	4.0E-03	**3.7E-05**	**3.0E+00**
AOI 16	SS-18-1	INORG	Barium	7440-39-3	NC	3.80E+02	NC	9.0E-04	NC	2.5E-03	NC	1.2E-02	NC	7.7E-03
AOI 16	SS-18-1	INORG	Beryllium	7440-41-7	B1	5.00E-01	5.0E-11	1.1E-03	4.1E-10	1.1E-03	2.0E-10	5.1E-03	2.2E-10	9.7E-03
AOI 16	SS-18-1	INORG	Cadmium	7440-43-9	B1	1.10E-01	1.9E-11	6.4E-05	1.6E-10	6.9E-05	7.5E-11	2.1E-04	8.4E-11	4.8E-04
AOI 16	SS-18-1	INORG	Chromium (total)	7440-47-3		2.70E+01	NC	8.3E-06	NC	1.9E-05	NC	9.3E-05	NC	7.2E-05
AOI 16	SS-18-1	INORG	Cobalt	7440-48-4	LC	1.30E+01	4.9E-09	1.9E-02	4.0E-08	2.1E-02	1.9E-08	1.5E-02	2.1E-08	**1.7E-01**
AOI 16	SS-18-1	INORG	Copper	7440-50-8	D	7.00E+01	NC	3.0E-03	NC	2.5E-03	NC	1.2E-02	NC	2.7E-02
AOI 16	SS-18-1	INORG	Lead	7439-92-1	B2	2.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-1	INORG	Mercury	7439-97-6	D	3.60E-02	NC	2.5E-03	NC	8.8E-04	NC	1.2E-03	NC	1.1E-02
AOI 16	SS-18-1	INORG	Molybdenum	7439-98-7		9.30E-01	NC	8.0E-05	NC	6.6E-05	NC	3.2E-04	NC	7.2E-04
AOI 16	SS-18-1	INORG	Nickel	7440-02-0	A	2.30E+01	2.5E-10	1.1E-03	2.0E-09	4.6E-03	9.8E-10	3.3E-03	1.1E-09	8.9E-03
AOI 16	SS-18-1	INORG	Selenium	7782-49-2	D	4.40E-01	NC	3.8E-05	NC	3.1E-05	NC	1.5E-04	NC	3.4E-04
AOI 16	SS-18-1	INORG	Thallium	7440-28-0	ID	1.30E-01	NC	5.6E-03	NC	4.6E-03	NC	NC	NC	5.0E-02
AOI 16	SS-18-1	INORG	Vanadium	7440-62-2	ID	6.90E+01	NC	5.9E-03	NC	6.5E-03	NC	2.0E-02	NC	5.3E-02
AOI 16	SS-18-1	INORG	Zinc	7440-66-6	ID	5.10E+01	NC	7.3E-05	NC	6.1E-05	NC	2.9E-04	NC	6.6E-04
AOI 16	SS-18-10	INORG	Arsenic	7440-38-2	A	3.00E+00	**3.7E-06**	**3.1E-01**	**9.7E-07**	**2.0E-01**	**4.7E-07**	3.0E-03	**2.8E-05**	**2.3E+00**
AOI 16	SS-18-11	INORG	Arsenic	7440-38-2	A	3.00E+00	**3.7E-06**	**3.1E-01**	**9.7E-07**	**2.0E-01**	**4.7E-07**	3.0E-03	**2.8E-05**	**2.3E+00**
AOI 16	SS-18-12	INORG	Arsenic	7440-38-2	A	4.50E+00	**5.6E-06**	**4.7E-01**	**1.5E-06**	**3.0E-01**	**7.0E-07**	4.4E-03	**4.2E-05**	**3.4E+00**
AOI 16	SS-18-13	INORG	Arsenic	7440-38-2	A	2.70E+00	**3.4E-06**	**2.8E-01**	**8.7E-07**	**1.8E-01**	**4.2E-07**	2.7E-03	**2.5E-05**	**2.0E+00**
AOI 16	SS-18-14	INORG	Arsenic	7440-38-2	A	2.70E+00	**3.4E-06**	**2.8E-01**	**8.7E-07**	**1.8E-01**	**4.2E-07**	2.7E-03	**2.5E-05**	**2.0E+00**
AOI 16	SS-18-2	PDIST	Diesel Range Organics	DRO		4.90E+00	NC	9.0E-04	NC	4.9E-04	NC	4.1E-03	NC	4.2E-03
AOI 16	SS-18-2	INORG	Antimony	7440-36-0	ID	1.10E+00	NC	1.2E-03	NC	9.8E-04	NC	4.7E-03	NC	1.1E-02
AOI 16	SS-18-2	INORG	Arsenic	7440-38-2	A	5.60E+00	**7.0E-06**	**5.8E-01**	**1.8E-06**	**3.8E-01**	**8.7E-07**	5.5E-03	**5.2E-05**	**4.2E+00**
AOI 16	SS-18-2	INORG	Barium	7440-39-3	NC	5.70E+02	NC	1.4E-03	NC	3.7E-03	NC	1.8E-02	NC	1.2E-02
AOI 16	SS-18-2	INORG	Beryllium	7440-41-7	B1	5.40E-01	5.4E-11	1.2E-03	4.4E-10	1.1E-03	2.1E-10	5.5E-03	2.4E-10	1.0E-02
AOI 16	SS-18-2	INORG	Cadmium	7440-43-9	B1	1.20E-01	2.1E-11	7.0E-05	1.7E-10	7.5E-05	8.2E-11	2.2E-04	9.2E-11	5.2E-04
AOI 16	SS-18-2	INORG	Chromium (total)	7440-47-3		5.50E+01	NC	1.7E-05	NC	3.9E-05	NC	1.9E-04	NC	1.5E-04
AOI 16	SS-18-2	INORG	Cobalt	7440-48-4	LC	1.60E+01	6.0E-09	2.3E-02	4.9E-08	2.5E-02	2.4E-08	1.8E-02	2.6E-08	**2.1E-01**
AOI 16	SS-18-2	INORG	Copper	7440-50-8	D	8.90E+01	NC	3.8E-03	NC	3.2E-03	NC	1.5E-02	NC	3.4E-02
AOI 16	SS-18-2	INORG	Lead	7439-92-1	B2	7.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 16	SS-18-2	INORG	Mercury	7439-97-6	D	3.00E-01	NC	2.1E-02	NC	7.3E-03	NC	1.0E-02	NC	9.1E-02
AOI 16	SS-18-2	INORG	Molybdenum	7439-98-7		9.10E-01	NC	7.8E-05	NC	6.5E-05	NC	3.1E-04	NC	7.1E-04
AOI 16	SS-18-2	INORG	Nickel	7440-02-0	A	6.30E+01	6.8E-10	3.0E-03	5.6E-09	1.3E-02	2.7E-09	9.0E-03	3.0E-09	2.4E-02
AOI 16	SS-18-2	INORG	Selenium	7782-49-2	D	2.30E-01	NC	2.0E-05	NC	1.6E-05	NC	7.9E-05	NC	1.8E-04
AOI 16	SS-18-2	INORG	Vanadium	7440-62-2	ID	5.50E+01	NC	4.7E-03	NC	5.2E-03	NC	1.6E-02	NC	4.3E-02
AOI 16	SS-18-2	INORG	Zinc	7440-66-6	ID	8.40E+01	NC	1.2E-04	NC	1.0E-04	NC	4.8E-04	NC	1.1E-03
AOI 16	SS-18-2-A1	INORG	Arsenic	7440-38-2	A	2.40E+00	**3.0E-06**	**2.5E-01**	**7.7E-07**	**1.6E-01**	**3.7E-07**	2.4E-03	**2.2E-05**	**1.8E+00**
AOI 16	SS-18-2-B1	INORG	Arsenic	7440-38-2	A	2.90E+00	**3.6E-06**	**3.0E-01**	**9.3E-07**	**2.0E-01**	**4.5E-07**	2.9E-03	**2.7E-05**	**2.2E+00**

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 16	SS-18-2-B2	INORG	Arsenic	7440-38-2	A	3.70E+00	**4.6E-06**	**3.9E-01**	**1.2E-06**	**2.5E-01**	**5.7E-07**	3.7E-03	**3.5E-05**	**2.8E+00**
AOI 16	SS-18-2-C1	INORG	Arsenic	7440-38-2	A	2.70E+00	**3.4E-06**	**2.8E-01**	**8.7E-07**	**1.8E-01**	**4.2E-07**	2.7E-03	**2.5E-05**	**2.0E+00**
AOI 16	SS-18-2-C2	INORG	Arsenic	7440-38-2	A	3.20E+00	**4.0E-06**	**3.3E-01**	**1.0E-06**	**2.2E-01**	**5.0E-07**	3.2E-03	**3.0E-05**	**2.4E+00**
AOI 16	SS-18-2-C3	INORG	Arsenic	7440-38-2	A	2.30E+00	**2.9E-06**	**2.4E-01**	**7.4E-07**	**1.6E-01**	**3.6E-07**	2.3E-03	**2.2E-05**	**1.7E+00**
AOI 16	SS-18-2-D1	INORG	Arsenic	7440-38-2	A	2.60E+00	**3.2E-06**	**2.7E-01**	**8.4E-07**	**1.8E-01**	**4.0E-07**	2.6E-03	**2.4E-05**	**2.0E+00**
AOI 16	SS-18-2-D2	INORG	Arsenic	7440-38-2	A	3.30E+00	**4.1E-06**	**3.4E-01**	**1.1E-06**	**2.2E-01**	**5.1E-07**	3.3E-03	**3.1E-05**	**2.5E+00**
AOI 16	SS-18-3	INORG	Arsenic	7440-38-2	A	3.85E+00	**4.8E-06**	**4.0E-01**	**1.2E-06**	**2.6E-01**	**6.0E-07**	3.8E-03	**3.6E-05**	**2.9E+00**
AOI 16	SS-18-4	INORG	Arsenic	7440-38-2	A	3.70E+00	**4.6E-06**	**3.9E-01**	**1.2E-06**	**2.5E-01**	**5.7E-07**	3.7E-03	**3.5E-05**	**2.8E+00**
AOI 16	SS-18-5	INORG	Arsenic	7440-38-2	A	3.30E+00	**4.1E-06**	**3.4E-01**	**1.1E-06**	**2.2E-01**	**5.1E-07**	3.3E-03	**3.1E-05**	**2.5E+00**
AOI 16	SS-18-6	INORG	Arsenic	7440-38-2	A	3.60E+00	**4.5E-06**	**3.8E-01**	**1.2E-06**	**2.4E-01**	**5.6E-07**	3.6E-03	**3.4E-05**	**2.7E+00**
AOI 16	SS-18-7	INORG	Arsenic	7440-38-2	A	3.10E+00	**3.9E-06**	**3.2E-01**	**1.0E-06**	**2.1E-01**	**4.8E-07**	3.1E-03	**2.9E-05**	**2.3E+00**
AOI 16	SS-18-8	INORG	Arsenic	7440-38-2	A	2.90E+00	**3.6E-06**	**3.0E-01**	**9.3E-07**	**2.0E-01**	**4.5E-07**	2.9E-03	**2.7E-05**	**2.2E+00**
AOI 16	SS-18-9	INORG	Arsenic	7440-38-2	A	2.40E+00	**3.0E-06**	**2.5E-01**	**7.7E-07**	**1.6E-01**	**3.7E-07**	2.4E-03	**2.2E-05**	**1.8E+00**
AOI 17	SS-9-1	INORG	Antimony	7440-36-0	ID	5.00E-01	NC	5.4E-04	NC	4.5E-04	NC	2.1E-03	NC	4.8E-03
AOI 17	SS-9-1	INORG	Arsenic	7440-38-2	A	3.00E+00	**3.7E-06**	**3.1E-01**	**9.7E-07**	**2.0E-01**	**4.7E-07**	3.0E-03	**2.8E-05**	**2.3E+00**
AOI 17	SS-9-1	INORG	Barium	7440-39-3	NC	2.30E+02	NC	5.5E-04	NC	1.5E-03	NC	7.2E-03	NC	4.7E-03
AOI 17	SS-9-1	INORG	Beryllium	7440-41-7	B1	4.40E-01	4.4E-11	9.5E-04	3.6E-10	9.3E-04	1.7E-10	4.5E-03	1.9E-10	8.6E-03
AOI 17	SS-9-1	INORG	Chromium (total)	7440-47-3		2.50E+01	NC	7.7E-06	NC	1.8E-05	NC	8.6E-05	NC	6.7E-05
AOI 17	SS-9-1	INORG	Cobalt	7440-48-4	LC	4.40E+00	1.7E-09	6.4E-03	1.3E-08	7.0E-03	6.5E-09	5.0E-03	7.2E-09	5.7E-02
AOI 17	SS-9-1	INORG	Copper	7440-50-8	D	4.80E+01	NC	2.1E-03	NC	1.7E-03	NC	8.2E-03	NC	1.9E-02
AOI 17	SS-9-1	INORG	Lead	7439-92-1	B2	7.70E+00	NC	NC	NC	NC	NC	NC	NC	NC
AOI 17	SS-9-1	INORG	Mercury	7439-97-6	D	3.90E-02	NC	2.7E-03	NC	9.5E-04	NC	1.3E-03	NC	1.2E-02
AOI 17	SS-9-1	INORG	Molybdenum	7439-98-7		1.50E+00	NC	1.3E-04	NC	1.1E-04	NC	5.1E-04	NC	1.2E-03
AOI 17	SS-9-1	INORG	Nickel	7440-02-0	A	1.20E+01	1.3E-10	5.7E-04	1.1E-09	2.4E-03	5.1E-10	1.7E-03	5.7E-10	4.6E-03
AOI 17	SS-9-1	INORG	Selenium	7782-49-2	D	9.00E-01	NC	7.7E-05	NC	6.4E-05	NC	3.1E-04	NC	7.0E-04
AOI 17	SS-9-1	INORG	Vanadium	7440-62-2	ID	4.40E+01	NC	3.8E-03	NC	4.2E-03	NC	1.3E-02	NC	3.4E-02
AOI 17	SS-9-1	INORG	Zinc	7440-66-6	ID	1.80E+01	NC	2.6E-05	NC	2.1E-05	NC	1.0E-04	NC	2.3E-04
AOI 17	SS-9-2	INORG	Antimony	7440-36-0	ID	5.50E-01	NC	5.9E-04	NC	4.9E-04	NC	2.4E-03	NC	5.3E-03
AOI 17	SS-9-2	INORG	Arsenic	7440-38-2	A	3.40E+00	**4.2E-06**	**3.6E-01**	**1.1E-06**	**2.3E-01**	**5.3E-07**	3.4E-03	**3.2E-05**	**2.6E+00**
AOI 17	SS-9-2	INORG	Barium	7440-39-3	NC	3.40E+02	NC	8.1E-04	NC	2.2E-03	NC	1.1E-02	NC	6.9E-03
AOI 17	SS-9-2	INORG	Beryllium	7440-41-7	B1	3.80E-01	3.8E-11	8.2E-04	3.1E-10	8.1E-04	1.5E-10	3.9E-03	1.7E-10	7.4E-03
AOI 17	SS-9-2	INORG	Cadmium	7440-43-9	B1	1.00E-01	1.8E-11	5.9E-05	1.4E-10	6.2E-05	6.9E-11	1.9E-04	7.6E-11	4.4E-04
AOI 17	SS-9-2	INORG	Chromium (total)	7440-47-3		2.70E+01	NC	8.3E-06	NC	1.9E-05	NC	9.3E-05	NC	7.2E-05
AOI 17	SS-9-2	INORG	Cobalt	7440-48-4	LC	1.10E+01	4.1E-09	1.6E-02	3.4E-08	1.7E-02	1.6E-08	1.3E-02	1.8E-08	1.4E-01
AOI 17	SS-9-2	INORG	Copper	7440-50-8	D	5.10E+01	NC	2.2E-03	NC	1.8E-03	NC	8.7E-03	NC	2.0E-02
AOI 17	SS-9-2	INORG	Lead	7439-92-1	B2	2.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 17	SS-9-2	INORG	Mercury	7439-97-6	D	6.40E-02	NC	4.5E-03	NC	1.6E-03	NC	2.2E-03	NC	1.9E-02
AOI 17	SS-9-2	INORG	Molybdenum	7439-98-7		6.50E-01	NC	5.6E-05	NC	4.6E-05	NC	2.2E-04	NC	5.0E-04
AOI 17	SS-9-2	INORG	Nickel	7440-02-0	A	2.00E+01	2.2E-10	9.5E-04	1.8E-09	4.0E-03	8.5E-10	2.9E-03	9.5E-10	7.7E-03
AOI 17	SS-9-2	INORG	Selenium	7782-49-2	D	5.90E-01	NC	5.1E-05	NC	4.2E-05	NC	2.0E-04	NC	4.6E-04
AOI 17	SS-9-2	INORG	Vanadium	7440-62-2	ID	5.20E+01	NC	4.5E-03	NC	4.9E-03	NC	1.5E-02	NC	4.0E-02
AOI 17	SS-9-2	INORG	Zinc	7440-66-6	ID	4.30E+01	NC	6.1E-05	NC	5.1E-05	NC	2.5E-04	NC	5.6E-04
AOI 17	SS-9-3	INORG	Antimony	7440-36-0	ID	5.80E-01	NC	6.2E-04	NC	5.2E-04	NC	2.5E-03	NC	5.6E-03
AOI 17	SS-9-3	INORG	Arsenic	7440-38-2	A	2.50E+00	**3.1E-06**	**2.6E-01**	**8.1E-07**	**1.7E-01**	**3.9E-07**	2.5E-03	**2.3E-05**	**1.9E+00**
AOI 17	SS-9-3	INORG	Barium	7440-39-3	NC	3.70E+02	NC	8.8E-04	NC	2.4E-03	NC	1.2E-02	NC	7.5E-03
AOI 17	SS-9-3	INORG	Beryllium	7440-41-7	B1	4.20E-01	4.2E-11	9.1E-04	3.4E-10	8.9E-04	1.6E-10	4.3E-03	1.8E-10	8.2E-03
AOI 17	SS-9-3	INORG	Cadmium	7440-43-9	B1	1.80E-01	3.2E-11	1.1E-04	2.6E-10	1.1E-04	1.2E-10	3.4E-04	1.4E-10	7.8E-04
AOI 17	SS-9-3	INORG	Chromium (total)	7440-47-3		2.50E+01	NC	7.7E-06	NC	1.8E-05	NC	8.6E-05	NC	6.7E-05
AOI 17	SS-9-3	INORG	Cobalt	7440-48-4	LC	1.20E+01	4.5E-09	1.7E-02	3.7E-08	1.9E-02	1.8E-08	1.4E-02	2.0E-08	**1.6E-01**
AOI 17	SS-9-3	INORG	Copper	7440-50-8	D	6.00E+01	NC	2.6E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 17	SS-9-3	INORG	Lead	7439-92-1	B2	3.10E+01	NC	NC	NC	NC	NC	NC	NC	NC

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 17	SS-9-3	INORG	Mercury	7439-97-6	D	4.70E-02	NC	3.3E-03	NC	1.2E-03	NC	1.6E-03	NC	1.4E-02
AOI 17	SS-9-3	INORG	Molybdenum	7439-98-7		5.20E-01	NC	4.5E-05	NC	3.7E-05	NC	1.8E-04	NC	4.0E-04
AOI 17	SS-9-3	INORG	Nickel	7440-02-0	A	2.50E+01	2.7E-10	1.2E-03	2.2E-09	5.1E-03	1.1E-09	3.6E-03	1.2E-09	9.7E-03
AOI 17	SS-9-3	INORG	Selenium	7782-49-2	D	5.30E-01	NC	4.5E-05	NC	3.8E-05	NC	1.8E-04	NC	4.1E-04
AOI 17	SS-9-3	INORG	Vanadium	7440-62-2	ID	3.80E+01	NC	3.3E-03	NC	3.6E-03	NC	1.1E-02	NC	2.9E-02
AOI 17	SS-9-3	INORG	Zinc	7440-66-6	ID	7.40E+01	NC	1.1E-04	NC	8.8E-05	NC	4.2E-04	NC	9.6E-04
AOI 18	SS-21-1	PCB	PCBs (total)	1336-36-3	B2	7.80E-02	5.9E-08	3.6E-03	1.1E-08	1.8E-03	6.2E-09	3.5E-03	**3.4E-07**	2.1E-02
AOI 18	SS-21-1	INORG	Lead	7439-92-1	B2	1.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-1	INORG	Lead	7439-92-1	B2	1.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-2	PCB	PCBs (total)	1336-36-3	B2	5.80E-02	4.4E-08	2.7E-03	8.3E-09	1.3E-03	4.6E-09	2.6E-03	**2.5E-07**	1.6E-02
AOI 18	SS-5-2	INORG	Lead	7439-92-1	B2	5.90E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5-3	INORG	Lead	7439-92-1	B2	7.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-1	INORG	Lead	7439-92-1	B2	8.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-2	INORG	Lead	7439-92-1	B2	1.50E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 18	SS-5A-3	INORG	Lead	7439-92-1	B2	1.50E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-1	INORG	Lead	7439-92-1	B2	4.90E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-2	INORG	Lead	7439-92-1	B2	7.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-3	INORG	Lead	7439-92-1	B2	6.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-4	INORG	Lead	7439-92-1	B2	1.10E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-5	INORG	Lead	7439-92-1	B2	2.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 19	SS-19-6	INORG	Lead	7439-92-1	B2	5.60E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-1	INORG	Lead	7439-92-1	B2	3.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-2	INORG	Lead	7439-92-1	B2	2.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-3	INORG	Lead	7439-92-1	B2	6.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-4	INORG	Lead	7439-92-1	B2	1.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-5	INORG	Lead	7439-92-1	B2	1.50E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	BC-L-COMP	PDIST	Diesel Range Organics	DRO		6.20E+00	NC	1.1E-03	NC	6.2E-04	NC	5.2E-03	NC	5.3E-03
AOI 20	BC-L-COMP	INORG	Lead	7439-92-1	B2	3.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	ID-U	INORG	Lead	7439-92-1	B2	1.90E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 20	SS-20-1	PCB	PCBs (total)	1336-36-3	B2	6.88E-02	5.2E-08	3.2E-03	9.8E-09	1.6E-03	5.5E-09	3.1E-03	**3.0E-07**	1.9E-02
AOI 20	SS-20-1	INORG	Lead	7439-92-1	B2	4.90E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-1	INORG	Lead	7439-92-1	B2	1.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-2	INORG	Lead	7439-92-1	B2	6.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-3	PCB	PCBs (total)	1336-36-3	B2	7.50E-02	5.6E-08	3.5E-03	1.1E-08	1.7E-03	6.0E-09	3.3E-03	**3.3E-07**	2.0E-02
AOI 21	SS-4-3	INORG	Lead	7439-92-1	B2	1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-4	INORG	Lead	7439-92-1	B2	2.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-5	PCB	PCBs (total)	1336-36-3	B2	7.80E-02	5.9E-08	3.6E-03	1.1E-08	1.8E-03	6.2E-09	3.5E-03	**3.4E-07**	2.1E-02
AOI 21	SS-4-5	INORG	Lead	7439-92-1	B2	8.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-6	INORG	Lead	7439-92-1	B2	3.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-7	INORG	Lead	7439-92-1	B2	1.20E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4-8	PCB	PCBs (total)	1336-36-3	B2	6.40E-02	4.8E-08	3.0E-03	9.2E-09	1.5E-03	5.1E-09	2.8E-03	**2.8E-07**	1.7E-02
AOI 21	SS-4-8	INORG	Lead	7439-92-1	B2	6.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-1	INORG	Lead	7439-92-1	B2	2.10E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-2	INORG	Lead	7439-92-1	B2	8.00E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-3	INORG	Lead	7439-92-1	B2	1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-4	INORG	Lead	7439-92-1	B2	4.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-5	INORG	Lead	7439-92-1	B2	7.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-6	INORG	Lead	7439-92-1	B2	2.40E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-7	INORG	Lead	7439-92-1	B2	3.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 21	SS-4A-8	INORG	Lead	7439-92-1	B2	6.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-1	INORG	Lead	7439-92-1	B2	3.10E+01	NC	NC	NC	NC	NC	NC	NC	NC

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Chem Group	Chemical	CASRN	Carc Class	Max Detect from All Depths (mg/kg)	Park Worker Outdoor Activities		Maintenance Worker Outdoor Activities		Construction Worker Outdoor Activities		Resident Outdoor Activities	
							Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 22	SS-7-2	INORG	Lead	7439-92-1	B2	9.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 22	SS-7-SED	INORG	Lead	7439-92-1	B2	5.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-1	INORG	Lead	7439-92-1	B2	1.30E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-2	PCB	PCBs (total)	1336-36-3	B2	2.00E-01	**1.5E-07**	9.4E-03	2.9E-08	4.6E-03	1.6E-08	8.9E-03	**8.7E-07**	5.4E-02
AOI 23	SS-8-2	INORG	Lead	7439-92-1	B2	1.10E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-3	INORG	Lead	7439-92-1	B2	1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-4	INORG	Lead	7439-92-1	B2	2.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-5	INORG	Lead	7439-92-1	B2	7.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8-6	INORG	Lead	7439-92-1	B2	1.40E+03	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-1	INORG	Lead	7439-92-1	B2	4.50E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-2	INORG	Lead	7439-92-1	B2	3.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-3	INORG	Lead	7439-92-1	B2	6.40E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-4	INORG	Lead	7439-92-1	B2	3.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-5	INORG	Antimony	7440-36-0	ID	2.30E+00	NC	2.5E-03	NC	2.0E-03	NC	9.8E-03	NC	2.2E-02
AOI 23	SS-8A-5	INORG	Arsenic	7440-38-2	A	4.00E+00	**5.0E-06**	**4.2E-01**	**1.3E-06**	**2.7E-01**	**6.2E-07**	4.0E-03	**3.7E-05**	**3.0E+00**
AOI 23	SS-8A-5	INORG	Barium	7440-39-3	NC	3.70E+02	NC	8.8E-04	NC	2.4E-03	NC	1.2E-02	NC	7.5E-03
AOI 23	SS-8A-5	INORG	Beryllium	7440-41-7	B1	5.30E-01	5.3E-11	1.1E-03	4.3E-10	1.1E-03	2.1E-10	5.4E-03	2.3E-10	1.0E-02
AOI 23	SS-8A-5	INORG	Cadmium	7440-43-9	B1	5.20E-01	9.1E-11	3.0E-04	7.4E-10	3.2E-04	3.6E-10	9.7E-04	4.0E-10	2.3E-03
AOI 23	SS-8A-5	INORG	Chromium (total)	7440-47-3		6.20E+01	NC	1.9E-05	NC	4.4E-05	NC	2.1E-04	NC	1.7E-04
AOI 23	SS-8A-5	INORG	Cobalt	7440-48-4	LC	1.70E+01	6.4E-09	2.5E-02	5.2E-08	2.7E-02	2.5E-08	1.9E-02	2.8E-08	**2.2E-01**
AOI 23	SS-8A-5	INORG	Copper	7440-50-8	D	6.00E+01	NC	2.6E-03	NC	2.1E-03	NC	1.0E-02	NC	2.3E-02
AOI 23	SS-8A-5	INORG	Lead	7439-92-1	B2	2.00E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 23	SS-8A-5	INORG	Mercury	7439-97-6	D	6.60E-02	NC	4.6E-03	NC	1.6E-03	NC	2.3E-03	NC	2.0E-02
AOI 23	SS-8A-5	INORG	Molybdenum	7439-98-7		1.20E+00	NC	1.0E-04	NC	8.6E-05	NC	4.1E-04	NC	9.3E-04
AOI 23	SS-8A-5	INORG	Nickel	7440-02-0	A	4.00E+01	4.3E-10	1.9E-03	3.5E-09	8.1E-03	1.7E-09	5.7E-03	1.9E-09	1.5E-02
AOI 23	SS-8A-5	INORG	Selenium	7782-49-2	D	5.90E-01	NC	5.1E-05	NC	4.2E-05	NC	2.0E-04	NC	4.6E-04
AOI 23	SS-8A-5	INORG	Silver	7440-22-4	D	1.50E-01	NC	1.5E-05	NC	4.6E-05	NC	2.2E-04	NC	1.2E-04
AOI 23	SS-8A-5	INORG	Thallium	7440-28-0	ID	1.20E-01	NC	5.1E-03	NC	4.3E-03	NC	NC	NC	4.6E-02
AOI 23	SS-8A-5	INORG	Vanadium	7440-62-2	ID	6.60E+01	NC	5.7E-03	NC	6.2E-03	NC	1.9E-02	NC	5.1E-02
AOI 23	SS-8A-5	INORG	Zinc	7440-66-6	ID	1.20E+02	NC	1.7E-04	NC	1.4E-04	NC	6.9E-04	NC	1.5E-03
AOI 23	SS-8A-6	INORG	Lead	7439-92-1	B2	1.50E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	DO-1	PCB	PCBs (total)	1336-36-3	B2	1.60E+00	**1.2E-06**	7.5E-02	**2.3E-07**	3.7E-02	1.3E-07	7.1E-02	**7.0E-06**	**4.3E-01**
AOI 24	DO-1	INORG	Antimony	7440-36-0	ID	2.70E+00	NC	2.9E-03	NC	2.4E-03	NC	1.2E-02	NC	2.6E-02
AOI 24	DO-1	INORG	Arsenic	7440-38-2	A	3.40E+00	**4.2E-06**	**3.6E-01**	**1.1E-06**	**2.3E-01**	**5.3E-07**	3.4E-03	**3.2E-05**	**2.6E+00**
AOI 24	DO-1	INORG	Barium	7440-39-3	NC	4.90E+02	NC	1.2E-03	NC	3.2E-03	NC	1.5E-02	NC	1.0E-02
AOI 24	DO-1	INORG	Beryllium	7440-41-7	B1	5.60E-01	5.6E-11	1.2E-03	4.6E-10	1.2E-03	2.2E-10	5.7E-03	2.5E-10	1.1E-02
AOI 24	DO-1	INORG	Cadmium	7440-43-9	B1	5.80E+00	1.0E-09	3.4E-03	8.3E-09	3.6E-03	4.0E-09	1.1E-02	4.4E-09	2.5E-02
AOI 24	DO-1	INORG	Chromium (total)	7440-47-3		5.10E+01	NC	1.6E-05	NC	3.6E-05	NC	1.8E-04	NC	1.4E-04
AOI 24	DO-1	INORG	Cobalt	7440-48-4	LC	1.90E+01	7.1E-09	2.7E-02	5.8E-08	3.0E-02	2.8E-08	2.2E-02	3.1E-08	**2.5E-01**
AOI 24	DO-1	INORG	Copper	7440-50-8	D	1.10E+02	NC	4.7E-03	NC	3.9E-03	NC	1.9E-02	NC	4.3E-02
AOI 24	DO-1	INORG	Lead	7439-92-1	B2	1.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	DO-1	INORG	Mercury	7439-97-6	D	7.40E-02	NC	5.2E-03	NC	1.8E-03	NC	2.5E-03	NC	2.2E-02
AOI 24	DO-1	INORG	Nickel	7440-02-0	A	2.70E+01	2.9E-10	1.3E-03	2.4E-09	5.5E-03	1.1E-09	3.9E-03	1.3E-09	1.0E-02
AOI 24	DO-1	INORG	Selenium	7782-49-2	D	5.40E-01	NC	4.6E-05	NC	3.9E-05	NC	1.9E-04	NC	4.2E-04
AOI 24	DO-1	INORG	Vanadium	7440-62-2	ID	8.70E+01	NC	7.5E-03	NC	8.2E-03	NC	2.5E-02	NC	6.7E-02
AOI 24	DO-1	INORG	Zinc	7440-66-6	ID	1.00E+03	NC	1.4E-03	NC	1.2E-03	NC	5.7E-03	NC	1.3E-02
AOI 24	SS-2-1	SVOC	4,6-Dinitro-2-methylphenol	534-52-1	ID	4.60E+01	NC	**4.5E-01**	NC	**2.5E-01**	NC	1.2E-01	NC	**2.9E+00**
AOI 24	SS-2-1	PDIST	Diesel Range Organics	DRO		7.70E+00	NC	1.4E-03	NC	7.7E-04	NC	6.5E-03	NC	6.6E-03
AOI 24	SS-2-1	PCB	PCBs (total)	1336-36-3	B2	1.50E+01	**1.1E-05**	**7.0E-01**	**2.1E-06**	**3.5E-01**	**1.2E-06**	**6.7E-01**	**6.6E-05**	**4.0E+00**
AOI 24	SS-2-1	INORG	Antimony	7440-36-0	ID	3.40E+00	NC	3.6E-03	NC	3.0E-03	NC	1.5E-02	NC	3.3E-02
AOI 24	SS-2-1	INORG	Arsenic	7440-38-2	A	3.90E+00	**4.8E-06**	**4.1E-01**	**1.3E-06**	**2.6E-01**	**6.0E-07**	3.9E-03	**3.7E-05**	**3.0E+00**

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 24	SS-2-1	INORG	Barium	7440-39-3	NC	5.70E+02	NC	1.4E-03	NC	3.7E-03	NC	1.8E-02	NC	1.2E-02
AOI 24	SS-2-1	INORG	Beryllium	7440-41-7	B1	8.90E-01	8.9E-11	1.9E-03	7.3E-10	1.9E-03	3.5E-10	9.1E-03	3.9E-10	1.7E-02
AOI 24	SS-2-1	INORG	Cadmium	7440-43-9	B1	8.20E+00	1.4E-09	4.8E-03	1.2E-08	5.1E-03	5.6E-09	1.5E-02	6.3E-09	3.6E-02
AOI 24	SS-2-1	INORG	Chromium (total)	7440-47-3		4.40E+01	NC	1.4E-05	NC	3.1E-05	NC	1.5E-04	NC	1.2E-04
AOI 24	SS-2-1	INORG	Cobalt	7440-48-4	LC	1.60E+01	6.0E-09	2.3E-02	4.9E-08	2.5E-02	2.4E-08	1.8E-02	2.6E-08	**2.1E-01**
AOI 24	SS-2-1	INORG	Copper	7440-50-8	D	1.30E+02	NC	5.6E-03	NC	4.6E-03	NC	2.2E-02	NC	5.0E-02
AOI 24	SS-2-1	INORG	Lead	7439-92-1	B2	1.30E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-1	INORG	Mercury	7439-97-6	D	1.10E-01	NC	7.7E-03	NC	2.7E-03	NC	3.8E-03	NC	3.3E-02
AOI 24	SS-2-1	INORG	Molybdenum	7439-98-7		5.50E-01	NC	4.7E-05	NC	3.9E-05	NC	1.9E-04	NC	4.3E-04
AOI 24	SS-2-1	INORG	Nickel	7440-02-0	A	4.30E+01	4.7E-10	2.0E-03	3.8E-09	8.7E-03	1.8E-09	6.1E-03	2.0E-09	1.7E-02
AOI 24	SS-2-1	INORG	Selenium	7782-49-2	D	4.40E-01	NC	3.8E-05	NC	3.1E-05	NC	1.5E-04	NC	3.4E-04
AOI 24	SS-2-1	INORG	Silver	7440-22-4	D	3.90E-01	NC	3.8E-05	NC	1.2E-04	NC	5.8E-04	NC	3.2E-04
AOI 24	SS-2-1	INORG	Thallium	7440-28-0	ID	1.20E-01	NC	5.1E-03	NC	4.3E-03	NC	NC	NC	4.6E-02
AOI 24	SS-2-1	INORG	Vanadium	7440-62-2	ID	8.30E+01	NC	7.1E-03	NC	7.8E-03	NC	2.4E-02	NC	6.4E-02
AOI 24	SS-2-1	INORG	Zinc	7440-66-6	ID	4.80E+03	NC	6.8E-03	NC	5.7E-03	NC	2.7E-02	NC	6.2E-02
AOI 24	SS-2-2	INORG	Antimony	7440-36-0	ID	1.80E+00	NC	1.9E-03	NC	1.6E-03	NC	7.7E-03	NC	1.7E-02
AOI 24	SS-2-2	INORG	Arsenic	7440-38-2	A	3.30E+00	**4.1E-06**	**3.4E-01**	**1.1E-06**	**2.2E-01**	**5.1E-07**	3.3E-03	**3.1E-05**	**2.5E+00**
AOI 24	SS-2-2	INORG	Barium	7440-39-3	NC	5.60E+02	NC	1.3E-03	NC	3.7E-03	NC	1.8E-02	NC	1.1E-02
AOI 24	SS-2-2	INORG	Beryllium	7440-41-7	B1	7.10E-01	7.1E-11	1.5E-03	5.8E-10	1.5E-03	2.8E-10	7.2E-03	3.1E-10	1.4E-02
AOI 24	SS-2-2	INORG	Cadmium	7440-43-9	B1	1.70E+00	3.0E-10	9.9E-04	2.4E-09	1.1E-03	1.2E-09	3.2E-03	1.3E-09	7.4E-03
AOI 24	SS-2-2	INORG	Chromium (total)	7440-47-3		5.80E+01	NC	1.8E-05	NC	4.1E-05	NC	2.0E-04	NC	1.6E-04
AOI 24	SS-2-2	INORG	Cobalt	7440-48-4	LC	1.90E+01	7.1E-09	2.7E-02	5.8E-08	3.0E-02	2.8E-08	2.2E-02	3.1E-08	**2.5E-01**
AOI 24	SS-2-2	INORG	Copper	7440-50-8	D	1.40E+02	NC	6.0E-03	NC	5.0E-03	NC	2.4E-02	NC	5.4E-02
AOI 24	SS-2-2	INORG	Lead	7439-92-1	B2	2.20E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-2	INORG	Mercury	7439-97-6	D	6.00E-02	NC	4.2E-03	NC	1.5E-03	NC	2.1E-03	NC	1.8E-02
AOI 24	SS-2-2	INORG	Molybdenum	7439-98-7		5.80E-01	NC	5.0E-05	NC	4.1E-05	NC	2.0E-04	NC	4.5E-04
AOI 24	SS-2-2	INORG	Nickel	7440-02-0	A	3.30E+01	3.6E-10	1.6E-03	2.9E-09	6.7E-03	1.4E-09	4.7E-03	1.6E-09	1.3E-02
AOI 24	SS-2-2	INORG	Selenium	7782-49-2	D	6.20E-01	NC	5.3E-05	NC	4.4E-05	NC	2.1E-04	NC	4.8E-04
AOI 24	SS-2-2	INORG	Silver	7440-22-4	D	3.90E-01	NC	3.8E-05	NC	1.2E-04	NC	5.8E-04	NC	3.2E-04
AOI 24	SS-2-2	INORG	Thallium	7440-28-0	ID	1.50E-01	NC	6.4E-03	NC	5.3E-03	NC	NC	NC	5.8E-02
AOI 24	SS-2-2	INORG	Vanadium	7440-62-2	ID	1.10E+02	NC	9.5E-03	NC	1.0E-02	NC	3.1E-02	NC	8.5E-02
AOI 24	SS-2-2	INORG	Zinc	7440-66-6	ID	4.10E+02	NC	5.9E-04	NC	4.9E-04	NC	2.3E-03	NC	5.3E-03
AOI 24	SS-2-3	INORG	Antimony	7440-36-0	ID	5.90E-01	NC	6.3E-04	NC	5.3E-04	NC	2.5E-03	NC	5.7E-03
AOI 24	SS-2-3	INORG	Arsenic	7440-38-2	A	3.60E+00	**4.5E-06**	**3.8E-01**	**1.2E-06**	**2.4E-01**	**5.6E-07**	3.6E-03	**3.4E-05**	**2.7E+00**
AOI 24	SS-2-3	INORG	Barium	7440-39-3	NC	1.30E+03	NC	3.1E-03	NC	8.5E-03	NC	4.1E-02	NC	2.6E-02
AOI 24	SS-2-3	INORG	Beryllium	7440-41-7	B1	8.90E-01	8.9E-11	1.9E-03	7.3E-10	1.9E-03	3.5E-10	9.1E-03	3.9E-10	1.7E-02
AOI 24	SS-2-3	INORG	Cadmium	7440-43-9	B1	3.80E-01	6.7E-11	2.2E-04	5.4E-10	2.4E-04	2.6E-10	7.1E-04	2.9E-10	1.7E-03
AOI 24	SS-2-3	INORG	Chromium (total)	7440-47-3		2.10E+01	NC	6.5E-06	NC	1.5E-05	NC	7.2E-05	NC	5.6E-05
AOI 24	SS-2-3	INORG	Cobalt	7440-48-4	LC	1.50E+01	5.6E-09	2.2E-02	4.6E-08	2.4E-02	2.2E-08	1.7E-02	2.5E-08	**1.9E-01**
AOI 24	SS-2-3	INORG	Copper	7440-50-8	D	1.70E+02	NC	7.3E-03	NC	6.1E-03	NC	2.9E-02	NC	6.6E-02
AOI 24	SS-2-3	INORG	Lead	7439-92-1	B2	1.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-3	INORG	Mercury	7439-97-6	D	6.00E-02	NC	4.2E-03	NC	1.5E-03	NC	2.1E-03	NC	1.8E-02
AOI 24	SS-2-3	INORG	Molybdenum	7439-98-7		3.20E-01	NC	2.7E-05	NC	2.3E-05	NC	1.1E-04	NC	2.5E-04
AOI 24	SS-2-3	INORG	Nickel	7440-02-0	A	3.80E+01	4.1E-10	1.8E-03	3.4E-09	7.7E-03	1.6E-09	5.4E-03	1.8E-09	1.5E-02
AOI 24	SS-2-3	INORG	Selenium	7782-49-2	D	4.70E-01	NC	4.0E-05	NC	3.4E-05	NC	1.6E-04	NC	3.6E-04
AOI 24	SS-2-3	INORG	Thallium	7440-28-0	ID	1.40E-01	NC	6.0E-03	NC	5.0E-03	NC	NC	NC	5.4E-02
AOI 24	SS-2-3	INORG	Vanadium	7440-62-2	ID	4.80E+01	NC	4.1E-03	NC	4.5E-03	NC	1.4E-02	NC	3.7E-02
AOI 24	SS-2-3	INORG	Zinc	7440-66-6	ID	1.10E+02	NC	1.6E-04	NC	1.3E-04	NC	6.3E-04	NC	1.4E-03
AOI 24	SS-2-4	INORG	Antimony	7440-36-0	ID	6.40E-01	NC	6.9E-04	NC	5.7E-04	NC	2.7E-03	NC	6.2E-03
AOI 24	SS-2-4	INORG	Arsenic	7440-38-2	A	3.60E+00	**4.5E-06**	**3.8E-01**	**1.2E-06**	**2.4E-01**	**5.6E-07**	3.6E-03	**3.4E-05**	**2.7E+00**
AOI 24	SS-2-4	INORG	Barium	7440-39-3	NC	1.20E+03	NC	2.8E-03	NC	7.8E-03	NC	3.8E-02	NC	2.4E-02

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 24	SS-2-4	INORG	Beryllium	7440-41-7	B1	1.10E+00	1.1E-10	2.4E-03	9.0E-10	2.3E-03	4.3E-10	1.1E-02	4.8E-10	2.1E-02
AOI 24	SS-2-4	INORG	Cadmium	7440-43-9	B1	1.10E-01	1.9E-11	6.4E-05	1.6E-10	6.9E-05	7.5E-11	2.1E-04	8.4E-11	4.8E-04
AOI 24	SS-2-4	INORG	Chromium (total)	7440-47-3		3.20E+01	NC	9.9E-06	NC	2.3E-05	NC	1.1E-04	NC	8.6E-05
AOI 24	SS-2-4	INORG	Cobalt	7440-48-4	LC	1.80E+01	6.8E-09	2.6E-02	5.5E-08	2.8E-02	2.6E-08	2.1E-02	3.0E-08	**2.3E-01**
AOI 24	SS-2-4	INORG	Copper	7440-50-8	D	2.10E+02	NC	9.0E-03	NC	7.5E-03	NC	3.6E-02	NC	8.1E-02
AOI 24	SS-2-4	INORG	Lead	7439-92-1	B2	1.80E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-4	INORG	Mercury	7439-97-6	D	6.10E-02	NC	4.3E-03	NC	1.5E-03	NC	2.1E-03	NC	1.8E-02
AOI 24	SS-2-4	INORG	Molybdenum	7439-98-7		3.70E-01	NC	3.2E-05	NC	2.6E-05	NC	1.3E-04	NC	2.9E-04
AOI 24	SS-2-4	INORG	Nickel	7440-02-0	A	4.20E+01	4.6E-10	2.0E-03	3.7E-09	8.5E-03	1.8E-09	6.0E-03	2.0E-09	1.6E-02
AOI 24	SS-2-4	INORG	Selenium	7782-49-2	D	7.90E-01	NC	6.8E-05	NC	5.6E-05	NC	2.7E-04	NC	6.1E-04
AOI 24	SS-2-4	INORG	Thallium	7440-28-0	ID	1.40E-01	NC	6.0E-03	NC	5.0E-03	NC	NC	NC	5.4E-02
AOI 24	SS-2-4	INORG	Vanadium	7440-62-2	ID	5.60E+01	NC	4.8E-03	NC	5.3E-03	NC	1.6E-02	NC	4.3E-02
AOI 24	SS-2-4	INORG	Zinc	7440-66-6	ID	7.00E+01	NC	1.0E-04	NC	8.3E-05	NC	4.0E-04	NC	9.0E-04
AOI 24	SS-2-5	INORG	Antimony	7440-36-0	ID	1.20E+00	NC	1.3E-03	NC	1.1E-03	NC	5.1E-03	NC	1.2E-02
AOI 24	SS-2-5	INORG	Arsenic	7440-38-2	A	4.00E+00	**5.0E-06**	**4.2E-01**	**1.3E-06**	**2.7E-01**	**6.2E-07**	4.0E-03	**3.7E-05**	**3.0E+00**
AOI 24	SS-2-5	INORG	Barium	7440-39-3	NC	5.30E+02	NC	1.3E-03	NC	3.5E-03	NC	1.7E-02	NC	1.1E-02
AOI 24	SS-2-5	INORG	Beryllium	7440-41-7	B1	6.20E-01	6.2E-11	1.3E-03	5.1E-10	1.3E-03	2.4E-10	6.3E-03	2.7E-10	1.2E-02
AOI 24	SS-2-5	INORG	Cadmium	7440-43-9	B1	1.20E+00	2.1E-10	7.0E-04	1.7E-09	7.5E-04	8.2E-10	2.2E-03	9.2E-10	5.2E-03
AOI 24	SS-2-5	INORG	Chromium (total)	7440-47-3		2.90E+01	NC	9.0E-06	NC	2.1E-05	NC	9.9E-05	NC	7.8E-05
AOI 24	SS-2-5	INORG	Cobalt	7440-48-4	LC	1.20E+01	4.5E-09	1.7E-02	3.7E-08	1.9E-02	1.8E-08	1.4E-02	2.0E-08	**1.6E-01**
AOI 24	SS-2-5	INORG	Copper	7440-50-8	D	8.10E+01	NC	3.5E-03	NC	2.9E-03	NC	1.4E-02	NC	3.1E-02
AOI 24	SS-2-5	INORG	Lead	7439-92-1	B2	6.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-5	INORG	Mercury	7439-97-6	D	4.20E-02	NC	2.9E-03	NC	1.0E-03	NC	1.4E-03	NC	1.3E-02
AOI 24	SS-2-5	INORG	Molybdenum	7439-98-7		1.10E+00	NC	9.4E-05	NC	7.8E-05	NC	3.8E-04	NC	8.5E-04
AOI 24	SS-2-5	INORG	Nickel	7440-02-0	A	3.30E+01	3.6E-10	1.6E-03	2.9E-09	6.7E-03	1.4E-09	4.7E-03	1.6E-09	1.3E-02
AOI 24	SS-2-5	INORG	Selenium	7782-49-2	D	4.30E-01	NC	3.7E-05	NC	3.1E-05	NC	1.5E-04	NC	3.3E-04
AOI 24	SS-2-5	INORG	Silver	7440-22-4	D	7.80E-02	NC	7.6E-06	NC	2.4E-05	NC	1.2E-04	NC	6.4E-05
AOI 24	SS-2-5	INORG	Vanadium	7440-62-2	ID	5.40E+01	NC	4.7E-03	NC	5.1E-03	NC	1.5E-02	NC	4.2E-02
AOI 24	SS-2-5	INORG	Zinc	7440-66-6	ID	1.50E+02	NC	2.1E-04	NC	1.8E-04	NC	8.6E-04	NC	1.9E-03
AOI 24	SS-2-6	INORG	Antimony	7440-36-0	ID	1.40E+00	NC	1.5E-03	NC	1.2E-03	NC	6.0E-03	NC	1.4E-02
AOI 24	SS-2-6	INORG	Arsenic	7440-38-2	A	2.80E+00	**3.5E-06**	**2.9E-01**	**9.0E-07**	**1.9E-01**	**4.3E-07**	2.8E-03	**2.6E-05**	**2.1E+00**
AOI 24	SS-2-6	INORG	Barium	7440-39-3	NC	4.70E+02	NC	1.1E-03	NC	3.1E-03	NC	1.5E-02	NC	9.6E-03
AOI 24	SS-2-6	INORG	Beryllium	7440-41-7	B1	5.50E-01	5.5E-11	1.2E-03	4.5E-10	1.2E-03	2.2E-10	5.6E-03	2.4E-10	1.1E-02
AOI 24	SS-2-6	INORG	Cadmium	7440-43-9	B1	1.60E+00	2.8E-10	9.4E-04	2.3E-09	1.0E-03	1.1E-09	3.0E-03	1.2E-09	7.0E-03
AOI 24	SS-2-6	INORG	Chromium (total)	7440-47-3		3.00E+01	NC	9.3E-06	NC	2.1E-05	NC	1.0E-04	NC	8.0E-05
AOI 24	SS-2-6	INORG	Cobalt	7440-48-4	LC	1.30E+01	4.9E-09	1.9E-02	4.0E-08	2.1E-02	1.9E-08	1.5E-02	2.1E-08	**1.7E-01**
AOI 24	SS-2-6	INORG	Copper	7440-50-8	D	9.90E+01	NC	4.2E-03	NC	3.5E-03	NC	1.7E-02	NC	3.8E-02
AOI 24	SS-2-6	INORG	Lead	7439-92-1	B2	8.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-6	INORG	Mercury	7439-97-6	D	3.00E-02	NC	2.1E-03	NC	7.3E-04	NC	1.0E-03	NC	9.1E-03
AOI 24	SS-2-6	INORG	Molybdenum	7439-98-7		4.00E-01	NC	3.4E-05	NC	2.9E-05	NC	1.4E-04	NC	3.1E-04
AOI 24	SS-2-6	INORG	Nickel	7440-02-0	A	2.60E+01	2.8E-10	1.2E-03	2.3E-09	5.3E-03	1.1E-09	3.7E-03	1.2E-09	1.0E-02
AOI 24	SS-2-6	INORG	Selenium	7782-49-2	D	4.60E-01	NC	3.9E-05	NC	3.3E-05	NC	1.6E-04	NC	3.6E-04
AOI 24	SS-2-6	INORG	Silver	7440-22-4	D	1.70E-01	NC	1.7E-05	NC	5.3E-05	NC	2.5E-04	NC	1.4E-04
AOI 24	SS-2-6	INORG	Vanadium	7440-62-2	ID	4.80E+01	NC	4.1E-03	NC	4.5E-03	NC	1.4E-02	NC	3.7E-02
AOI 24	SS-2-6	INORG	Zinc	7440-66-6	ID	3.40E+02	NC	4.9E-04	NC	4.0E-04	NC	1.9E-03	NC	4.4E-03
AOI 24	SS-2-7	INORG	Antimony	7440-36-0	ID	1.40E+00	NC	1.5E-03	NC	1.2E-03	NC	6.0E-03	NC	1.4E-02
AOI 24	SS-2-7	INORG	Arsenic	7440-38-2	A	2.80E+00	**3.5E-06**	**2.9E-01**	**9.0E-07**	**1.9E-01**	**4.3E-07**	2.8E-03	**2.6E-05**	**2.1E+00**
AOI 24	SS-2-7	INORG	Barium	7440-39-3	NC	4.20E+02	NC	1.0E-03	NC	2.7E-03	NC	1.3E-02	NC	8.5E-03
AOI 24	SS-2-7	INORG	Beryllium	7440-41-7	B1	5.90E-01	5.9E-11	1.3E-03	4.8E-10	1.3E-03	2.3E-10	6.0E-03	2.6E-10	1.1E-02
AOI 24	SS-2-7	INORG	Cadmium	7440-43-9	B1	1.50E+00	2.6E-10	8.8E-04	2.1E-09	9.4E-04	1.0E-09	2.8E-03	1.2E-09	6.5E-03
AOI 24	SS-2-7	INORG	Chromium (total)	7440-47-3		1.00E+02	NC	3.1E-05	NC	7.1E-05	NC	3.4E-04	NC	2.7E-04

Appendix A
Table 8
Total Soil Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
						Max Detect from All Depths	Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	Location	Chem Group	Chemical	CASRN	Carc Class	(mg/kg)	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
AOI 24	SS-2-7	INORG	Cobalt	7440-48-4	LC	1.40E+01	5.3E-09	2.0E-02	4.3E-08	2.2E-02	2.1E-08	1.6E-02	2.3E-08	**1.8E-01**
AOI 24	SS-2-7	INORG	Copper	7440-50-8	D	7.70E+01	NC	3.3E-03	NC	2.7E-03	NC	1.3E-02	NC	3.0E-02
AOI 24	SS-2-7	INORG	Lead	7439-92-1	B2	3.80E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-7	INORG	Mercury	7439-97-6	D	5.80E-02	NC	4.1E-03	NC	1.4E-03	NC	2.0E-03	NC	1.7E-02
AOI 24	SS-2-7	INORG	Molybdenum	7439-98-7		5.80E-01	NC	5.0E-05	NC	4.1E-05	NC	2.0E-04	NC	4.5E-04
AOI 24	SS-2-7	INORG	Nickel	7440-02-0	A	2.60E+01	2.8E-10	1.2E-03	2.3E-09	5.3E-03	1.1E-09	3.7E-03	1.2E-09	1.0E-02
AOI 24	SS-2-7	INORG	Selenium	7782-49-2	D	6.30E-01	NC	5.4E-05	NC	4.5E-05	NC	2.2E-04	NC	4.9E-04
AOI 24	SS-2-7	INORG	Silver	7440-22-4	D	3.10E-01	NC	3.0E-05	NC	9.6E-05	NC	4.6E-04	NC	2.6E-04
AOI 24	SS-2-7	INORG	Thallium	7440-28-0	ID	1.10E-01	NC	4.7E-03	NC	3.9E-03	NC	NC	NC	4.3E-02
AOI 24	SS-2-7	INORG	Vanadium	7440-62-2	ID	6.80E+01	NC	5.9E-03	NC	6.4E-03	NC	1.9E-02	NC	5.3E-02
AOI 24	SS-2-7	INORG	Zinc	7440-66-6	ID	3.20E+02	NC	4.6E-04	NC	3.8E-04	NC	1.8E-03	NC	4.1E-03
AOI 24	SS-2-8	INORG	Antimony	7440-36-0	ID	7.70E-01	NC	8.2E-04	NC	6.9E-04	NC	3.3E-03	NC	7.5E-03
AOI 24	SS-2-8	INORG	Arsenic	7440-38-2	A	2.40E+00	**3.0E-06**	**2.5E-01**	**7.7E-07**	**1.6E-01**	**3.7E-07**	2.4E-03	**2.2E-05**	**1.8E+00**
AOI 24	SS-2-8	INORG	Barium	7440-39-3	NC	4.00E+02	NC	9.5E-04	NC	2.6E-03	NC	1.3E-02	NC	8.1E-03
AOI 24	SS-2-8	INORG	Beryllium	7440-41-7	B1	4.40E-01	4.4E-11	9.5E-04	3.6E-10	9.3E-04	1.7E-10	4.5E-03	1.9E-10	8.6E-03
AOI 24	SS-2-8	INORG	Cadmium	7440-43-9	B1	6.50E-01	1.1E-10	3.8E-04	9.3E-10	4.1E-04	4.5E-10	1.2E-03	5.0E-10	2.8E-03
AOI 24	SS-2-8	INORG	Chromium (total)	7440-47-3		3.10E+01	NC	9.6E-06	NC	2.2E-05	NC	1.1E-04	NC	8.3E-05
AOI 24	SS-2-8	INORG	Cobalt	7440-48-4	LC	1.10E+01	4.1E-09	1.6E-02	3.4E-08	1.7E-02	1.6E-08	1.3E-02	1.8E-08	1.4E-01
AOI 24	SS-2-8	INORG	Copper	7440-50-8	D	7.70E+01	NC	3.3E-03	NC	2.7E-03	NC	1.3E-02	NC	3.0E-02
AOI 24	SS-2-8	INORG	Lead	7439-92-1	B2	9.30E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 24	SS-2-8	INORG	Mercury	7439-97-6	D	2.80E-02	NC	2.0E-03	NC	6.9E-04	NC	9.6E-04	NC	8.4E-03
AOI 24	SS-2-8	INORG	Molybdenum	7439-98-7		3.80E-01	NC	3.3E-05	NC	2.7E-05	NC	1.3E-04	NC	2.9E-04
AOI 24	SS-2-8	INORG	Nickel	7440-02-0	A	2.00E+01	2.2E-10	9.5E-04	1.8E-09	4.0E-03	8.5E-10	2.9E-03	9.5E-10	7.7E-03
AOI 24	SS-2-8	INORG	Selenium	7782-49-2	D	3.80E-01	NC	3.3E-05	NC	2.7E-05	NC	1.3E-04	NC	2.9E-04
AOI 24	SS-2-8	INORG	Silver	7440-22-4	D	1.70E-01	NC	1.7E-05	NC	5.3E-05	NC	2.5E-04	NC	1.4E-04
AOI 24	SS-2-8	INORG	Vanadium	7440-62-2	ID	4.60E+01	NC	4.0E-03	NC	4.3E-03	NC	1.3E-02	NC	3.6E-02
AOI 24	SS-2-8	INORG	Zinc	7440-66-6	ID	1.70E+02	NC	2.4E-04	NC	2.0E-04	NC	9.7E-04	NC	2.2E-03
AOI 25	SS-3-1	INORG	Lead	7439-92-1	B2	1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3-2	PCB	PCBs (total)	1336-36-3	B2	1.20E-01	9.0E-08	5.6E-03	1.7E-08	2.8E-03	9.6E-09	5.3E-03	**5.2E-07**	3.2E-02
AOI 25	SS-3-2	INORG	Lead	7439-92-1	B2	1.60E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3A-1	INORG	Lead	7439-92-1	B2	4.70E+01	NC	NC	NC	NC	NC	NC	NC	NC
AOI 25	SS-3A-2	INORG	Lead	7439-92-1	B2	5.20E+01	NC	NC	NC	NC	NC	NC	NC	NC

Notes:
Only chemicals detected at each location are shown.
Exposure concentrations conservatively calculated using the maximum detected soil concentrations observed at each location, regardless of depth.
Single-chemical cancer risk and HQ estimates in excess of 1/10 NPS's thresholds for cumulative cancer risk and HI of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HQ estimates were not calculated for detected chemicals with inadequate toxicity
or physical/chemical parameters or where chemical concentrations were non-detect.
Chem Group - chemical group
Carc Class - USEPA Weight-of-Evidence Cancer Classification

Appendix A
Table 9
Upper-Bound Total Sediment Cumulative Cancer Risks and Noncancer HIs
GGNRA Hawk Hill, Marin Headlands, CA

Area	Location	Park Worker		Maintenance Worker		Construction Worker		Resident	
		Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
		Risk	HI	Risk	HI	Risk	HI	Risk	HI
AOI 14	CO-COMP	**5E-06**	5E-01	1E-06	3E-01	6E-07	1E-01	**4E-05**	**3E+00**

Notes:
Cumulative cancer risk and HI estimates in excess of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HI estimates were not calculated for detected chemicals with inadequate toxicity
or physical/chemical parameters or where chemical concentrations were non-detect.

Appendix A
Table 10
Total Sediment Single-Chemical Cancer Risk and Noncancer HQ
GGNRA Hawk Hill, Marin Headlands, CA

							Park Worker		Maintenance Worker		Construction Worker		Resident	
							Outdoor Activities		Outdoor Activities		Outdoor Activities		Outdoor Activities	
Area	**Location**	**Chem Group**	**Chemical**	**CASRN**	**Carc Class**	**Max Detect** (mg/kg)	**Risk**	**HQ**	**Risk**	**HQ**	**Risk**	**HQ**	**Risk**	**HQ**
AOI 14	CO-COMP	PDIST	Diesel Range Organics	DRO		3.10E+01	NC	5.7E-03	NC	3.1E-03	NC	2.6E-02	NC	2.6E-02
AOI 14	CO-COMP	INORG	Antimony	7440-36-0	ID	3.70E+00	NC	4.0E-03	NC	3.3E-03	NC	1.6E-02	NC	3.6E-02
AOI 14	CO-COMP	INORG	Arsenic	7440-38-2	A	4.00E+00	**5.0E-06**	**4.2E-01**	**1.3E-06**	**2.7E-01**	**6.2E-07**	4.0E-03	**3.7E-05**	**3.0E+00**
AOI 14	CO-COMP	INORG	Barium	7440-39-3	NC	3.40E+02	NC	8.1E-04	NC	2.2E-03	NC	1.1E-02	NC	6.9E-03
AOI 14	CO-COMP	INORG	Cadmium	7440-43-9	B1	6.80E-01	1.2E-10	4.0E-04	9.7E-10	4.2E-04	4.7E-10	1.3E-03	5.2E-10	3.0E-03
AOI 14	CO-COMP	INORG	Chromium (total)	7440-47-3		3.30E+01	NC	1.0E-05	NC	2.4E-05	NC	1.1E-04	NC	8.8E-05
AOI 14	CO-COMP	INORG	Cobalt	7440-48-4	LC	1.50E+01	5.6E-09	2.2E-02	4.6E-08	2.4E-02	2.2E-08	1.7E-02	2.5E-08	**1.9E-01**
AOI 14	CO-COMP	INORG	Copper	7440-50-8	D	8.20E+01	NC	3.5E-03	NC	2.9E-03	NC	1.4E-02	NC	3.2E-02
AOI 14	CO-COMP	INORG	Lead	7439-92-1	B2	1.70E+02	NC	NC	NC	NC	NC	NC	NC	NC
AOI 14	CO-COMP	INORG	Mercury	7439-97-6	D	1.10E-01	NC	7.7E-03	NC	2.7E-03	NC	3.8E-03	NC	3.3E-02
AOI 14	CO-COMP	INORG	Molybdenum	7439-98-7		1.70E+00	NC	1.5E-04	NC	1.2E-04	NC	5.8E-04	NC	1.3E-03
AOI 14	CO-COMP	INORG	Nickel	7440-02-0	A	3.50E+01	3.8E-10	1.7E-03	3.1E-09	7.1E-03	1.5E-09	5.0E-03	1.7E-09	1.4E-02
AOI 14	CO-COMP	INORG	Vanadium	7440-62-2	ID	6.30E+01	NC	5.4E-03	NC	5.9E-03	NC	1.8E-02	NC	4.9E-02
AOI 14	CO-COMP	INORG	Zinc	7440-66-6	ID	2.90E+02	NC	4.1E-04	NC	3.4E-04	NC	1.7E-03	NC	3.7E-03

Notes:
Only chemicals detected at each location are shown.
Exposure concentrations conservatively calculated using the maximum detected soil concentrations observed at each location, regardless of depth.
Single-chemical cancer risk and HQ estimates in excess of 1/10 CalEPA's thresholds for cumulative cancer risk and HI of 1E-6 and 1, respectively, are shaded and bold.
NC - Risk and HQ estimates were not calculated for detected chemicals with inadequate toxicity
or physical/chemical parameters or where chemical concentrations were non-detect.
Chem Group - chemical group
Carc Class - USEPA Weight-of-Evidence Cancer Classification

APPENDIX B
ECOLOGICAL RISK ASSESSMENT SUPPORTING INFORMATION

- Attachment 1 – Mission Blue Butterfly Profile
- Attachment 2 – Reg Legged Frog Profile
- Table 1 – Bioaccumulation Factors and EP Concentrations for Terrestrial Wildlife Receptors
- Table 2 – Receptor Home Range and Area Use Factor Calculation
- Table 3 – Calculation of Food and Soil Ingestion Rates for Terrestrial Wildlife Receptors
- Table 4a – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 13)
- Table 4b – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 14)
- Table 4c – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 15)
- Table 4d – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 16)
- Table 4e – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 17)
- Table 4f – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 18)
- Table 4g – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 19)
- Table 4h – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 20)
- Table 4i – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 21)
- Table 4j – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 22)
- Table 4k – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 23)
- Table 4l – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 24)
- Table 4m – Estimate of Risk for Terrestrial Wildlife Receptors (AOI 25)
- Table 5 – Ecological Toxicity Reference Values
- Table 6 – Plant and Invertebrate Threshold Values

Mission Blue Butterfly Profile

Introduction

The mission blue butterfly (*Icaricia icaroides missionensis*) has been federally listed as an endangered species since 1976, primarily due to habitat loss from development as well as the impact of invasive species. Most of the remaining colonies are found on San Bruno Mountain, San Mateo County, CA. Other colonies have been discovered in San Mateo County at Milagra and Sweeney Ridges in the GGNRA. The species has also been collected from Fort Baker, Marin County (Coast Ride Ecology 2018; May & Associates 2006).

Life Cycle and Habitat Requirements

The mission blue butterfly is a small, delicate butterfly in the Lycaenidae (gossamer-winged butterfly) family. The body of the male is dark bluish brown and the females have dark brown upper wing surfaces marked with blue basal areas.

The mission blue butterfly habitat consists of coastal grassland or a mix of coastal grassland and scrub that must also support one of three species of lupine: the preferred silver lupine (*Lupinus albifrons var. collinus*), the summer lupine (*Lupinus formosus*) or the varied lupine (*Lupinus variicolor*). While the adult butterflies feed on nectar from a variety of plants, the females must lay their eggs on one of these three species of plants as these are the only plants that the larvae can live on.

The eggs are laid singly on the leaves, stems, flowers and seed pods of the lupines from as early as mid-February to as late as mid-July. The eggs hatch four to seven days later, and the larvae feed on the inner tissues of the host plant and the entire flower. After feeding, the small second instar larvae (caterpillars that have shed their skin once) enter a dormant stage during the cooler winter months in the litter at the base of the lupine plant. The following spring, the larvae emerge from dormancy and begin feeding again. As such, one generation of butterflies is produced each year (May & Associates 2006).

Habitat Implications for Hawk Hill

The grasslands and coastal shrub of Hawk Hill are known to support patchy areas of the silver lupine and wildflowers, therefore providing host and nectar plant habitat for the mission blue butterfly (May & Associates 2006) (see Figure 1).

However, at Hawk Hill, as with other locations, the mission blue butterfly habitat is threatened by non-native, invasive plants such as Blackwood acacia (*Acacia melanoxylon*), Hemlock (*Conium maculatum*), Jubata grass (*Cortaderia jubata*), and Thoroughwort (*Ageratina adenophora*).[1] In the Bay Area, these introduced species often reproduce rapidly and outcompete the native lupines. Other plant species such as the Australian tea tree (*Leptospermum laevigatum*) and the Monterey cypress (*Cupressus macrocarpa*) reduce and fragment mission blue habitat. At Hawk Hill, this habitat has also been impacted by recreational use (use of unofficial trails) and fragmented by roads as well as official trails

[1] At Hawk Hill, it is possible that some of these non-native plants were accidently introduced to the area as seeds by the military during construction of Battery 129 in the 1940s.

and hiking routes. Because mission blue butterflies are weak fliers, taller invasive plants and breaks in the lupine patches reduce the ability of the butterfly to move between available habitat.

Recognizing the importance of the mission blue butterfly, the NPS has been leading habitat restoration projects throughout the GGNRA since the late 1980s. For the Hawk Hill, this restoration includes the elimination of non-native plants and the establishment of mission blue butterfly host plants. For example, in 2001-2002, 150 trees were removed from 8 acres of Hawk Hill. In their place over 3,000 native grassland plants were planted including purple needle grass (*Nassella pulchra*) and coast buckwheat (*Eriogonum latifolium*), as well as just over 600 silver lupine plants.[2] Habitat restoration projects such as these are continuing as are surveys of the adult butterflies on the Marin Headlands (Coast Ride Ecology, 2018).

Potential Effect of Surface Soil Metals on Hawk Hill Plants

The ecological risk assessment presented in Section 3.2 of the report included an evaluation of potential risks to terrestrial plants. The outcome of this analysis is presented in Table 3-7 based on maximum soil COPEC concentrations, and in Table 3-8 and Figure 3-3 based on individual soil sample COPEC concentrations. Potential risks to terrestrial plants were identified from exposure to lead in AOIs 18 to 21, and AOI 23, as well as from exposure to barium, vanadium, and zinc in AOI 24. These potential risks are evaluated qualitatively below.

As described in Section 3.2.4, given the lack of data on the toxicity of barium and vanadium to terrestrial plants, there is considerable uncertainty with respect to potential risks. For barium, the threshold value is based on one soil exposure study of shoot growth in barley; as a result, the authors have low confidence in its use (Efroymson et al. 1997). Although barium is not an essential element for plants, it is often found in plant tissue. Similarly, for vanadium, the threshold value is based on a single study with collard (LANL 2017). Vanadium is also not an essential element for plant growth; but it may be involved in nitrogen fixation in legume roots (lupines are in the legume family). Furthermore, following uptake, most vanadium remains in the root system as an insoluble form with Ca (Wallace and Romney 1977 in Efroymson and coworkers).

Lead in soil is converted to immobile forms such as insoluble sulfates or phosphates and can form complexes with organic matter and clay minerals (EcoSSL 2005). The translocation of lead to the shoots is limited as it remains bound to the outside of roots and in the cell walls of absorbing roots (Wallace and Romney 1977 in Efroymson and coworkers). The toxicity of lead to plants is relatively low compared to other trace elements (Miles et al. 1972 in Efroymson and coworkers).

Zinc is strongly adsorbed to soil at pH 5 or above resulting in low soil solution concentrations compared total soil zinc concentrations, and therefore, relatively low bioavailability (EcoSSL 2007). Zinc is an essential element for plant growth and is involved in many enzyme systems and in metabolism. As a result, it is actively taken up by roots and becomes evenly distributed between the roots and shoots (Wallace and Romney 1977 in Efroymson and coworkers). Toxicity can include chlorosis and depressed plant growth (Chapman 1966 in Efroymson and coworkers).

[2] http://californiagardenclubs.com/sites/default/files/Projects/MissionBlueHabitatRestoration.pdf

A review of the sources for the plant-based thresholds indicates that overall, there is limited information on the phytotoxicity of metals to terrestrial plants from soil exposure. For many of the metals, if uptake does occur, translocation to the leaves, shoots, and flowers is often limited. Because the critical stage in the life cycle of the mission blue butterfly is the dependence of the larvae on consuming the leaves, shoots, and flowers of the lupine plants, it is unlikely that the concentrations of the metals in the soil of Hawk Hill will adversely affect the success of the mission blue butterfly at the Site.

References

Coast Ride Ecology. 2018. Survey Results for the Mission Blue Butterfly at GGNRA, Marin Headlands, CA. 2018. Prepared for GG National Parks Conservancy. Prepared by Coast Ride Ecology LLC., San Francisco. December 2018.

Efroymson R.A., M.E. Will, G.W. Suter II, A.C. Wooten. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Prepared for the U.S. Department of Energy, Office of Environmental Management. ES/ER/TM-85/R3.

Los Alamos National Laboratory (LANL).2017. EcoRisk Database, Release 4.1. October 19.

May & Associates, Inc. 2006. Biological Assessment Marin Headlands – Fort Baker Transportation Management Plan and Coastal Corridor Enhancement Project. Location: Golden Gate National Recreation Area, Marin County, California. Prepared for GGNRA, Natural Resources Division. Prepared by May & Associates, Inc., San Francisco.

USEPA 2005. Ecological Soil Screening Levels for Lead. Interim Final. Office of Solid Waste and Emergency Response. Directive 9285.7-70.

USEPA 2007. Ecological Soil Screening Levels for Zinc. Interim Final. Office of Solid Waste and Emergency Response. Directive 9285.7-73.

California Reg Legged Frog Profile

Introduction

The California red-legged frog (*Rana aurora draytonii*) is now extirpated from around 70 percent of its former range and was federally listed as a threatened species in June 1996. It is currently found in the California coastal drainages from Marin County, California, to northern Baja California, Mexico. As described in a Recovery Plan for the California red-legged frog (USFWS 2002), the primary threats to this frog are the elimination or degradation of habitat due to land development, urban encroachment, construction of reservoirs and water diversions, as well as habitat invasion by non-native aquatic species.

Life History

The California red-legged frog breeds from November through April with most adult frogs laying their eggs in March. It takes approximately 20 to 22 days for the eggs to develop into tadpoles and about 11 to 20 weeks for the tadpoles to develop into frogs (Bobzien et al. 2000 in USFWS 2002). Sexual maturity is reached in 2 years for males and 3 years for females. Adults can live up to 10 years (Jennings et al. 1992 in USFWS 2002), although the average is likely lower. Juveniles are active during the day and night, while adults tend to be nocturnal. Seasonal activity depends on the local climate with those in coastal areas active year-round given the moderate maritime temperatures, and those further inland becoming inactive during periods of lower temperature.

Habitat and Breeding Requirements

The ideal habitat for the red-legged frog is one where there are multiple breeding areas within a matrix of aquatic, riparian, and upland habitats. Breeding areas include pools, backwaters with streams and creek, ponds, marshes, springs, dune ponds, but can also include artificial impoundments such as stock ponds. Breeding adults prefer still or slow-moving water (over 2 feet deep), with emergent vegetation or a shrubby riparian zone. Emergent vegetation provides a surface on which the females lay their egg-masses, and the riparian zone provides cover and moisture for the adult frogs to rest and forage on insects.

Given the Californian Mediterranean climate, these habitats will change spatially in response to fluctuations in precipitation, temperature, natural water flow, and sedimentation rates. As a result, there is variation in how the red-legged frog uses its environment. For example, some populations may complete their entire life cycle in a pond while others may move between different habitat types, particularly with the onset of a wet-weather event. As noted by USFWS (2002), a study of marked and radio-tagged red-legged frogs on the San Luis Obispo County coast suggests that the red-legged frog can travel up to 1 mile via upland habitats over the course of a wet season. However, Jennings et al. (1992) showed that during dry periods, the California red-legged frog is rarely found far from water. If water is not available during an extended dry period, the frog will seek refuge in large cracks in the bottom of ponds or creeks, or under boulders, rocks, downed trees etc.

In March 2001, the USFWS finalized designation of critical habitat for the California red-legged frog (USFWS 2001). The primary elements of this critical habitat are at least two suitable breeding locations,

a permanent water source, uplands surrounding the water source up to 300 ft from the water's edge, all within 1.25 miles of one another and connected by barrier-free dispersal habitat that is at least 300 ft wide. Based on a 2005 revision to proposed critical habitats, this does not include a red-legged frog critical habitat unit in the GGNRA including the Marin Headlands (May & Associates 2006).

Diet

Foraging typically occurs on the surface of the water and along the shoreline but can also occur several feet into the denser riparian areas. The diet of the California red-legged frog depends on life-stage. The larvae likely graze on algae while the adults predominantly feed on invertebrates such as insects (Hayes and Tennant 1985). For larger adults, tree frogs and mice can make up over half of their dietary intake.

Current Distribution with Respect to Hawk Hill.

As described in the 2002 Recovery Plan, California has designed eight recovery units for the red-legged frog[1]. Of these, the Golden Gate National Recreation Area (GGNRA), including Hawk Hill, is within the North Coast and North San Francisco Recover Unit 3. While the report notes that the frog has been observed in the GGNRA (Marin County), larger numbers, including breeding populations, have been recorded much further afield. For example, large numbers were reported to occur in Olema Marsh in Point Reynes National Park, approximately 20 miles northwest of the GGNRA, and a large breeding population is located at Ledson Marsh in Annadel State Park (Sonoma County) which is approximately 40 miles north of GGNRA. In addition, sightings of the frog have also occurred Near Suisun Marsh, Solano County, approximately 35 miles north of GGNRA.

As part of a conservation measure under Section 7(a)(2) of the Endangered Species Act, the GGNRA has initiated a volunteer program to observe frogs during the winter in three watersheds (Tennessee, Lower Redwood/Big Lagoon, and Rodeo Valley) (May & Associates 2006). Of these, Rodeo Valley is approximately 1.5 miles from Hawk Hill. However, not only is the distance between the two greater than the typical distance traveled by the California red-legged frog, these two areas are divided by Bunker Road which will likely act as a barrier and deterrent for its movement between the two.

Because the breeding and foraging requirements for the frog are dependent on a permanent water source, the presence of emergent vegetation, and a shrubby riparian zone, Hawk Hill does not provide suitable habitat. Furthermore, the proposed cleaning out and renovation of the Casemate gun pit will eliminate any standing water thereby further reducing the potential for suitable habitat in the future.

References

May & Associates, Inc. 2006. Biological Assessment Marin Headlands – Fort Baker Transportation Management Plan and Coastal Corridor Enhancement Project. Location: Golden Gate National Recreation Area, Marin County, California. Prepared for GGNRA, Natural Resources Division. Prepared by May & Associates, Inc., San Francisco.

United States Fish and Wildlife Service (USFWS). 2001. Final determination of critical habitat for the California red-legged frog. Federal Register 66(49):14626-14758.

[1] See the California Department of Fish and Game's Natural Diversity Database 2001 for details on distribution

USFWS 2002. Recovery Plan for the California Red-legged frog (*Rana aurora draytonii*). Region 1 U.S. Fish and Wildlife Service, Portland, Oregon.

Appendix B
Table 1
Bioaccumulation Factors and Exposure Point Concentrations for Terrestrial Wildlife Receptors
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	Soil Concentration (mg/kg dw)	Soil to Plant BAF	Plant Concentration (mg/kg ww)	Soil to Invertebrate BAF	Invertebrate Concentration (mg/kg ww)	Soil to Small Mammal BAF	Small Mammal Concentration (mg/kg ww)
				Value		Value		Value	
PCB	PCBs (total)	1336-36-3	1.50E+01	2.70E-02	8.10E-02	6.80E+00	2.04E+01	1.62E-02	4.86E-02
INORG	Antimony	7440-36-0	1.20E+01	3.38E-02	8.11E-02	1.00E+00	2.40E+00	1.20E-01	5.76E-02
INORG	Barium	7440-39-3	1.30E+03	1.56E-01	4.06E+01	9.10E-02	2.37E+01	1.77E-01	8.40E-01
INORG	Cadmium	7440-43-9	8.20E+00	2.39E-01	3.92E-01	5.38E+00	8.82E+00	9.37E-02	1.54E-01
INORG	Chromium (total)	7440-47-3	1.00E+02	4.10E-02	8.20E-01	3.06E-01	6.12E+00	6.82E-02	1.36E+00
INORG	Lead	7439-92-1	1.90E+03	9.64E-03	3.66E+00	1.87E-01	7.12E+01	1.60E-02	6.08E+00
INORG	Mercury	7439-97-6	3.00E-01	6.40E-01	3.84E-02	1.69E-01	1.01E-02	3.81E-01	2.29E-02
INORG	Selenium	7782-49-2	9.00E-01	5.03E-01	9.05E-02	9.54E-01	1.72E-01	7.05E-01	1.27E-01
INORG	Vanadium	7440-62-2	1.10E+02	4.85E-03	1.07E-01	4.20E-02	9.24E-01	1.23E-02	2.71E-01
INORG	Zinc	7440-66-6	4.80E+03	1.10E-01	1.06E+02	2.87E-01	2.76E+02	2.98E-02	2.86E+01

Notes:
BAF - bioaccumulation factor
dw - dry weight
ww - wet weight
Estimated plant and invertebrate concentrations include a dw to ww converstion of 0.2.
BAF for PCBs (total) assume Aroclor-1260

Appendix B
Table 2
Receptor Home Range and Area Use Factor Calculation
GGNRA Hawk Hill, Marin Headlands, CA

Table 2a
Receptor Home Ranges (Acres)

American Robin (herbivore/invertivore)	Deer Mouse (herbivore/invertivore)	Red-tailed Hawk (top level carnivore)	Red Fox (top level carnivore)
1.00	0.27	272.00	237.00

Table 2b
Calculation of Area Use Factors

Area of Concern	Area (acres)	American Robin (herbivore/invertivore)	Deer Mouse (herbivore/invertivore)	Red-tailed Hawk (top level carnivore)	Red Fox (top level carnivore)
AOI 05	2.70E-02	2.70E-02	1.00E-01	9.93E-05	1.14E-04
AOI 13	1.35E-02	1.35E-02	5.01E-02	4.97E-05	5.71E-05
AOI 14	7.82E-02	7.82E-02	2.90E-01	2.87E-04	3.30E-04
AOI 15	8.74E-02	8.74E-02	3.24E-01	3.21E-04	3.69E-04
AOI 16	1.61E-01	1.61E-01	5.98E-01	5.93E-04	6.81E-04
AOI 17	2.22E-02	2.22E-02	8.23E-02	8.17E-05	9.38E-05
AOI 18	6.05E-02	6.05E-02	2.24E-01	2.22E-04	2.55E-04
AOI 19	4.53E-02	4.53E-02	1.68E-01	1.67E-04	1.91E-04
AOI 20	5.86E-02	5.86E-02	2.17E-01	2.15E-04	2.47E-04
AOI 21	6.88E-02	6.88E-02	2.55E-01	2.53E-04	2.90E-04
AOI 22	2.16E-02	2.16E-02	7.98E-02	7.93E-05	9.10E-05
AOI 23	3.54E-02	3.54E-02	1.31E-01	1.30E-04	1.49E-04
AOI 24	1.27E-02	1.27E-02	4.69E-02	4.65E-05	5.34E-05
AOI 25	1.25E-02	1.25E-02	4.64E-02	4.60E-05	5.28E-05

Note:
Area use factor is calculated by the dividing the area of an AOI by the receptor's home range.

Appendix B
Table 3
Calculation of Food and Soil Ingestion Rates for Terrestrial Wildlife Receptors
GGNRA Hawk Hill, Marin Headlands, CA

	American Robin (herbivore/invertivore)				Deer Mouse (herbivore/invertivore)				Red-tailed Hawk (top level carnivore)				Red Fox (top level carnivore)			
Prey type	**Proportion of Diet** (percent)	**Gross Energy** (kcal/g ww)	**Assimilation Efficiency** (percent)	**Metabolic Energy** (kcal/g ww)	**Proportion of Diet** (percent)	**Gross Energy** (kcal/g ww)	**Assimilation Efficiency** (percent)	**Metabolic Energy** (kcal/g ww)	**Proportion of Diet** (percent)	**Gross Energy** (kcal/g ww)	**Assimilation Efficiency** (percent)	**Metabolic Energy** (kcal/g ww)	**Proportion of Diet** (percent)	**Gross Energy** (kcal/g ww)	**Assimilation Efficiency** (percent)	**Metabolic Energy** (kcal/g ww)
Terrestrial Plants	28%	1.1E+00	64%	7.0E-01	50%	1.5E+00	76%	1.1E+00					11%	1.5E+00	76%	1.1E+00
Terrestrial Invertebrates	72%	1.3E+00	72%	9.6E-01	50%	1.3E+00	87%	1.2E+00					4%	1.3E+00	87%	1.2E+00
Small Mammals									100%	1.7E+00	78%	1.3E+00	85%	1.7E+00	84%	1.4E+00

Parameter	Value	Value	Value	Value
Normalized Free-living Metabolic Rate (kcal/kg-d)	7.1E+02	5.6E+02	2.0E+02	1.6E+02
Body Weight (kg)	7.7E-02	1.9E-02	1.1E+00	4.5E+00
Home Range (acres)	1.0E+00	2.7E-01	2.7E+02	2.4E+02
Total Normalized Ingestion Rate (g/kg-d)	8.0E+02	4.9E+02	1.5E+02	1.2E+02
Total Normalized Ingestion Rate (g/g-d)	8.0E-01	4.9E-01	1.5E-01	1.2E-01
Food Ingestion Rate (kg/d)	6.2E-02	9.4E-03	1.7E-01	5.4E-01
Soil Ingestion Rate (kg/d)	1.3E-03	1.9E-04		1.5E-02

Appendix B
Table 4a
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 13)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	6.6E-02	3.6E-04	9.0E-02	2.1E-04	7.1E-04	2.6E+00	3E-04	1.1E-03	2.1E+01	5E-05	1.6E-09	2.6E+00	6E-10	3.9E-08	2.1E+01	2E-09

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4b
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 14)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
INORG	Lead	7439-92-1	2.4E+02	1.1E+00	1.3E+01	2.4E+00	9.4E-01	6.6E+00	1E-01	1.7E+00	6.5E+00	3E-01	1.0E-04	6.6E+00	2E-05	3.7E-04	6.5E+00	6E-05

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4c
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 15)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
INORG	Selenium	7782-49-2	8.6E-01	8.6E-02	1.7E-01	1.2E-01	1.1E-02	4.1E-01	3E-02	2.3E-02	1.8E-01	1E-01	5.9E-06	4.1E-01	1E-05	6.4E-06	1.8E-01	4E-05
INORG	Vanadium	7440-62-2	8.3E+01	8.1E-02	7.0E-01	2.0E-01	1.6E-01	4.9E-01	3E-01	3.2E-01	5.9E+00	5E-02	9.7E-06	4.9E-01	2E-05	1.1E-04	5.9E+00	2E-05

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4d
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 16)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
INORG	Antimony	7440-36-0	1.2E+01	8.1E-02	2.4E+00	5.8E-02	2.6E-01			4.3E-01	1.9E-01	**2E+00**	5.1E-06			4.0E-05	1.9E-01	2E-04
INORG	Chromium (total)	7440-47-3	5.5E+01	4.5E-01	3.4E+00	8.8E-01	4.8E-01	6.4E+00	7E-02	8.8E-01	1.2E+01	7E-02	7.7E-05	6.4E+00	1E-05	2.0E-04	1.2E+01	2E-05
INORG	Lead	7439-92-1	1.0E+02	7.0E-01	6.6E+00	1.7E+00	9.1E-01	6.6E+00	1E-01	1.6E+00	6.5E+00	3E-01	1.5E-04	6.6E+00	2E-05	3.7E-04	6.5E+00	6E-05
INORG	Mercury	7439-97-6	3.0E-01	3.8E-02	1.0E-02	2.3E-02	3.2E-03	2.0E-02	2E-01	8.8E-03	7.2E-02	1E-01	2.0E-06	2.0E-02	1E-04	2.6E-06	7.2E-02	4E-05
INORG	Selenium	7782-49-2	5.9E-01	5.7E-02	1.3E-01	1.1E-01	1.5E-02	4.1E-01	4E-02	3.0E-02	1.8E-01	2E-01	9.5E-06	4.1E-01	2E-05	9.7E-06	1.8E-01	6E-05
INORG	Vanadium	7440-62-2	6.9E+01	6.7E-02	5.8E-01	1.7E-01	2.4E-01	4.9E-01	5E-01	5.0E-01	5.9E+00	8E-02	1.5E-05	4.9E-01	3E-05	1.7E-04	5.9E+00	3E-05
INORG	Zinc	7440-66-6	2.2E+02	1.9E+01	1.0E+02	2.3E+01	1.1E+01	1.1E+02	1E-01	1.9E+01	1.5E+02	1E-01	2.0E-03	1.1E+02	2E-05	2.6E-03	1.5E+02	2E-05

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4e
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 17)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
INORG	Selenium	7782-49-2	9.0E-01	9.0E-02	1.7E-01	1.3E-01	3.0E-03	4.1E-01	7E-03	6.0E-03	1.8E-01	3E-02	1.5E-06	4.1E-01	4E-06	1.7E-06	1.8E-01	1E-05

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4f
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 18)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	7.8E-02	4.2E-04	1.1E-01	2.5E-04	3.8E-03	2.6E+00	1E-03	6.0E-03	2.1E+01	3E-04	8.3E-09	2.6E+00	3E-09	2.1E-07	2.1E+01	1E-08
INORG	Lead	7439-92-1	7.8E+02	2.2E+00	3.5E+01	4.1E+00	2.0E+00	6.6E+00	3E-01	3.7E+00	6.5E+00	6E-01	1.4E-04	6.6E+00	2E-05	8.2E-04	6.5E+00	1E-04

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4g
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 19)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
INORG	Lead	7439-92-1	5.6E+02	1.8E+00	2.7E+01	3.5E+00	1.1E+00	6.6E+00	2E-01	2.1E+00	6.5E+00	3E-01	8.7E-05	6.6E+00	1E-05	4.5E-04	6.5E+00	7E-05

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4h
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 20)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	1.3E-01	7.0E-04	1.8E-01	4.2E-04	6.1E-03	2.6E+00	2E-03	9.7E-03	2.1E+01	5E-04	1.3E-08	2.6E+00	5E-09	3.4E-07	2.1E+01	2E-08
INORG	Lead	7439-92-1	1.9E+03	3.7E+00	7.1E+01	6.1E+00	4.3E+00	6.6E+00	7E-01	8.0E+00	6.5E+00	1E+00	1.9E-04	6.6E+00	3E-05	1.8E-03	6.5E+00	3E-04

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4i
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 21)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	7.8E-02	4.2E-04	1.1E-01	2.5E-04	4.3E-03	2.6E+00	2E-03	6.8E-03	2.1E+01	3E-04	9.5E-09	2.6E+00	4E-09	2.4E-07	2.1E+01	1E-08
INORG	Lead	7439-92-1	8.8E+02	2.4E+00	3.8E+01	4.3E+00	2.6E+00	6.6E+00	4E-01	4.7E+00	6.5E+00	7E-01	1.6E-04	6.6E+00	2E-05	1.0E-03	6.5E+00	2E-04

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4j
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 22)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
INORG	Lead	7439-92-1	9.2E+01	6.7E-01	6.2E+00	1.6E+00	1.1E-01	6.6E+00	2E-02	2.0E-01	6.5E+00	3E-02	1.9E-05	6.6E+00	3E-06	4.6E-05	6.5E+00	7E-06

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4k
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 23)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	2.0E-01	1.1E-03	2.7E-01	6.5E-04	5.7E-03	2.6E+00	2E-03	9.0E-03	2.1E+01	4E-04	1.2E-08	2.6E+00	5E-09	3.1E-07	2.1E+01	1E-08
INORG	Chromium (total)	7440-47-3	6.2E+01	5.1E-01	3.8E+00	9.6E-01	1.2E-01	6.4E+00	2E-02	2.2E-01	1.2E+01	2E-02	1.8E-05	6.4E+00	3E-06	4.9E-05	1.2E+01	4E-06
INORG	Lead	7439-92-1	1.4E+03	3.1E+00	5.6E+01	5.3E+00	2.0E+00	6.6E+00	3E-01	3.7E+00	6.5E+00	6E-01	1.0E-04	6.6E+00	2E-05	8.2E-04	6.5E+00	1E-04
INORG	Selenium	7782-49-2	5.9E-01	5.7E-02	1.3E-01	1.1E-01	3.4E-03	4.1E-01	8E-03	6.6E-03	1.8E-01	4E-02	2.1E-06	4.1E-01	5E-06	2.1E-06	1.8E-01	1E-05
INORG	Vanadium	7440-62-2	6.6E+01	6.4E-02	5.5E-01	1.6E-01	5.1E-02	4.9E-01	1E-01	1.0E-01	5.9E+00	2E-02	3.1E-06	4.9E-01	6E-06	3.6E-05	5.9E+00	6E-06

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4l
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 24)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	1.5E+01	8.1E-02	2.0E+01	4.9E-02	1.5E-01	2.6E+00	6E-02	2.4E-01	2.1E+01	1E-02	3.3E-07	2.6E+00	1E-07	8.4E-06	2.1E+01	4E-07
INORG	Antimony	7440-36-0	3.4E+00	2.5E-02	6.8E-01	4.6E-03	5.7E-03			9.6E-03	1.9E-01	5E-02	3.2E-08			8.3E-07	1.9E-01	4E-06
INORG	Barium	7440-39-3	1.3E+03	4.1E+01	2.4E+01	8.4E-01	5.6E-01	2.9E+01	2E-02	1.3E+00	6.5E+01	2E-02	5.8E-06	2.9E+01	2E-07	2.7E-04	6.5E+01	4E-06
INORG	Cadmium	7440-43-9	8.2E+00	3.9E-01	8.8E+00	1.5E-01	6.7E-02	3.1E+00	2E-02	1.1E-01	2.4E+00	4E-02	1.1E-06	3.1E+00	3E-07	4.9E-06	2.4E+00	2E-06
INORG	Chromium (total)	7440-47-3	1.0E+02	8.2E-01	6.1E+00	1.4E+00	6.8E-02	6.4E+00	1E-02	1.2E-01	1.2E+01	1E-02	9.4E-06	6.4E+00	1E-06	2.7E-05	1.2E+01	2E-06
INORG	Lead	7439-92-1	3.8E+02	1.5E+00	1.9E+01	3.0E+00	2.3E-01	6.6E+00	3E-02	4.1E-01	6.5E+00	6E-02	2.1E-05	6.6E+00	3E-06	9.0E-05	6.5E+00	1E-05
INORG	Selenium	7782-49-2	7.9E-01	7.8E-02	1.6E-01	1.2E-01	1.5E-03	4.1E-01	4E-03	3.0E-03	1.8E-01	2E-02	8.3E-07	4.1E-01	2E-06	8.9E-07	1.8E-01	5E-06
INORG	Vanadium	7440-62-2	1.1E+02	1.1E-01	9.2E-01	2.7E-01	3.0E-02	4.9E-01	6E-02	6.2E-02	5.9E+00	1E-02	1.9E-06	4.9E-01	4E-06	2.1E-05	5.9E+00	4E-06
INORG	Zinc	7440-66-6	4.8E+03	1.1E+02	2.8E+02	2.9E+01	3.3E+00	1.1E+02	3E-02	6.5E+00	1.5E+02	4E-02	2.0E-04	1.1E+02	2E-06	1.2E-03	1.5E+02	8E-06

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 4m
Estimate of Risk for Terrestrial Wildlife Receptors (AOI 25)
GGNRA Hawk Hill, Marin Headlands, CA

			Exposure Concentrations				American Robin (herbivore/invertivore)			Deer Mouse (herbivore/invertivore)			Red-tailed Hawk (top level carnivore)			Red Fox (top level carnivore)		
Chem Group	**Chemical**	**CASRN**	**Soil** (mg/kg dw)	**Plant** (mg/kg ww)	**Invertebrate** (mg/kg ww)	**Small Mammal** (mg/kg ww)	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**	**Total Daily Intake** (mg/kg-day)	**Toxic Reference Value** (mg/kg-day)	**HQ**
PCB	PCBs (total)	1336-36-3	1.2E-01	6.5E-04	1.6E-01	3.9E-04	1.2E-03	2.6E+00	5E-04	1.9E-03	2.1E+01	9E-05	2.7E-09	2.6E+00	1E-09	6.6E-08	2.1E+01	3E-09
INORG	Lead	7439-92-1	1.7E+02	9.5E-01	1.0E+01	2.1E+00	1.1E-01	6.6E+00	2E-02	2.0E-01	6.5E+00	3E-02	1.4E-05	6.6E+00	2E-06	4.4E-05	6.5E+00	7E-06

Notes:
dw - dry weight
ww - wet weight
Toxicity Reference Values (TRVs) based upon GeoMean (NOAEL, LOAEL)

Appendix B
Table 5
Ecological Toxicity Reference Values
GGNRA Hawk Hill, Marin Headlands, CA

			Mammal TRV (mg/kg-bw/day)						**Avian TRV** (mg/kg-bw/day)					
Chem Group	**Chemical**	**CASRN**	**NOAEL**			**LOAEL**			**NOAEL***			**LOAEL****		
			Value	**Ref**	**Notes**	**Value**	**Ref**	**Notes**	**Value**	**Ref**	**Notes**	**Value**	**Ref**	**Notes**
VOC	Benzene	71-43-2												
VOC	Ethyl Benzene	100-41-4												
VOC	Toluene	108-88-3												
VOC	Xylenes (total)	1330-20-7												
SVOC	4,6-Dinitro-2-methylphenol	534-52-1												
PDIST	Diesel Range Organics	DRO												
PCB	PCBs (total)	1336-36-3	1.4E+01	20	23	3.3E+01	20	23	2.2E+00	20	23	3.0E+00	20	23
INORG	Antimony	7440-36-0	5.9E-02	15		5.9E-01	15	24		15	90		15	90
INORG	Arsenic	7440-38-2	1.0E+00	3		1.7E+00	3	24	2.2E+00	3		4.5E+00	3	18
INORG	Barium	7440-39-3	5.2E+01	16	3	8.3E+01	16	10	2.1E+01	2	25	4.2E+01	2	25
INORG	Beryllium	7440-41-7	5.3E-01	17		6.7E-01	17	18		17	90		17	90
INORG	Cadmium	7440-43-9	7.7E-01	4		7.7E+00	4	24	1.5E+00	4	3	6.4E+00	4	10
INORG	Chromium (total)	7440-47-3	2.4E+00	5	3,4	5.8E+01	5	4,10	2.7E+00	5	3,4	1.6E+01	5	10
INORG	Cobalt	7440-48-4	7.3E+00	11	3	1.9E+01	11	10	7.6E+00	11	3	1.8E+01	11	10
INORG	Copper	7440-50-8	5.6E+00	18		9.3E+00	18	24	4.1E+00	18		1.2E+01	18	24
INORG	Lead	7439-92-1	4.7E+00	6		8.9E+00	6	24	4.4E+00	21	26	9.8E+00	21	27
INORG	Mercury	7439-97-6	3.2E-02	2	5	1.6E-01	2	5	6.4E-03	2	6	6.4E-02	2	6
INORG	Molybdenum	7439-98-7	2.6E-01	2	7	2.6E+00	2	7	3.5E+00	2	19	3.5E+01	2	19
INORG	Nickel	7440-02-0	1.7E+00	7		3.4E+00	7	24	6.7E+00	7	3	1.9E+01	7	10
INORG	Selenium	7782-49-2	1.4E-01	8		2.2E-01	8	24	2.9E-01	8		5.8E-01	8	24
INORG	Silver	7440-22-4	6.0E+00	19	21	6.0E+01	19		2.0E+00	19	21	8.0E+01	19	18
INORG	Thallium	7440-28-0	7.1E-03	20	21	7.1E-02	20		3.5E-01	20	21	3.5E+00	20	
INORG	Vanadium	7440-62-2	4.2E+00	13		8.3E+00	13	24	3.4E-01	13		6.9E-01	13	24
INORG	Zinc	7440-66-6	7.5E+01	9	3	3.0E+02	9	10	6.6E+01	9	3	1.7E+02	9	10

Appendix B
Table 5
Ecological Toxicity Reference Values
GGNRA Hawk Hill, Marin Headlands, CA

References:

1 USEPA. 2007. Ecological Soil Screening Levels for DDT and Metabolites. OSWER Directive 9285.7-57. April.
2 Sample et al. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision.
3 USEPA. 2005. Ecological Soil Screening Levels for Arsenic. Interim Final. OSWER Directive 9285.7-62. March.
4 USEPA. 2005. Ecological Soil Screening Levels for Cadmium. Interim Final. OSWER Directive 9285.7-65. March.
5 USEPA. 2008. Ecological Soil Screening Levels for Chromium. Interim Final. OSWER Directive 9285.7-66. April.
6 USEPA. 2005. Ecological Soil Screening Levels for Lead. Interim Final. OSWER Directive 9285.7-70. March.
7 USEPA. 2005. Ecological Soil Screening Levels for Nickel. Interim Final. OSWER Directive 9285.7-76. March.
8 USEPA. 2007. Ecological Soil Screening Levels for Selenium. Interim Final. OSWER Directive 9285.7-72. July.
9 USEPA. 2007. Ecological Soil Screening Levels for Zinc. Interim Final. OSWER Directive 9285.7-73. June.
10 USEPA. 2007. Ecological Soil Screening Levels for PAHs. Interim Final. OSWER Directive 9285.7-78. June.
11 USEPA. 2005. Ecological Soil Screening Levels for Cobalt. Interim Final. OSWER Directive 9285.7-67. March.
12 USEPA. 2007. Ecological Soil Screening Levels for Manganese. Interim Final. OSWER Directive 9285.7-71. April.
13 USEPA. 2005. Ecological Soil Screening Levels for Vanadium. Interim Final. OSWER Directive 9285.7-75. April.
14 USEPA. 2007. Ecological Soil Screening Levels for Dieldrin. Interim Final. OSWER Directive 9285.7-56. April.
15 USEPA. 2005. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 9285.7-61. February.
16 USEPA. 2005. Ecological Soil Screening Levels for Barium. Interim Final. OSWER Directive 9285.7-63. February.
17 USEPA. 2005. Ecological Soil Screening Levels for Beryllium. Interim Final. OSWER Directive 9285.7-64. February.
18 USEPA. 2007. Ecological Soil Screening Levels for Copper. Interim Final. OSWER Directive 9285.7-68. February.
19 USEPA. 2006. Ecological Soil Screening Levels for Silver. Interim Final. OSWER Directive 9285.7-77. September.
20 Los Alamos National Laboratory (2007). ECORISK Database, Release 4.1. October.
21 Sample et al. 2019. Revisiting the Avian Eco-SSL for Lead: Recommendations for Revision. March.

Appendix B
Table 5
Ecological Toxicity Reference Values
GGNRA Hawk Hill, Marin Headlands, CA

Notes:

* Except for Lead, where the TRV is an ED10.
** Except for Lead, where the TRV is an ED20.
1 From Treon and Cleveland (1955). Test species rat.
2 From Mendenhall (1983). Test species barn owl.
3 Geometric mean of the NOAEL values for reproduction and growth.
4 Value for chromium III used.
5 From Verschuuren et al. (1976). Test species rat. Methyl mercury chloride.
6 From Heinz (1979). Test species mallard duck. Methyl mercury dicyandiamide.
7 From Schroeder and Mitchner (1971). Test species mouse. Molybdate.
8 From Landis Assoc. Inc. (1985). Test species bobwhite. Naphthalene.
9 From Trust et al. (1994). Test species european starling. 7,12-dimethylbenz(a)anthracene.
10 Geometric mean of the LOAEL values for reproduction and growth.
11 From Aulerich and Ringer (1980). Test species mink.
12 From Bleavins et al. (1980). Test species mink.
13 From McLane and Hughes (1980). Test species screech owl.
14 From Barsotti et al. (1976). Test species rhesus monkey.
15 From Dahlgren et al. (1972). Test species ring-necked pheasant.
16 From McCoy et al. (1995). Test species oldfield mouse.
17 Used TRV for Aroclor-1254 from the noted reference as a surrogate.
18 Geometric mean of the LOAEL values presented in the noted reference for reproduction, growth, and survival, where available.
19 From Lepore and Miller (1965). Test species chicken. Sodium molybdate.
20 From Formigli et at. (1986). Test species rat. Thallium sulfate.
21 NOAEL TRV is extrapolated from the LOAEL TRV by applying an uncertainty factor of 10.
23 Used TRV for Aroclor-1260 from the noted reference as a surrogate. Test species deer mouse and american robin.
24 LOAEL is based on a NOAEL and LOAEL pair.
25 From Johnson et al. (1960). Test species 1-day old chicks. Barium Hydroxide
26 TRV is an ED10. Test species chicken.
27 TRV is an ED20. Test species chicken.
90 According to the noted source, inadequate data are available to derive TRV.

Appendix B
Table 6
Plant and Invertebrate Threshold Values
GGNRA Hawk Hill, Marin Headlands, CA

Chem Group	Chemical	CASRN	Plant Threshold Value (mg/kg)	Invertebrates Threshold Value (mg/kg)
SVOC	4,6-Dinitro-2-methylphenol	534-52-1		
INORG	Antimony	7440-36-0	2.53E+01	2.47E+02
INORG	Barium	7440-39-3	1.69E+02	1.03E+03
INORG	Cadmium	7440-43-9	7.16E+01	3.26E+02
INORG	Chromium (total)	7440-47-3		
INORG	Lead	7439-92-1	2.62E+02	3.78E+03
INORG	Selenium	7782-49-2	1.25E+00	1.30E+01
INORG	Vanadium	7440-62-2	6.93E+01	
INORG	Zinc	7440-66-6	3.60E+02	1.06E+03

Notes:
4,6 dinitro-2-methylphenol and chromium (total) were retained for the simple BERA. However, 4,6 dinitro-2-methylphenol has no readily available ESV or threshold values, and chromium was not evaluted in the simple BERA due to the lack of threshold values chromium (III).

APPENDIX C
DETAILED COST ESTIMATES

- Table C-1: Cost Estimate (Alternative 2)
- Table C-2: Cost Estimate (Alternative 3)

Appendix C
Table C-1
Cost Estimate (Alternative 2)
GGNRA Hawk Hill, Marin Headlands, CA

Alternative summary: Alternative 2 would involve excavation and off-site disposal of shallow soil from the approximate areas shown on Figure 6-1. The horizontal and vertical limits described below and shown on Figure 6-1 are estimates based on the existing soil data set. Confirmation samples will be collected from the excavation bottom and sidewalls and the results compared to RGs to confirm if the limits of excavation are complete. Under this alternative, an estimated total of 100 bank cubic yards (BCY) of soil would be excavated. Excavated soil would be transported and disposed off-site at a waste facility licensed to accept the type of waste identified.

		Preliminary Cost Estimates			
Item	**Unit**	Quantity	Unit Cost	Line Cost	Subtotals
Capital Costs					
Direct Capital Costs - Soil Excavations					
Excavation Mobilization / Demobilization	ls	1	$25,000	$25,000	
Site Preparation - Clearing and Grubbing, Erosion Control Measures	acre	0.1	$25,000	$2,500	
Soil excavation and handling - PCB remediation waste	BCY	16	$20	$320	
Soil excavation and handling - California hazardous waste	BCY	87	$20	$1,740	
Soil excavation and handling - non hazardous waste	BCY	0.4	$20	$8	
Transportation and disposal					
Transportation & Disposal - PCB remediation waste	TON	26	$250	$6,400	
Transportation & Disposal - California hazardous waste	TON	139	$150	$20,880	
Transportation & Disposal - non hazardous waste	TON	0.7	$50	$34	
Hazardous Waste Generator Fees	YR	1	$5,000	$5,000	
Imported fill, delivered, placed and compacted	TON	165	$55	$9,101	
Site restoration	SF	3,200	$1	$3,200	
Confirmation sampling and analyses					
Lead	EA	44	$50	$2,200	
Arsenic	EA	5	$50	$250	
Zinc	EA	5	$50	$250	
PCBs	EA	5	$65	$325	
SVOCs	EA	5	$155	$775	
Waste Characterization	EA	4	$750	$3,000	
Dust monitoring (during excavation and soil loading)	week	2	$500	$1,000	
Subtotal: Direct Capital Costs - Soil Excavations:					$82,000
Indirect Capital Costs - Professional & Technical Services					
Project Management	%	10%		$8,200	
Remedial Design	%	20%		$16,400	
Construction Management	%	15%		$12,300	
Subtotal: Indirect Capital Costs - Professional & Technical Services:					$36,900
Scope Contingency (Percentage of Direct Capital Costs):	%	30%			$24,600
Bid Contingency (Percentage of Direct Capital Costs):	%	10%			$8,200
Total - Capital Costs (rounded to nearest thousands):					**$152,000**

Operation and Maintenance (same costs with or without a development plan)					
Annual O&M Activities					
Annual Inspection and Report Preparation (years 1-30)	EVENT/YR	1	$3,000	$3,000	
Total Annual O&M Costs (years 1-30):					$3,000
Periodic Reporting					
Five Year Review	EVENT/5 YR	1	$5,000	$5,000	
Total Periodic O&M Costs (years 1-30):					$5,000

Appendix C
Table C-1
Cost Estimate (Alternative 2)
GGNRA Hawk Hill, Marin Headlands, CA

	O&M NET PRESENT VALUE ANALYSIS WITH A DEVELOPMENT PLAN				
YEAR	ANNUAL COST	PERIODIC COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (0.7%)	PRESENT VALUE
0		0	$0	1	$0
1	$3,000		$3,000	1.003	$3,009
2	$3,000		$3,000	1.006	$3,018
3	$3,000		$3,000	1.009	$3,027
4	$3,000		$3,000	1.012	$3,036
5	$3,000	$5,000	$8,000	1.015	$8,121
6	$3,000		$3,000	1.018	$3,055
7	$3,000		$3,000	1.021	$3,064
8	$3,000		$3,000	1.024	$3,073
9	$3,000		$3,000	1.027	$3,082
10	$3,000	$5,000	$8,000	1.031	$8,244
11	$3,000		$3,000	1.034	$3,101
12	$3,000		$3,000	1.037	$3,110
13	$3,000		$3,000	1.040	$3,119
14	$3,000		$3,000	1.043	$3,129
15	$3,000	$5,000	$8,000	1.046	$8,369
16	$3,000		$3,000	1.049	$3,148
17	$3,000		$3,000	1.052	$3,157
18	$3,000		$3,000	1.056	$3,167
19	$3,000		$3,000	1.059	$3,176
20	$3,000	$5,000	$8,000	1.062	$8,495
21	$3,000		$3,000	1.065	$3,195
22	$3,000		$3,000	1.068	$3,205
23	$3,000		$3,000	1.072	$3,215
24	$3,000		$3,000	1.075	$3,224
25	$3,000	$5,000	$8,000	1.078	$8,624
26	$3,000		$3,000	1.081	$3,244
27	$3,000		$3,000	1.085	$3,254
28	$3,000		$3,000	1.088	$3,263
29	$3,000		$3,000	1.091	$3,273
30	$3,000	$5,000	$8,000	1.094	$8,755
			TOTAL PRESENT VALUE OF O&M		$130,000

-0.30% = 2021 30 year real interest rate (OMB Circular from https://www.whitehouse.gov/wp-content/uploads/2020/12/M-21-09.pdf)

Appendix C
Table C-1
Cost Estimate (Alternative 2)
GGNRA Hawk Hill, Marin Headlands, CA

Notes:

1. Assume 1.6 tons per cubic yard of soil.
2. Unit costs are based similar recent project experience.
3. Generator fees from Department of Toxic Substances Control for 2021.
4. The costs associated with professional/technical services use the USEPA's rule-of-thumb percentages of total project capital cost presented in "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA 2000).
5. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of institutional controls (e.g., licensing).
6. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases.
7. Construction management includes services to manage construction or installation of the remedial action, except any similar services provided as part of regular construction activities. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings
8. Contingency estimate from USEPA Guidance "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA 2000).
9. Estimated costs in 2021 dollars rounded to the nearest thousands.
10. Discount rate is the 30-year real interest rate of -0.3% as presented in the 2021 OMB Circular A-94, Appendix C.

Appendix C
Table C-2
Cost Estimate (Alternative 3)
GGNRA Hawk Hill, Marin Headlands, CA

Alternative summary: Alternative 3 would involve excavation and off-site disposal of shallow soil from the approximate areas shown on Figure 6-2. The horizontal and vertical limits described below and shown on Figure 6-2 are estimates based on the existing soil data set. Confirmation samples will be collected from the excavation bottom and sidewalls and the results compared to RGs to confirm if the limits of excavation are complete. Under this alternative, an estimated total of 300 bank cubic yards (BCY) of soil would be excavated. Excavated soil would be transported and disposed off-site at a waste facility licensed to accept the type of waste identified.

		Preliminary Cost Estimates			
Item	**Unit**	Quantity	Unit Cost	Line Cost	Subtotals
Capital Costs					
Direct Capital Costs - Soil Excavations					
Excavation Mobilization / Demobilization	ls	1	$25,000	$25,000	
Site Preparation - Clearing and Grubbing, Erosion Control Measures	acre	0.2	$25,000	$5,000	
Soil excavation and handling - PCB remediation waste	BCY	22	$20	$440	
Soil excavation and handling - California hazardous waste	BCY	274	$20	$5,480	
Soil excavation and handling - non hazardous waste	BCY	0.4	$20	$8	
Soil removed from drain in Battery Commander Station	BCY	3	$1,000	$3,000	
Transportation and disposal					
Transportation & Disposal - PCB remediation waste	TON	35	$250	$8,800	
Transportation & Disposal - California hazardous waste	TON	443	$150	$66,480	
Transportation & Disposal - non hazardous waste	TON	0.7	$50	$34	
Hazardous Waste Generator Fees	YR	1	$25,000	$25,000	
Imported fill, delivered, placed and compacted	TON	479	$55	$26,349	
Site restoration	SF	8,000	$1	$8,000	
Confirmation sampling and analyses					
Lead	EA	120	$50	$6,000	
Arsenic	EA	5	$50	$250	
Zinc	EA	7	$50	$350	
PCBs	EA	7	$65	$455	
SVOCs	EA	7	$155	$1,085	
Waste Characterization	EA	6	$750	$4,473	
Dust monitoring (during excavation and soil loading)	week	3	$500	$1,500	
Subtotal: Direct Capital Costs - Soil Excavations:					$188,000
Indirect Capital Costs - Professional & Technical Services					
Project Management	%	10%		$18,800	
Remedial Design	%	20%		$37,600	
Construction Management	%	15%		$28,200	
Subtotal: Indirect Capital Costs - Professional & Technical Services:					$84,600
Scope Contingency (Percentage of Direct Capital Costs):	%	30%			$56,400
Bid Contingency (Percentage of Direct Capital Costs):	%	10%			$18,800
Total - Capital Costs (rounded to nearest thousands):					**$348,000**

Appendix C
Table C-2
Cost Estimate (Alternative 3)
GGNRA Hawk Hill, Marin Headlands, CA

Notes:

1. Assume 1.6 tons per cubic yard of soil.
2. Unit costs are based similar recent project experience.
3. Generator fees from Department of Toxic Substances Control for 2021.
4. The costs associated with professional/technical services use the USEPA's rule-of-thumb percentages of total project capital cost presented in "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA 2000).
5. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of institutional controls (e.g., licensing).
6. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases.
7. Construction management includes services to manage construction or installation of the remedial action, except any similar services provided as part of regular construction activities. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings
8. Contingency estimate from USEPA Guidance "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA 2000).
9. Estimated costs in 2021 dollars rounded to the nearest thousands.