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NASD VIEQUES
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FINAL RECORD OF DECISION AREA OF CONCERN E (AOC E) ATLANTIC FLEET WEAPONS TRAINING AREA FORMER NAVAL AMMUNITION SUPPORT DETACHMENT (ENGLISH VERSION) VIEQUES ISLAND PUERTO RICO

01/01/2015

CH2M HILL

1 Declaration

1.1 Site Name and Location

This Record of Decision (ROD[1]) documents the selected remedy for Area of Concern (AOC) E, located at the former Naval Ammunition Support Detachment (NASD) in Vieques, Puerto Rico. The former NASD is part of the Atlantic Fleet Weapons Training Area - Vieques, which was placed on the National Priorities List (NPL) on February 11, 2005 (Comprehensive Environmental Response, Compensation, and Liability Information System [CERCLIS] National Superfund database identification number: PRN000204694). AOC E is also known as Operable Unit (OU) 2 in the CERCLIS database.

1.2 Statement of Basis and Purpose

The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The U.S. Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Atlantic Division, U.S. Environmental Protection Agency (EPA) Region 2, Puerto Rico Environmental Quality Board (PREQB), and the Department of Interior (DOI) entered into a Federal Facility Agreement (FFA) for the former NASD in 2007, as a result of the NPL listing and pursuant to CERCLA. The FFA establishes the procedural framework and schedule for implementing the CERCLA response actions for Vieques. The Navy is the lead agency and responsible for ensuring the appropriate CERCLA response alternatives are developed and implemented as necessary to protect public health, welfare, and the environment.

The Navy and EPA jointly select the remedy for AOC E with the concurrence of PREQB. This decision is based on information contained in the Administrative Record file for this remedy. Information not specifically summarized in this ROD or its references, but contained in the Administrative Record, has been considered and is relevant to the remedy selection at AOC E. Thus, the ROD is based upon and relies on those portions of the Administrative Record file for the site that pertain to AOC E in making this decision. This ROD is presented in a format that is conducive for the general public to read and understand the information upon which the decision for AOC E was made, while providing links to the technical details presented in the Administrative Record.

1.3 Scope and Role of Response Action

Based on the results of environmental investigations conducted, unacceptable risks to human health were identified for a hypothetical resident exposed to groundwater at AOC E. As a result, an In-Situ Chemical Oxidation (ISCO) pilot study was implemented, using persulfate as the additive to reduce

[1] This acronym, and all additional acronyms used, can be found defined in alphabetical order in the Acronym table located at the end of this document.

concentrations of chemicals of concern (COC) to levels below regulatory standards. Residual persulfate from the pilot study is still present, and while it is expected to slowly dissipate over time, the residual persulfate can continue to actively reduce COCs that partition or diffuse from soil to groundwater. As a consequence, because the persulfate can continue to degrade the COCs while it is still present above certain levels, confirmation that COC concentrations will remain below regulatory standards for the long term cannot take place until the residual persulfate dissipates. Therefore, the selected remedy will address residual persulfate and the potential for rebound of COCs to levels above regulatory standards once the residual persulfate dissipates.

AOC E is one of 17 sites within the former NASD having been or currently being evaluated in accordance with CERCLA under the Navy's Environmental Restoration Program (ERP). The Site Management Plan (SMP) for Vieques further details the investigation history and the schedule for CERCLA investigations/remediation activities at the former NASD and is updated annually. The response action selected in this ROD is intended to be the final remedy for AOC E and does not include or affect any other sites at the former NASD under the CERCLA process. The final determinations for the other sites within the former NASD have been documented in past decision documents or will be documented separately in future decision documents.

1.4 Description of Selected Remedy

The selected remedy for AOC E is Groundwater Monitoring and Institutional Controls (ICs) with Contingency Plans to address the potential for persistent persulfate (Contingency Plan 2a) and COC rebound (Contingency Plan 2b). The components of the remedy include groundwater monitoring to ensure persulfate concentrations decline, annual groundwater monitoring of COCs for 3 years after persulfate levels decline to ensure contaminant rebound does not occur, and implementing ICs to restrict potable groundwater use until the remedial action objective (RAO) is met. Contingency Plan 2a includes injection of a hydrogen peroxide solution to accelerate residual persulfate (above 500 milligrams per liter [mg/L]) decline if an overall decline is not demonstrated after three successive monitoring events. Contingency Plan 2b includes injection of hydrogen peroxide-activated sodium persulfate in wells in which rebound is observed, if COC concentrations above remediation goals (RGs) are observed and persist after three successive annual monitoring events. Because the RGs are associated with drinking water, ensuring the RGs are met will ensure groundwater has been restored to potential beneficial reuse as potable water.

1.5 Statutory Determination

The selected remedy for AOC E meets the statutory requirements of CERCLA Section 121 and is protective of human health and the environment, complies with Federal and Commonwealth regulations that are applicable or relevant and appropriate to the remedial action, and is cost-effective. Because the remedial action may take several years to ensure groundwater conditions suitable for potable use are attained, the Navy will conduct policy reviews every 5 years after initiation of remedial action until the RAO is met to ensure that the remedy remains protective of human health and the environment.

1.6 Navy Authorizing Signature for the Record of Decision for AOC E, Atlantic Fleet Weapons Training Area - Vieques

Cheryl F. Barnett

Cherryl F. Barnett
Director, Environmental Programs
Naval Facilities Engineering Command, Atlantic

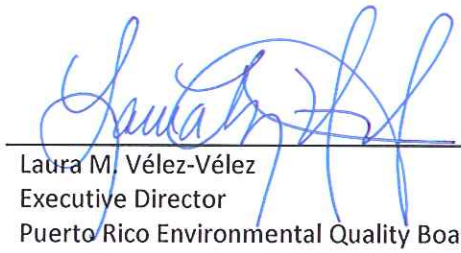
1/8/2015
Date

1.7 EPA Authorizing Signature for the Record of Decision for AOC E, Atlantic Fleet Weapons Training Area - Vieques

Walter E. Mugdan
Director, Emergency and Remedial Response Division
Environmental Protection Agency, Region 2

JAN. 14, 2015
Date

1.8 PREQB Concurrence Signature



21/10/2014

Laura M. Vélez-Vélez
Executive Director
Puerto Rico Environmental Quality Board

Date

2 Decision Summary

2.1 Site Description and History

Vieques Island is approximately 7 miles southeast of the eastern tip of the main island of Puerto Rico (**Figure 1**). Besides mainland Puerto Rico, Vieques is the largest island in the Commonwealth of Puerto Rico, encompassing 33,088 acres. The Navy purchased large portions of Vieques in the early 1940s to conduct activities related to military training. Operations within the former Vieques Naval Training Range (VNTR) (eastern half of Vieques) comprised various aspects of naval gunfire training, including air-to-ground ordnance delivery and amphibious landings, as well as housing the main base of operations for these activities at Camp García. Operations within the former Naval Ammunition Support Detachment (NASD; western one-third of Vieques), where AOC E is located, consisted mainly of ammunition loading and storage, vehicle and facility maintenance, and some training. **Figure 2** shows the location of AOC E within the former NASD.

The Navy ceased facility-wide operations on the former NASD in April 2001, in accordance with the January 30, 2000, Presidential Directive to the Secretary of Defense associated with the transfer of lands of the Navy-owned western portion of Vieques. The land transfer was completed on May 1, 2001, and the Navy has had no military presence at the main operational area since. Currently, the Navy's involvement at the former NASD comprises the environmental restoration program activities.

AOC E is less than one-tenth of an acre and is located within the main operational area of the former NASD (**Figure 2**). AOC E is the site of a former 500-gallon underground storage tank (UST) and former 500-gallon aboveground storage tank (AST) that stored used oil from vehicle maintenance activities. The UST was used from about 1970 until its removal and replacement in 1996 by the AST, which was subsequently removed in 2001. Oil was removed from vehicles on the vehicle service platform and drained to the UST via an underground pipe between the platform and the UST (**Figure 3**). Leaks from the former UST resulted in localized soil and groundwater contamination.

AOC E is located on property that was transferred to the Municipality of Vieques (MOV) as part of a Quitclaim Deed that transferred the former NASD property to the MOV and the Puerto Rico Conservation Trust. The site is within the current MOV Public Works facility. Based on the above, access to AOC E is restricted from the public.

FIGURE 1
Regional Location Map

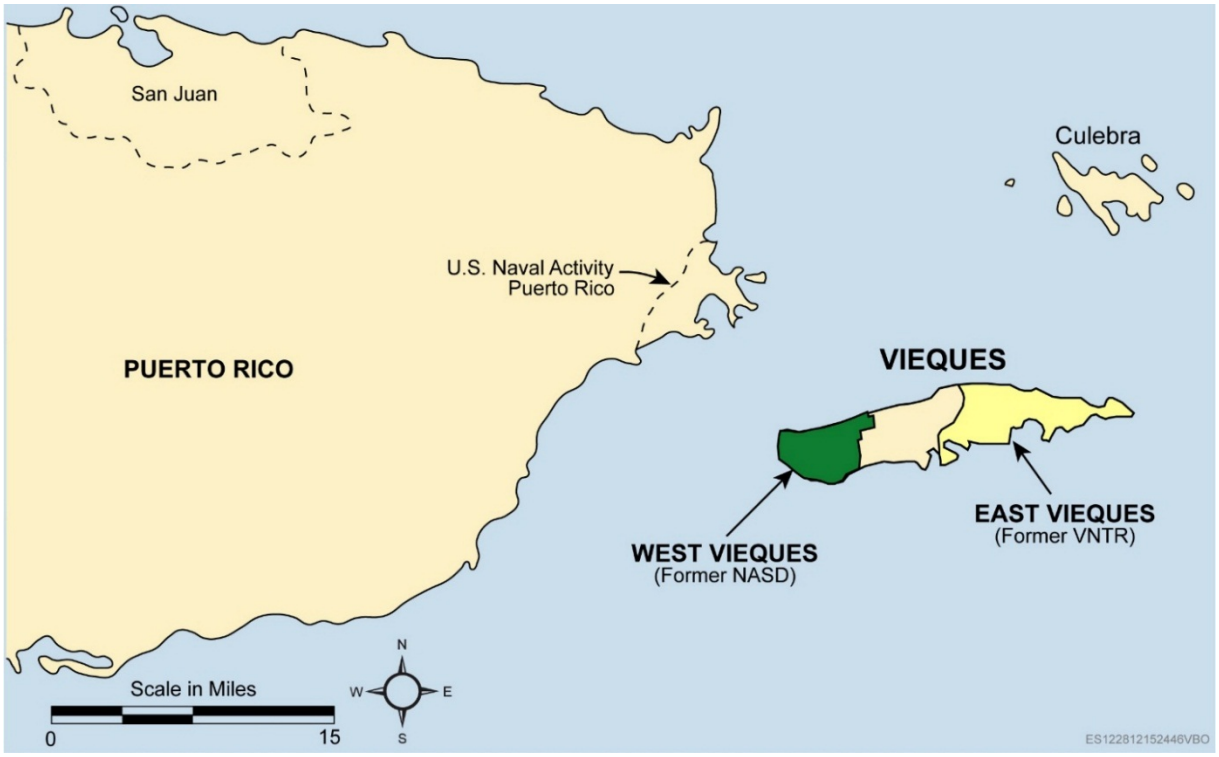
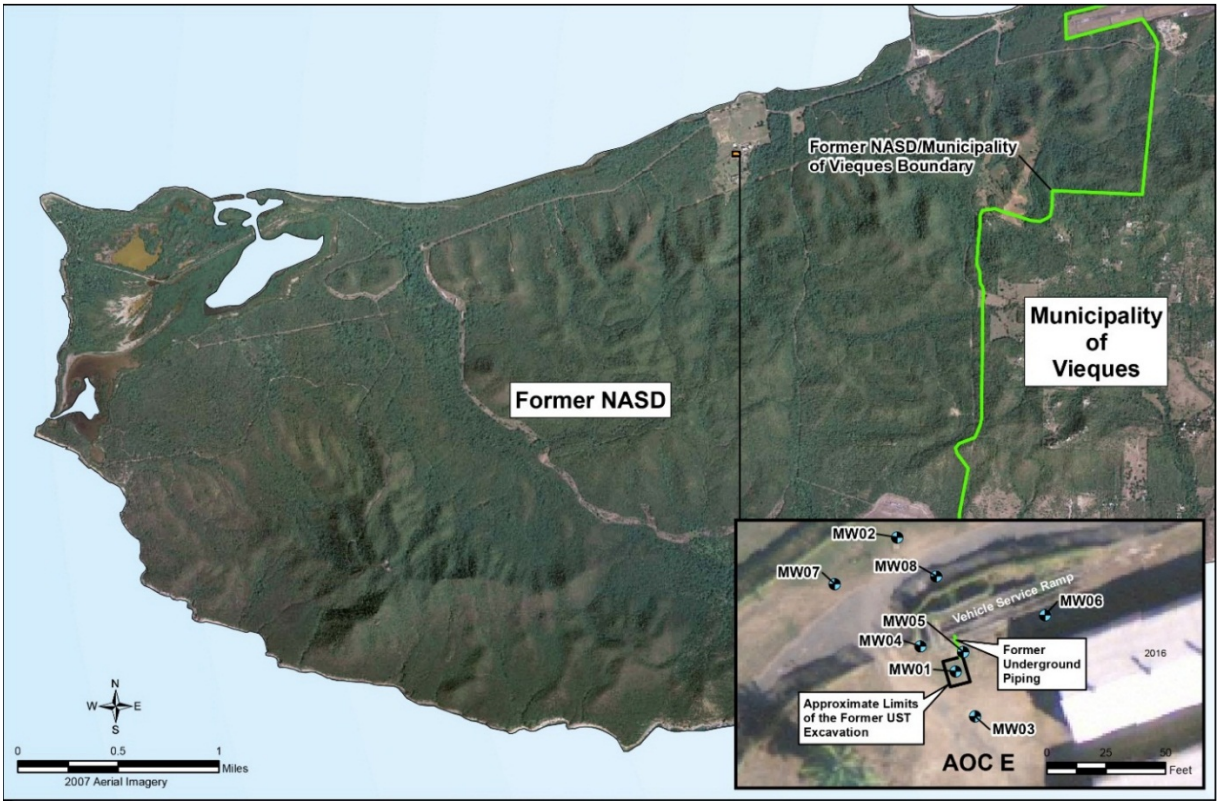


FIGURE 2
Former NASD and AOC E Location Map

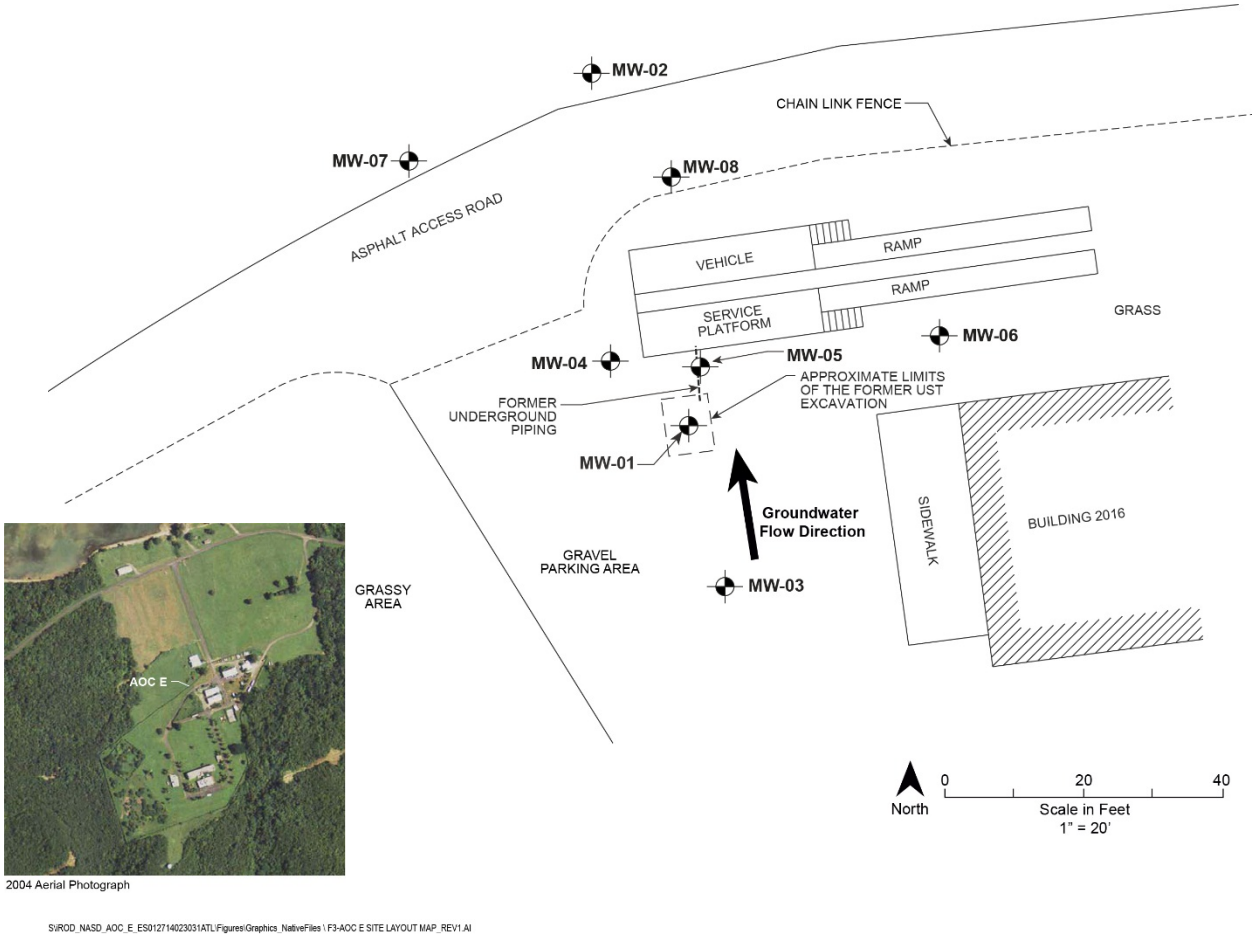


2.2 Site Characteristics

AOC E is approximately 43 feet (ft) above mean sea level and relatively flat. No surface water bodies are located at or immediately adjacent to AOC E. The site is covered primarily with periodically mowed grass, weeds, and scrub brush. The building on site is not occupied, and the site is fenced to discourage trespassing. Because it is developed and periodically maintained, the site has no significant ecological habitat.

Groundwater at AOC E is within weathered granodiorite bedrock (saprolite), overlain by silty/clayey sand alluvium. Groundwater occurs at depths ranging from approximately 28 to 43 ft below ground surface (bgs) and flows generally north-northwest (Figure 3) at approximately 1 ft per year.

FIGURE 3
Site Layout Map



2004 Aerial Photograph

SVROD_NASD_AOC_E_ES012714023031ATL\Figures\Graphics_NativeFiles \ F3-AOC E SITE LAYOUT MAP_REV1.AI

2.3 Previous Investigations

Environmental investigations at AOC E were initiated with a Site Characterization in 1998. Subsequently, an Expanded Preliminary Assessment/Site Inspection (PA/SI), Remedial Investigation (RI), multi-phase extraction pilot study, Supplemental RI, soil denitrification pilot study, and in-situ groundwater remediation pilot study were implemented between 2000 and 2011. A Focused Feasibility Study (FFS) was conducted in 2012 to evaluate groundwater remedial alternatives. **Table 1** summarizes all previous removals, investigations, and pilot studies conducted at AOC E.

TABLE 1
Previous Investigations

Previous Investigation*	Date	Investigation Activities
UST Removal	1996	The 500-gallon UST that stored used oil from vehicle maintenance activities and 110 cubic yards of contaminated soil adjacent to the UST were removed (Reliable Mechanical, Inc., 1997). The UST was replaced with a 500-gallon AST.
Site Characterization	1998	A site characterization was conducted in 1998 and included collecting eight soil samples and the installation and sampling of three monitoring wells. At that time, the site was designated Site 2016. Laboratory **analytical data**[1] showed exceedances of regulatory standards for several soil and groundwater samples (CH2M HILL, 1999).
Expanded Preliminary Assessment/Site Inspection	2000	An Expanded Preliminary Assessment/Site Inspection (PA/SI) was conducted to assess impacts to site groundwater from releases from the former UST. It included installing and sampling three monitoring wells and sampling two existing monitoring wells. The Expanded PA/SI **results**[2] indicated that there had been a release of petroleum hydrocarbons to groundwater and recommended a Remedial Investigation/Feasibility Study (RI/FS) (CH2M HILL, 2000).
AST Removal	2001	The 500-gallon AST which replaced the former 500-gallon UST in 1996 was removed when Navy operations ceased in 2001. There were no documented releases from the AST.
Initial Remedial Investigation	2002, 2003	An initial RI was conducted in 2002 and 2003. The RI field work included collecting 20 soil samples to help characterize the horizontal and vertical extent of soil contamination. In addition, two additional monitoring wells were installed and sampled and four existing monitoring wells were sampled (CH2M HILL, 2008). C**oncentrations of constituents detected in soil and groundwater during the RI**[3] are shown in **Table 2** and further discussed in Section 2.4.
Multiphase Extraction Pilot Study	2002	A **Multiphase Extraction (MPE) pilot study**[4] was conducted in 2002 to evaluate the effectiveness of this technology in removing free-phase contamination. A total of approximately 11,000 gallons of free-phase product and groundwater were recovered at a cost of approximately $113,000 (CH2M HILL, 2008). The pilot study was shown to be successful because no appreciable free-phase product has been observed in site wells since that time.
Supplemental Remedial Investigation	2004, 2005	A Supplemental RI was conducted in 2004-2005 and included collecting groundwater samples from all eight monitoring wells and additional soil samples (CH2M HILL, 2008). The Supplemental RI also included conducting **human health and ecological risk assessments**[5], which are summarized in Section 2.6.
Soil Denitrification-Based Bioremediation Pilot Study	2010, 2011	It was concluded based on the RI that there was no unacceptable risk associated with exposure to AOC E soil; therefore, no COCs were identified (CH2M HILL, 2008). However, a **soil denitrification-based bioremediation (DBB) pilot study**[6] was conducted to address potential soil-to-groundwater leaching (CH2M HILL, 2012). The pilot study consisted of injecting calcium nitrate into the soil (at a cost of approximately $70,000) to ensure that the concentrations of petroleum hydrocarbons in the unsaturated zone remained below levels representing a soil-to-groundwater leaching concern (**Table 3**).
Groundwater In-Situ Chemical Oxidation Pilot Study	2010, 2011	A **groundwater in-situ chemical oxidation (ISCO) pilot study**[7] was conducted in 2010-2011 using persulfate to evaluate whether the technology could reduce contaminant concentrations in groundwater below regulatory standards and reduce the time required to achieve those levels relative to the time it would take under natural conditions (CH2M HILL, 2012). Pilot Study goals were developed based upon the EPA Maximum Contaminant Levels (MCLs) or other standards for constituents without MCLs. The ISCO pilot test, covering the entire affected area at a cost of approximately $400,000, has shown ISCO to be effective in reducing the concentration of contaminants in groundwater below regulatory standards (**Table 4**). However, because of the residual persulfate presence, performance monitoring will need to be conducted for a period beyond the timeframe that residual persulfate persists in groundwater to verify that contaminants remain below the regulatory cleanup standards.
Focused Feasibility Study	2012	Because of the presence of residual persulfate levels, a Focused Feasibility Study (FFS) was conducted in 2012 to evaluate groundwater remedial alternatives at AOC E. Two remedial alternatives were evaluated including, Alternative 1 – No Action and Alternative 2 – Groundwater Monitoring and ICs. A more detailed description of the FFS is presented in Section 2.9.

* Documentation associated with the listed activities is available in the Administrative Record and provides detailed information used to support the remedy selection for AOC E. The relevant referenced information is also accessible by the hyperlinks in this document.

2.4 Distribution of Contamination

Analytical data collected as part of the RI, Supplemental RI, and pilot study monitoring provide the basis for evaluating the nature and extent of contamination in soil and groundwater; sample locations are shown in **Figure 4**. Chemical concentrations were compared to risk-based screening values for human health and ecological receptors and Puerto Rico UST-based screening values. Constituents detected, up through the Supplemental RI, above screening criteria and background concentrations in soil are summarized in **Table 2**. Groundwater COC concentrations during and after the DBB and ISCO pilot studies are provided in **Tables 3 and 4**, respectively, with the post-treatment data representing current conditions.

Two volatile organic compounds (VOCs) and one inorganic constituent were detected above risk-based screening criteria and background concentrations in soil during the RI and Supplemental RI (**Table 2**). Four VOCs, two SVOCs, one pesticide, and several inorganics were detected above risk-based screening criteria and background concentrations in groundwater during the RI and Supplemental RI (**Table 2**).

Contaminants detected in soil primarily occurred directly below the former UST, but at concentrations that pose no unacceptable human health or ecological risk (discussed in Section 2.6) and at concentrations no longer expected to leach to groundwater and cause exceedances of regulatory standards, as demonstrated by the DBB pilot study. As shown in **Table 4**, concentrations of measured COCs (i.e., benzene and naphthalene) in groundwater declined to non-detect levels during the ISCO pilot study.

FIGURE 4
Sample Locations

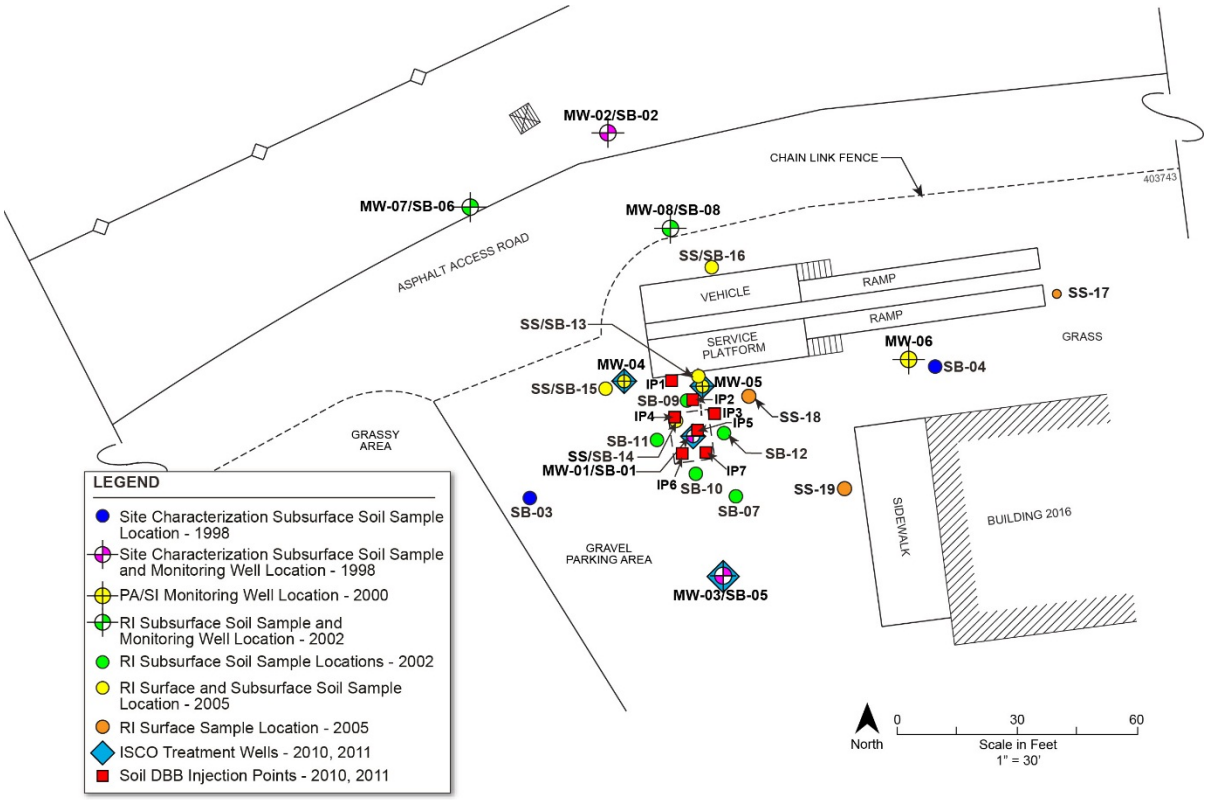


TABLE 2
Remedial Investigation Soil and Groundwater Exceedances for AOC E

Environmental Media	COPC	Maximum Concentration Detected Above Screening Criteria and Background	Background Value	Screening Criteria[2,3]		
				Vieques HHRA SO	Vieques Eco SO	PREQB UST Corrective Action Criteria
Soil	**Volatile Organic Compounds (µg/kg)**					
	Benzene	4,150 J	--	640	-- [1]	5,000
	Ethylbenzene	14,200	--	190,000	-- [1]	10,000
	Xylene, total	90,600	--	27,000	-- [1]	10,000
	Total Inorganics (mg/kg)					
	Iron	43,000	39,000	2,300	-- [1]	--
	Lead	52.1 J	6.9	400	120	50
	Total Petroleum Hydrocarbons (mg/kg)					
	Oil and Grease	19,300	--	--	--	100
	TPH-diesel range	490 J	--	--	--	100
	TPH-gas range	42,000	--	--	--	100
	TPH-oil range	2,800 J	--	--	--	100
	Total Petroleum Hydrocarbons, C10-C28	3,780 J	--	--	--	100
	Total Petroleum Hydrocarbons, C6-C10	2,150 J	--	--	--	100
	Total recoverable TPH	36,000	--	--	--	100

Environmental Media	COPC	Maximum Concentration Detected Above Screening Criteria and Background	Background Value	Screening Criteria		
				Vieques HHRA GW	MCL - GW	PREQB UST Corrective Action Criteria
Groundwater	**Volatile Organic Compounds (µg/L)**					
	1,2-Dichloroethane	32	--	0.12	5	--
	Benzene	17	--	0.35	5	5
	Chloroform	1.4	--	0.17	80	--
	Methyl-tert-butyl ether (MTBE)	1,220	--	11	--	--
	Semivolatile Organic Compounds (µg/L)					
	2-Methylnaphthalene	14	--	2.4	--	--
	Naphthalene	15	--	0.62	--	--
	Pesticide/Polychlorinated Biphenyls (µg/L)					
	Dieldrin	0.11	--	0.0042	--	--
	Total Inorganics (µg/L)					
	Aluminum	106,000	45.8 J	3,600	--	--
	Antimony	5.6 J	--	1.5	6	--
	Arsenic	15.2	1.3 J	0.045	10	--
	Barium	826	118 J	730	2,000	--
	Cadmium	7.2	5.51	1.8	5	--
	Chromium	141	2 J	11	100	--
	Cobalt	118	0.93 J	73	--	--
	Copper	247	3.31 J	150	1,300	--
	Iron	180,000	48.6 J	1,100	--	--
	Manganese	6,490	33.8	88	--	--
	Nickel	87.7	18.9 J	73	--	--
	Thallium	6.6 J	4.6 J	0.24	2	--
	Vanadium	489	11.7 J	3.6	--	--

Notes:

[1] Maximum concentration was detected in subsurface soil; the Vieques Eco SO screening criteria do not apply to subsurface soil

[2] Shading indicates screening criterion exceeded. COPCs in soil selected based on exceedance of HHRA SO and/or Eco SO values. COPCs in groundwater selected based on exceedances of HHRA GW.

[3] The human health and ecological screening criteria were those listed in the Master Standard Operating Procedures, Protocols, and Plans (CH2M HILL, 2007).

COPC = Chemical of Potential Concern
HHRA = Human Health Risk Assessment
Eco = Ecological
SO = Soil
GW = Groundwater
MCL = Maximum Contaminant Level
PREQB = Puerto Rico Environmental Quality Board
UST = Underground Storage Tank

TABLE 3
Denitrification-based Bioremediation (DBB) Pilot Study Soil COC Concentrations for AOC E

Environmental Media	COC	Pre-injection (Baseline) Monitoring Maximum Concentration Detected July 2008[1]	Post-injection Monitoring Maximum Concentration Detected November 2011[1]	Soil PAL[2]
Soil	**Volatile Organic Compounds (µg/kg)**			
	1,2-Dichloroethane	ND	ND	--
	Benzene	390	2,200	--
	Methyl-tert-butyl ether (MTBE)	1.3 J	370	--
	Xylene, total	72,000	150,000	--
	SPLP Volatile Organic Compounds (µg/L)			
	1,2-Dichloroethane, SPLP	ND	ND	10.5
	Benzene, SPLP	ND	ND	10.5
	Methyl-tert-butyl ether (MTBE), SPLP	ND	ND	252
	Xylene, total, SPLP	180	580	21,000
	Semivolatile Organic Compounds (µg/kg)			
	2-Methylnaphthalene	14,000	14,000	--
	Naphthalene	7,600	7,900	--
	SPLP Semivolatile Organic Compounds (µg/L)			
	2-Methylnaphthalene, SPLP	52	71 J	315
	Naphthalene, SPLP	80	89	210

Notes:
ND - Not detected
SPLP - Synthetic Precipitation Leaching Procedure
[1] Analytical data and reporting limits are provided in Appendix A of the FFS (CH2M HILL, 2012)
[2] The COCs Soil Project Action Levels (PALs) were established for protection of soil to groundwater leaching during the Enhanced In-situ Bioremediation (EISB) pilot study, which were groundwater pilot goals adjusted by dilution factor of 2.1, which is a conservative dilution factor obtained by dividing the pre-pilot study soil naphthalene concentration by the pre-pilot study groundwater naphthalene concentration.

TABLE 4
In-situ Chemical Oxidation (ISCO) Pilot Study Groundwater COC Concentrations for AOC E

Environmental Media	COC	Pre-injection (Baseline) Monitoring	Post-injection Monitoring		Pilot Study Goal
		Maximum Concentration Detected March 2010[1]	Maximum Concentration Detected January 2011	Maximum Concentration Detected May 2011	
Groundwater	**Volatile Organic Compounds (µg/L)**				
	1,2-Dichloroethane	ND	NA[2]	NA[2]	3.8
	Benzene	6.4	40	ND	5
	Methyl-tert-butyl ether (MTBE)	520	NA[2]	NA[2]	120
	Xylene, total	ND	NA[2]	NA[2]	10,000
	Semivolatile Organic Compounds (µg/L)				
	2-Methylnaphthalene	8	NA[2]	NA[2]	27
	Naphthalene	13	590	ND	6.1

Notes:
NA - Not analyzed
ND - Not detected
[1] Analytical data and reporting limits are provided in Appendix B of the FFS (CH2M HILL, 2012)
[2] Samples were not analyzed for 1,2-Dichloroethane, MTBE, total xylene, or 2-Methylnaphthalene because residual persulfate concentrations remained high following the injections. Samples were analyzed by the persulfate manufacturer (FMC Corporation) for benzene and naphthalene only using gas chromatography (GC)/mass spectrometry (MS)

2.5 Current and Potential Future Land and Resource Uses

The former NASD occupied approximately 8,000 acres, most of which are undeveloped. Military operations ceased on the former NASD in April 2001, and the land containing AOC E was transferred to the MOV. The site is currently fenced and vacant except for periodic maintenance of site vegetation. In addition, there is no continuous or daily human occupancy of the buildings located at AOC E (i.e., buildings 2015 and 2016). As noted previously, because it is developed and periodically maintained, the site has no significant ecological habitat. Groundwater beneath AOC E is classified by the Commonwealth of Puerto Rico as: (a) potential source of drinking water supply, (b) potential agricultural use, and/or (c) groundwater which flows into waters that support ecological communities of exceptional ecological value. However, groundwater at AOC E is not currently used as a potable water source. Once the RAO is met, future use of groundwater at AOC E is plausible, which could include future groundwater use as a potable water source. No archaeological or cultural resources are located within AOC E.

2.6 Summary of Site Risks

A conceptual site model (CSM) of AOC E is provided as **Figure 5**. Potential human health and ecological risks were quantitatively evaluated based on the receptor scenarios and potentially impacted media identified in the CSM. Summaries of the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) conducted for AOC E during the Supplemental RI are included in the following subsections and in **Table 5**. The HHRA and ERA, which are included in the Supplemental RI, provide more detailed analysis and evaluation.

TABLE 5
AOC E Risk Assessment Results

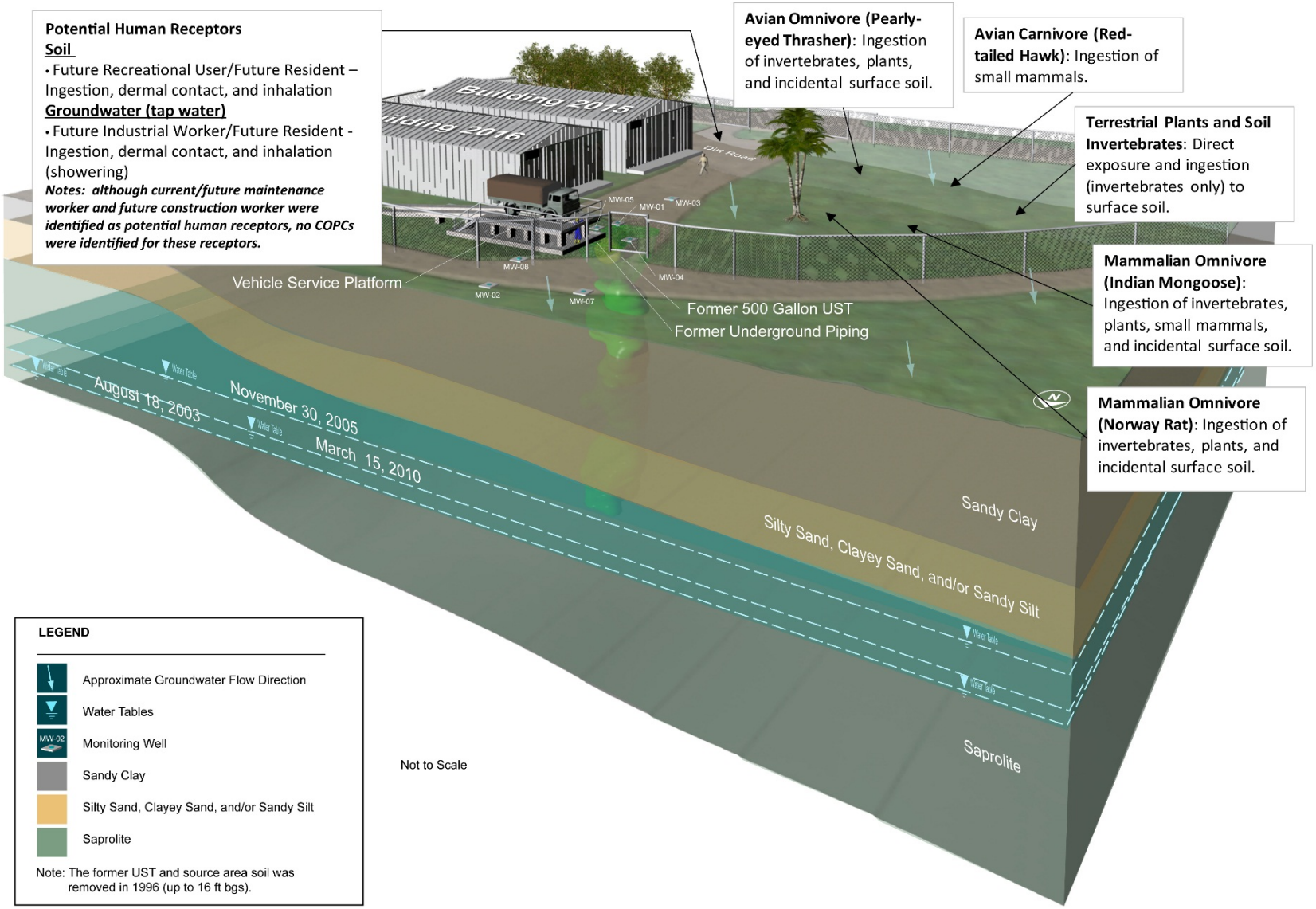
Media	Human Health Risk				
	Maintenance Workers	Recreational Users[1]	Construction Workers	Industrial Workers[1]	Residents[1]
Surface Soil (0-2 ft)	No COPCs	ELCR = $3x10^{-7}$ and HI = 0.2	No COPCs	No COPCs	ELCR=$1x10^{-6}$ and HI = 0.7
Total Soil (0-6 ft)	No exposure pathway	No exposure pathway	No COPCs	No COPCs	ELCR=$1x10^{-6}$ and HI = 0.7
Groundwater	No exposure pathway	No exposure pathway	No exposure pathway	ELCR=$6x10^{-5}$ and HI = 1	ELCR=$3x10^{-4}$ and HI = 7
Media	**Ecological Risk**				
	All Receptors				
Soil	Acceptable				

COPC – chemical of potential concern
ELCR – excess lifetime cancer risk; unacceptable ELCR > $1x10^{-4}$
HI – hazard index; unacceptable HI > 1
[1] – ELCR and HI values based on pre-ISCO pilot study data; all COC concentrations reduced to below regulatory standards during subsequent ISCO pilot study.

2.6.1 Human Health Risk Assessment

Based on the CSM, human health risks were quantitatively evaluated for **potential human receptors**[8] exposed to surface soil, subsurface soil, and groundwater using reasonable maximum exposure (RME) concentrations. The RME assumes the highest level of human exposure that could reasonably be expected to occur. The potential non-cancer hazards, expressed as the hazard index (HI), and cancer risk estimates were calculated using RME exposure assumptions. For non-cancer effects, a hazard quotient (HQ) represents the ratio between the reference dose and the RME dose for a person in contact with site chemicals of potential concern (COPCs), and the HI represents the sum of the HQs. An HI exceeding 1 indicates that adverse health effects may occur. For known or suspected carcinogens, acceptable exposure levels generally are concentration levels that represent an excess

FIGURE 5
Conceptual Site Model



upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} (a 1 in 10,000 to 1 in 1,000,000 chance of developing cancer from site exposures) using information on the relationship between dose and response. Surface soil, subsurface soil, and groundwater samples collected during the initial RI (2002, 2003) and the Supplemental RI (2004, 2005) were used to quantitatively evaluate potential human health risks because of potential exposure to site media. Exposure scenarios evaluated for site media comprised maintenance workers, industrial workers, construction workers, recreational users, and residents, based on current and potential future land use. Conservative exposure pathways were ingestion, dermal contact, and/or inhalation of chemicals in soil and groundwater.

The only **unacceptable human health risk**[9] identified based on exposure scenarios at AOC E was for a hypothetical resident exposed to groundwater. Based on the results of the HHRA, five COCs were identified in groundwater: 1,2-dichloroethane (DCA), 2-methylnaphthalene, methyl-tert-butyl ether (MTBE), naphthalene, and xylenes. Benzene was subsequently added as a COC because its concentration in groundwater exceeded the federal MCL. However, the ISCO pilot study conducted subsequent to the RI reduced COC concentrations below regulatory standards (i.e., to acceptable levels).

2.6.2 Ecological Risk Assessment

An ERA was conducted for AOC E, consisting of Steps 1 through 3A of the ERA process, in accordance with Navy ERA policy, and Navy and EPA ERA guidance. In Step 1 (preliminary problem formulation) the goals, scope, and focus of the ERA were established, and the environmental setting (i.e., habitats, vegetation, wildlife, protected species), types and concentrations of chemicals in surface soil, as well as potentially complete exposure pathways, were described. This information was used to develop the **ecological CSM**[10] and **ecological assessment and measurement endpoints**[11]. Potentially complete pathways were identified for lower trophic level receptors (plants and soil invertebrates) and upper-trophic level receptors (birds and mammals) exposed to surface soil. Surface water bodies are not present at AOC E or the immediate surrounding area; therefore, aquatic exposure pathways are not present.

In Step 2, HQs were calculated to characterize the potential for constituents to pose unacceptable ecological risk using conservative exposure assumptions. HQs represent a ratio of the exposure level to an ecological effect level, and are an estimate of potential risk. Maximum soil constituent concentrations in surface soil were used in Step 2 to estimate potential exposures to upper and lower trophic level ecological receptors selected to represent the assessment endpoints at AOC E. Upper trophic level effects were determined using a food web model that estimated the concentration of each **bioaccumulating chemical**[12] in each relevant dietary component, and then the total dietary intake of the chemicals were compared to wildlife **toxicity reference values**[13] (TRVs). TRVs were based on chronic No Observed Adverse Effect Levels (NOAELs) and chronic Lowest Observed Adverse Effect Levels (LOAELs) obtained from scientific literature. Only constituents with the potential to bioaccumulate were evaluated for food web exposures. For lower trophic level receptors, the exposure concentrations for soil were screened against **ecological soil screening levels**[14] (eco-SSLs) developed by EPA, or alternative regulatory-approved screening values as provided in the **Master Ecological Risk Assessment Protocol for Vieques**[15] if eco-SSLs were not available. Chemicals with HQs greater than 1 were identified as **ecological COPCs**[16] for further evaluation in Step 3A of the ERA. Identified COPCs at Step 2 comprised SVOCs, and inorganic constituents in surface soil.

In **Step 3A**[17], the conservative exposure assumptions employed for Step 2 were refined and risk estimates were recalculated using more realistic assumptions including the use of mean values for soil concentrations, bioaccumulation factors, and exposure parameters. Other factors considered in

Step 3A included comparison to background concentrations, other accepted ecological screening values in the scientific literature, frequency of detection, frequency and magnitude of screening value exceedance, and spatial distribution of the COPCs.

The Step 3A refinement resulted in no COCs being identified for either upper or lower trophic level receptors. Chemicals detected above ecological screening criteria were attributable to background. Thus, risks to ecological receptors are acceptable at AOC E.

2.6.3 Basis for Response Action

In cooperation with EPA and PREQB, and in accordance with applicable guidance, the Navy performed investigations at AOC E to evaluate the nature and extent of contamination associated with past releases, to assess the potential risks to human health and the environment posed by that contamination, and to evaluate technologies for their ability to reduce contaminant concentrations to acceptable levels. Although recent groundwater data show that the ISCO pilot study resulted in COC concentrations below regulatory standards, residual persulfate from what was injected remains and may still actively reduce contaminants that partition or diffuse from soil into groundwater. Therefore, the Navy developed the response action to ensure COC levels remain below regulatory standards once residual persulfate levels decline and that groundwater within the site boundaries is not used as a potable source during that time.

2.7 Principal Threat Waste

Principal threat wastes are generally considered to be hazardous or highly toxic source materials that result in ongoing contamination to surrounding media, generally cannot be reliably contained, or present a significant risk to human health or the environment should exposure occur. Although remedial action is warranted at AOC E, based on evaluation of site conditions and the results of human health and ecological risk assessments, there are no wastes that constitute a principal threat at AOC E.

2.8 Remedial Action Objective

An RAO is established based on attainment of regulatory requirements, standards, and guidance; contaminated media; chemicals of concern; potential receptors and exposure scenarios; and human health and ecological risks, as applicable. The following RAO was developed for groundwater contamination and potential exposure routes and receptors at AOC E:

- Prevent exposure to COCs in groundwater at concentrations above RGs.

The NCP addresses how Superfund should implement CERCLA's requirements and goals concerning cleanup levels, and states that RGs shall be protective of human health and the environment and developed by considering both cancer and non-cancer effects. The NCP also states that "The final selection of the appropriate risk level is made when the remedy is selected based on the balancing of criteria . . ."

EPA uses the general 10^{-4} to 10^{-6} risk range as a "target range" within which EPA strives to manage risks as part of a Superfund cleanup. Once a decision has been made to make an action, the EPA has expressed a preference for cleanups achieving the more protective end of the range (i.e., 10^{-6}), although waste management strategies achieving reductions in site risks anywhere within the risk range may be deemed acceptable by the EPA risk manager.

Both the law (CERCLA) and the regulation (NCP) call for cost-effective remedial alternatives. RGs must meet the "threshold criteria" of (1) protection of human health and the environment and (2) compliance with ARARs. However, the NCP also allows for modification of RGs during final remedy

selection based on the "balancing criteria" and "modifying criteria" and factors relating to uncertainty, exposure, and technical feasibility.

For AOC E, the RGs (**Table 6**) are based on chemical-specific ARARS (Federal MCLs for benzene and xylenes; PRWQS for 1,2-dichloroethane), where available. For those groundwater COCs without ARARs, risk-based RGs were developed (based on a HI of 1 for 2-methylnaphthalene and naphthalene, and based on a target risk 10^{-5} for MTBE). A target risk level above the point of departure (10^{-6}) was selected based on uncertainties in future use of site groundwater as a drinking water source, future use of the site for residential land use, uncertainties in the toxicity values used to calculate the risk-based concentrations, and precedence at other sites in EPA Region 2.

TABLE 6
Summary of Remediation Goals for Groundwater Chemicals of Concern

COCs	Remediation Goal (µg/L)	Remediation Goal Basis
Benzene	5	MCL
1,2-Dichloroethane	3.8	PRWQS
2-Methylnaphthalene	27	RSL[1]
MTBE	120	RSL[2]
Naphthalene	6.1	RSL[3]
Total Xylenes	10,000	MCL

Notes:
MCL – Federal Maximum Contaminant Level (EPA, 2009)
PRWQS – Puerto Rico Water Quality Standards (March 2010; for groundwater – class SG)
RSL – EPA **Regional Screening Level** (EPA, 2013) for tap water; lowest of the cancer-based and non-cancer based levels (based on ELCR of $1x10^{-6}$ and HI of 1).
[1] HI of 1; not a potential carcinogen (EPA, 2013)
[2] ELCR of $1X10^{-5}$ and HI of 0.02 (EPA, 2013)
[3] ELCR of $4X10^{-5}$ and HI of 1 (EPA, 2013)

2.9 Description and Comparative Analysis of Remedial Alternatives

Remedial alternatives were developed based on site-specific considerations related to the nature of the COCs and their current (post pilot-study) concentrations, site hydrogeologic conditions, and the successful implementation of the ISCO pilot study, as detailed in the FFS Report (CH2M HILL, 2012).

2.9.1 Description of Remedial Alternatives

Two remedial alternatives were developed for detailed evaluation and are summarized in **Table 7** and discussed in detail in Section 5 of the FFS (CH2M HILL, 2012). Consistent with the NCP, a no action alternative was evaluated as a baseline for the comparative analysis. A second alternative (with contingencies) was evaluated to meet the RAO.

TABLE 7
Remedial Alternatives Summary

Alternative[1]	Components	Details	Cost*
1. No Action No action and no restriction on activities.	- N/A	- No groundwater sampling would be performed to monitor concentrations of COCs or residual persulfate - No ICs would be implemented - Five-year reviews (for an estimated 30 years) would be required.	**Total Present-Worth Cost: $0****
2. Groundwater Monitoring and ICs	- Annual groundwater monitoring - ICs	- Groundwater monitoring to ensure persulfate concentrations decline - Annual groundwater monitoring for COCs for 3 years after persulfate levels decline to ensure contaminant rebound does not occur - Implementing ICs to restrict potable groundwater use until the RAO is met	Capital Cost: $66,000 Present Value of Future Annual Operations and Maintenance (O&M) Costs: $194,000 **Total Present-Worth Cost: $260,000** Discount Rate: 4% Assumed timeframe: 6 years
2a. Contingency Plan 1 (CP-1)	- ISCO injection using catalyzed hydrogen peroxide propagations (CHP) to address persistent persulfate	**Triggering Event** - If residual persulfate (above 500 mg/L) does not demonstrate an overall decline after three successive annual monitoring events, a hydrogen peroxide solution would be injected to accelerate the persulfate decline. - If COC rebound above acceptable levels is observed and is persistent after three successive annual monitoring events, proceed to contingency plan CP-2.	Capital Cost: $66,000+$126,000=$192,000 Present Value of Future Annual O&M Costs: $194,000+$87,000=$281,000 **Total Present-Worth Cost: $473,000** Discount Rate: 4% Assumed timeframe: 9 years
2b. Contingency Plan 2 (CP-2)	- ISCO injection using persulfate	**Triggering Event** - If COC rebound above acceptable levels is observed and is persistent after three successive annual monitoring events, hydrogen peroxide activated sodium persulfate would be injected in wells in which rebound is observed.	Capital Cost: $66,000+$117,000=$183,000 Present Value of Future Annual O&M Costs: $194,000+$77,000=$271,000 **Total Present-Worth Cost: $454,000** Discount Rate: 4% Assumed timeframe: 9 years

[1] Details of each alternative evaluated can be found in Section 5 of the FFS (CH2M HILL, 2012).

* The MPE, DBB, and ISCO pilot studies had a combined cost of approximately $583,000.

** The cost of five-year reviews was included in the alternative cost presented in the FFS (CH2M HILL, 2012).

2.9.2 Comparative Analysis of Remedial Alternatives

A **comprehensive analysis of each remedial alternative**[18] with respect to the **nine evaluation criteria**[19] was completed and is summarized below. **Table 8** depicts a comparison of the alternatives to the criteria to support ranking of the alternatives and Section 6 of the FFS (CH2M HILL, 2012) provides detailed comparison of the alternatives.

Threshold Criteria

Overall Protection of Human Health and the Environment. There is presently insufficient data available to conclude that Alternative 1 (no action) would achieve the RAO. Alternative 2, including the contingency plans, would be protective because the estimated timeframe to meet the RAO ranges from 6 to 9 years, and potential potable use of groundwater would be prevented by groundwater use restrictions until the RAO was met.

Compliance with Applicable or Relevant and Appropriate Requirements. Only Alternative 2 complies with the **Applicable or Relevant and Appropriate Requirements (ARARs)**[20] (**Attachment A, Tables A-1 through A-6**).

TABLE 8
Comparative Analysis of Remedial Alternatives

Criterion[1]	Alternative 1	Alternative 2
	No Action	Groundwater Monitoring and ICs with contingency plans 1 (persulfate persistence) and 2 (contaminant rebound)
Threshold Criterion		
Overall protection of human health and the environment	○	●
Compliance with ARARs	○	●
Compliance with Chemical-Specific ARARs	○	●
Compliance with Action-Specific ARARs	●	●
Compliance with Location-Specific ARARs	○	●
Balancing Criterion		
Long-term effectiveness and permanence	○	●
Magnitude of Residual Risk	○	●
Adequacy and Reliability of Controls	○	●
Reduction of toxicity, mobility, or volume through treatment	○	◔
Treatment Process Used and Materials Treated	○	●
Amount of Hazardous Materials Destroyed or Treated	Not Applicable	◔
Degree of Expected Reductions in Toxicity, Mobility, and Volume	Not Applicable	◔
Degree to Which Treatment is Irreversible	Not Applicable	●
Type and Quantity of Residual Remaining After Treatment	Not Applicable	◔
Short-term effectiveness	◔	◔
Protection of Community During Remedial Actions	●	●
Protection of Workers During Remedial Actions	●	◔
Environmental Impacts	●	◔
Time Until Remedial Action Objectives are Achieved	○	●
Implementability	◔	◔
Technical Feasibility	●	◔
Administrative Feasibility	○	●
Availability of Services, Equipment, and Materials	●	●
Cost (Total Present Value)	**$0***	**$260,000 (with contingency plan 1: $473,000); (with contingency plan 2: $454,000)**

Individual criterion scores: ○ not met ◔ poor ◒ satisfactory ◕ good ● excellent

[1] Details of the comparative analysis can be found in Section 6 of the FFS (CH2M HILL, 2012).

* The cost of five-year reviews was included in the alternative cost presented in the FFS (CH2M HILL, 2012).

Primary Balancing Criteria

Long-Term Effectiveness and Permanence. The long-term effectiveness would not be known for Alternative 1 because groundwater monitoring would not be performed. Alternative 2 provides adequate and reliable long-term protection because it utilizes groundwater monitoring to ensure that rebound does not occur which results in levels that are above drinking water standards or pose an unacceptable risk. In addition, Alternative 2 includes a contingency for additional ISCO injections in case COC levels rebound as well as contingency injections to reduce residual persulfate levels if necessary.

Reduction in Toxicity, Mobility, or Volume through Treatment. Reduction of toxicity, mobility, and volume was achieved by the pilot study; however, Alternative 1 would not verify whether the potential rebound would occur and whether there may be a need to achieve further reduction, if necessary, because of a lack of groundwater monitoring or additional treatment. For Alternative 2, long-term monitoring and, if necessary, implementing contingency plans would ensure the reduction of toxicity, mobility, and volume of COC concentrations is maintained.

Short-Term Effectiveness*.* Alternative 1 has no short-term construction impacts and the lowest environmental footprint since there would be no remedial construction activities. Alternative 2 short-term impacts would be negligible and primarily associated with equipment and personnel transport to the site during groundwater sampling activities, site inspections, and injection activities should implementation of a contingency be necessary. The estimated timeframe to meet the RAO for Alternative 2 ranges from 6 to 9 years, depending on whether contingency plans are needed. The contingencies would also enhance short-term effectiveness by providing a means of addressing persistent, elevated persulfate concentrations or COC rebound above acceptable levels.

As part of the short-term effectiveness evaluation, a sustainability analysis was conducted for each of the two remedial alternatives. Sustainability is focused on energy conservation, reduction of greenhouse gases, waste minimization, and re-use and recycling of materials. While, as mentioned above, Alternative 1 has no short-term construction impacts, the environmental footprint of Alternative 2 is also not significant because of the relatively negligible energy use and land disturbance.

Implementability. Alternative 1 requires no implementation. Alternative 2 is technically and administratively feasible because previous groundwater monitoring and ISCO injections have been successfully demonstrated at the site.

Cost. Alternative 1 would have no cost, but it cannot be conclusively determined that the RAOs will be attained. Alternative 2 has a **present-worth cost**[21] of $260,000 if the contingency treatments are not necessary, with an increase in cost to $473,000 or $454,000 if contingencies 2a or 2b, respectively, are required. The cost could be cumulative if both contingencies are ultimately required.

Modifying Criteria

Commonwealth Acceptance. Commonwealth involvement has been continual throughout the CERCLA process for AOC E, and PREQB concurs with the selected remedy.

Community Acceptance. The Proposed Plan was issued for public review from November 4 to December 19, 2013 and was discussed at a public meeting on November 14, 2013. No public comments on the Proposed Plan were received.

2.10 Selected Remedy

The selected remedy for AOC E groundwater is Alternative 2, Groundwater Monitoring and ICs with Contingency Plans 2a and 2b. This selected remedy is the preferred alternative that was presented in the Proposed Plan.

2.10.1 Rationale for Selected Remedy

Based on the evaluation of the data, information currently available, and the comparative analysis, the Navy and EPA, with the concurrence of PREQB, determine the selected remedy meets the statutory requirements of CERCLA for protection of human health and the environment under current and projected future unrestricted land use.

2.10.2 Description of Selected Remedy

Alternative 2, Groundwater Monitoring and ICs with Contingency Plans 2a and 2b, involves the implementation of periodic (at least annually) groundwater monitoring to ensure persulfate concentrations decline and annual groundwater monitoring for COCs for a period of 3 years after persulfate levels decline to ensure contaminant rebound does not occur. Section 5.2 of the FFS (CH2M HILL, 2012) provides the details of Alternative 2. The selected remedy will also include ICs to restrict potable groundwater use until the RAO is met. Until the RAO is met, five-year reviews will be conducted to evaluate the effectiveness of the selected remedy. Should residual persulfate levels not demonstrate an overall decline after three successive annual monitoring events, an ISCO injection using a hydrogen peroxide solution will be conducted to accelerate persulfate decline (**Table 7**, Contingency Plan 1, CP-1). If COCs rebound above acceptable levels and unacceptable concentrations persist after three successive annual monitoring events, an ISCO injection using persulfate would be conducted for wells in which rebound is observed (**Table 7**, Contingency Plan 2, CP-2). Implementation of either contingency plan would result in additional monitoring to ensure the RAO is met. A graphical depiction of the selected remedy is provided in **Attachment B**.

2.10.3 Expected Outcomes of the Selected Remedy

The expected outcome of the Selected Remedy is that residual persulfate levels decline and COCs in groundwater remain at or below acceptable regulatory levels. Potable groundwater use at AOC E will be restricted until the RAO is met.

Within 90 days following signature of the ROD, the Navy will prepare, in accordance with EPA guidance, and submit to EPA and PREQB, for review and concurrence, a Remedial Action Work Plan that includes a Land Use Control (LUC) Plan and a Remedial Action Groundwater Long-Term Monitoring Sampling and Analysis Plan (LTM SAP). The Navy is responsible for implementing, maintaining, inspecting, reporting on, and enforcing the ICs in accordance with the ROD.

2.10.4 Statutory Determinations

In accordance with the NCP, the selected remedy meets the following statutory determinations.

- **Protection of Human Health and the Environment -** The selected remedy is appropriate to prevent use of groundwater that would potentially pose an unacceptable risk to exposed receptors. ICs will be put in place and maintained to prevent potable groundwater use, and performance monitoring will be conducted.
- **Compliance with ARARs -** The selected remedy will attain the Federal and Commonwealth ARARs presented herein (**Attachment A, Tables A-1 through A-6**).
- **Cost-Effectiveness -** The selected remedy provides the best value relative to the cost.
- **Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable** - The selected remedy represents the

maximum extent to which permanent solutions and alternative treatment technologies can be used in a practicable manner at AOC E. Groundwater performance monitoring and ICs are expected to attain the RAO.

- **Preference for Treatment as a Principal Element –** The selected remedy monitors the results of groundwater treatment implemented as a pilot study. In addition, if residual persulfate concentrations do not decline or COC concentrations rebound above acceptable levels, contingency treatment will be implemented.
- **Five-Year Review Requirements –** Until the RAO is met, the Navy will maintain ICs and conduct a policy remedy review every 5 years after initiating the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. If the remedy is determined not to be protective of human health and the environment because, for example, ICs have failed, then additional ICs and/or remedial actions will be evaluated by the Navy, EPA, and PREQB for potential implementation.

2.11 Community Participation

The Navy, in consultation with the EPA, PREQB, and United States Fish and Wildlife Service (USFWS), established a community relations program for the Vieques environmental restoration program in 2001. The program promotes communication regarding site investigations and remediation activities between the stakeholder agencies (Navy, EPA, PREQB, and the USFWS) and the public. The community relations program formed a Restoration Advisory Board (RAB) in 2004 to encourage community involvement. RAB meetings are held approximately every 3 months and are open to the public for participation. A summary of the community participation efforts by the stakeholder agencies for this action are discussed in the next section.

3 Responsiveness Summary

The Responsiveness Summary is a concise summary of substantive comments received from the public during the public comment period and the associated responses. The Responsiveness Summary was prepared in accordance with guidance in *Community Relations in Superfund: A Handbook* (EPA, 1992) after the public comment period ended on December 19, 2013.

3.1 Overview

The Proposed Plan presented to the public identified that a remedial action, consisting of groundwater monitoring and ICs with contingency plans, is warranted at AOC E to protect human health and the environment.

3.2 Community Involvement Process

In accordance with Section 117(a) of CERCLA, the Navy provided a public comment period between November 4, 2013 and December 19, 2013, for the AOC E Proposed Plan. A **public meeting**[22] was held on November 14, 2013 at the Ice House, located at Carr. 200, Km 3, hm 2, Vieques, Puerto Rico to present information pertinent to the proposed remedial action determination and to accept comments and questions regarding this determination. No formal comments or questions were submitted to the Navy, EPA, or PREQB during the public meeting.

The Proposed Plan and previous investigation reports for AOC E were available during the public comment period and are currently available in the former NASD Administrative Record. The Administrative Record is accessible to the public via:

http://www.navfac.navy.mil/vieques

3.3 Summary of the Public Comment Period

No community members expressed opposition to the proposed remedial action determination for AOC E. No comments or questions were received by the Navy, EPA, or PREQB during the public comment period.

4 Acronyms

AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirements
AST	aboveground storage tank
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
COC	chemical of concern
COPC	chemical of potential concern
CSM	conceptual site model
DBB	denitrification-based bioremediation
DOI	Department of the Interior
eco-SSL	ecological soil screening level
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ERP	Environmental Restoration Program
FFA	Federal Facilities Agreement
FFS	Focused Feasibility Study
FS	Feasibility Study
ft	feet
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IC	Institutional Controls
ISCO	in-situ chemical oxidation
LOAEL	lowest observed adverse effect level
µg/L	micrograms per liter
mg/L	milligrams per liter
MCL	maximum contaminant level
MOV	Municipality of Vieques

MPE	multiphase extraction
MTBE	methyl-tert-butyl ether
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command
Navy	U.S. Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	no observed adverse effect level
NPL	National Priorities List
O&M	Operation & Maintenance
OU	operable unit
PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Inspection
PCB	polychlorinated biphenyl
PRAP	Proposed Remedial Action Plan
PREQB	Puerto Rico Environmental Quality Board
RAB	Restoration Advisory Board
RAO	remedial action objectives
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SMP	Site Management Plan
SSL	soil screening level
SVOC	semivolatile organic compound
TRV	toxicity reference value
USFWS	United States Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
VNTR	Vieques Naval Training Range

5 References

Item	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
Ref. 1	**analytical data**	Section 2.3	CH2M HILL, 1999. *Site Characterization Report for Site No. 2016, Prepared for United States Navy, Roosevelt Roads Naval Station, Ceiba, Puerto Rico.* April. Appendix H.
Ref. 2	**results**	Section 2.3	CH2M HILL, 2000. *Expanded Preliminary Assessment/Site Investigation, U.S. Naval Ammunition Storage Detachment, Vieques Island, Puerto Rico*. October. Table 11-1.
Ref. 3	**Concentrations of constituents detected in soil and groundwater during the RI**	Section 2.3	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Tables 4-1 through 4-3.
Ref. 4	**Multiphase Extraction (MPE) pilot study**	Section 2.3	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendix H.
Ref. 5	**human health and ecological risk assessments**	Section 2.3	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendices N and O.
Ref. 6	**soil denitrification-based bioremediation (DBB) pilot study**	Section 2.3	CH2M HILL, 2012. *Final Focused Feasibility Study Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November. Section 3.1, Appendix A.
Ref. 7	**groundwater in-situ chemical oxidation (ISCO) pilot study**	Section 2.3	CH2M HILL, 2012. *Final Focused Feasibility Study Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November. Section 3.2, Appendix B.
Ref. 8	**potential human receptors**	Section 2.6.1	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Figure 6-1.
Ref. 9	**unacceptable human health risk**	Section 2.6.1	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Sections 6.3 and 6.4.
Ref. 10	**ecological CSM**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Figure 7-1.

Item	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
Ref. 11	**ecological assessment and measurement endpoints**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendix O, Table O-18.
Ref. 12	**bioaccumulating chemical**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendix O, Table O-3.
Ref. 13	**toxicity reference values**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendix O, Tables O-7 and O-8.
Ref. 14	**ecological soil screening levels**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendix O, Table O-5.
Ref. 15	**Master Ecological Risk Assessment Protocol for Vieques**	Section 2.6.2	CH2M HILL, 2010. *Master Standard Operating Procedures, Protocols, and Plans. Environmental Restoration Program. Vieques, Puerto Rico*. Final. April. Table 18.
Ref. 16	**ecological COPCs**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Appendix O, Table O-9.
Ref. 17	**Step 3A**	Section 2.6.2	CH2M HILL, 2008. *Final Remedial Investigation Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* July. Section 3.2 and Table O-18.
Ref. 18	**comprehensive analysis of each remedial alternative**	Section 2.9.2	CH2M HILL, 2012. *Final Focused Feasibility Study Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November. Section 6.2 and 6.3, Table 6-1.
Ref. 19	**nine evaluation criteria**	Section 2.9.2	CH2M HILL, 2012. *Final Focused Feasibility Study Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November. Section 6.1.
Ref. 20	**Applicable or Relevant and Appropriate Requirements (ARARs)**	Section 2.9.2	CH2M HILL, 2012. *Final Focused Feasibility Study Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November. Tables 4-1a through 4-1f.
Ref. 21	**present-worth cost**	Section 2.9.2	CH2M HILL, 2012. *Final Focused Feasibility Study Report, Area of Concern (AOC) E, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November. Table 6-2.
Ref. 22	**public meeting**	Section 3.2	Transcript of the Public Hearing for the Meeting of Proposed Plans for AOC E, Former Underground Storage Tank Site and AOC I, Former Asphalt Plant Site, *Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* November 14, 2013.

Attachment A
Applicable or Relevant and Appropriate Requirements

Table A-1

Federal Chemical-Specific ARARs

AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
USEPA RSLs						
Groundwater	Chemical concentrations corresponding to target cancer risk and non-cancer hazard levels for human health.	RSLs are conservative, risk-based criteria for screening CERCLA sites. EPA has developed these risk-based concentrations for many constituents associated with contaminated sites.	USEPA RSL Table (May 2012) for Residential tap water only as they apply to 2-methylnaphthalene, MTBE, naphthalene	2, CP-1, CP-2	TBC	A baseline human health risk assessment has been performed to estimate site-specific risks and was used in the development of the following RGs: 2-Methylnaphthalene: 27 µg/L MTBE: 120 µg/L Naphthalene: 6.1 µg/L
Safe Drinking Water Act						
Groundwater	SDWA standards serve to protect public water systems. Primary drinking water standards consist of federally enforceable MCLs. MCLs are the highest level of a contaminant that is allowed in drinking water.	Groundwater contamination exceeds MCLs. Cleanup to MCLs for the contaminants presenting risks and hazards above EPA acceptable levels is being considered in order to meet the state's expectations for beneficial use.	40 CFR 141.61 (a)(2) and (18)	2, CP-1, CP-2	Relevant and Appropriate	Relevant and appropriate because the aquifer is neither currently, nor reasonably anticipated in the future to be used as a potable water supply. The MCLs were used to set the following RGs: Benzene: 5 µg/L Total xylenes: 10,000 µg/L

Table A-2

Puerto Rico Chemical-Specific ARARs

AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Puerto Rico Water Quality Standards						
Groundwater	Establishes water quality standards within the Commonwealth of Puerto Rico.	All groundwater in Puerto Rico must meet the requirements of a class SG water.	Puerto Rico Water Quality Standards apply to all chemicals with class SG standards	2, CP-1, CP-2	Applicable	The RGs set using the PRWQS are: 1,2-Dichloroethane: 3.8 µg/L

Table A-3

Federal Location-Specific ARARs

AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Coastal Zone						
Migratory Flyway						
Migratory bird area	Protects almost all species of native birds in the United States from unregulated taking.	Presence of migratory birds.	Migratory Bird Treaty Act, 16 USC 703	2, CP-1, CP-2	Applicable	The site is located in the Atlantic Americas Migratory Flyway. If migratory birds, or their nests or eggs, are identified at the site, operations will not destroy the birds, nests, or eggs.

Table A-4

Puerto Rico Location-Specific ARARs

AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
No Puerto Rico Location-Specific ARARs apply.						

Table A-5

Federal Action-Specific ARARs

AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Underground Injection Control						
Underground injection of treatment chemicals	Regulates the subsurface emplacement of liquids through the Underground Injection Control program, which governs the design and operation of five classes of injection wells in order to prevent contamination of underground sources of drinking water. The Underground Injection Control program regulates well construction, well operation, and monitoring.	Any dug hole or well that is deeper than its largest surface dimension, where the principal function of the hole is in subsurface placement of fluids.	40 CFR 144.12(a), 144.24(a), 144.82(a)(1) and (b), 144.83(a)(1)(i), 146.8(a)-(e), 146.10(c)	CP-1, CP-2	Applicable	Applicable to the installation of Class V wells. Permits are not applicable to on-site CERCLA injection wells; however, these remedial actions will comply with the substantive requirements of the regulations.

Table A-6

Puerto Rico Action-Specific ARARs

AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Noise Pollution						
Performing construction activities that generate noise	No construction activity may be performed at night or in such a way that vibrations are produced that can be felt beyond the property boundary. If equipment used in construction is not manufactured in accordance with USEPA standards for newly manufactured equipment then it may not produce noise that exceeds 70 dBA.	Construction activity including earthwork	Puerto Rico Regulation 3418.3.1.5(A),(C);3.1.10 ; 3.1.13; and 4.1	2, CP-1, CP-2	Applicable	The site is considered to be in Zone II (Commercial) for noise production. Noise pollution during onsite activities will be prevented.
Underground injection						
Underground injection	Establishes construction and operation standards for underground injection wells.	Construction of any dug hole or well that is deeper than its largest surface dimension, where the principal function of the hole is the subsurface emplacement of fluids. Fluids include both liquids and gasses.	Puerto Rico Underground Injection Regulations 304.A.2.a, b, d, e; 304.A.4, 304.B.1, C.2.a, b; C.3.c	CP-1, CP-2	Applicable	Applicable to ISCO injections. A permit would not be required; however, substantive requirements of the rule would be met. Injections would be accomplished with Class V type B7 wells. The Commonwealth of Puerto Rico does not have Class V permitting authority; however, they do maintain their own separate regulations regarding the operation and maintenance of underground injection systems.

Table A-6

Puerto Rico Action-Specific ARARs

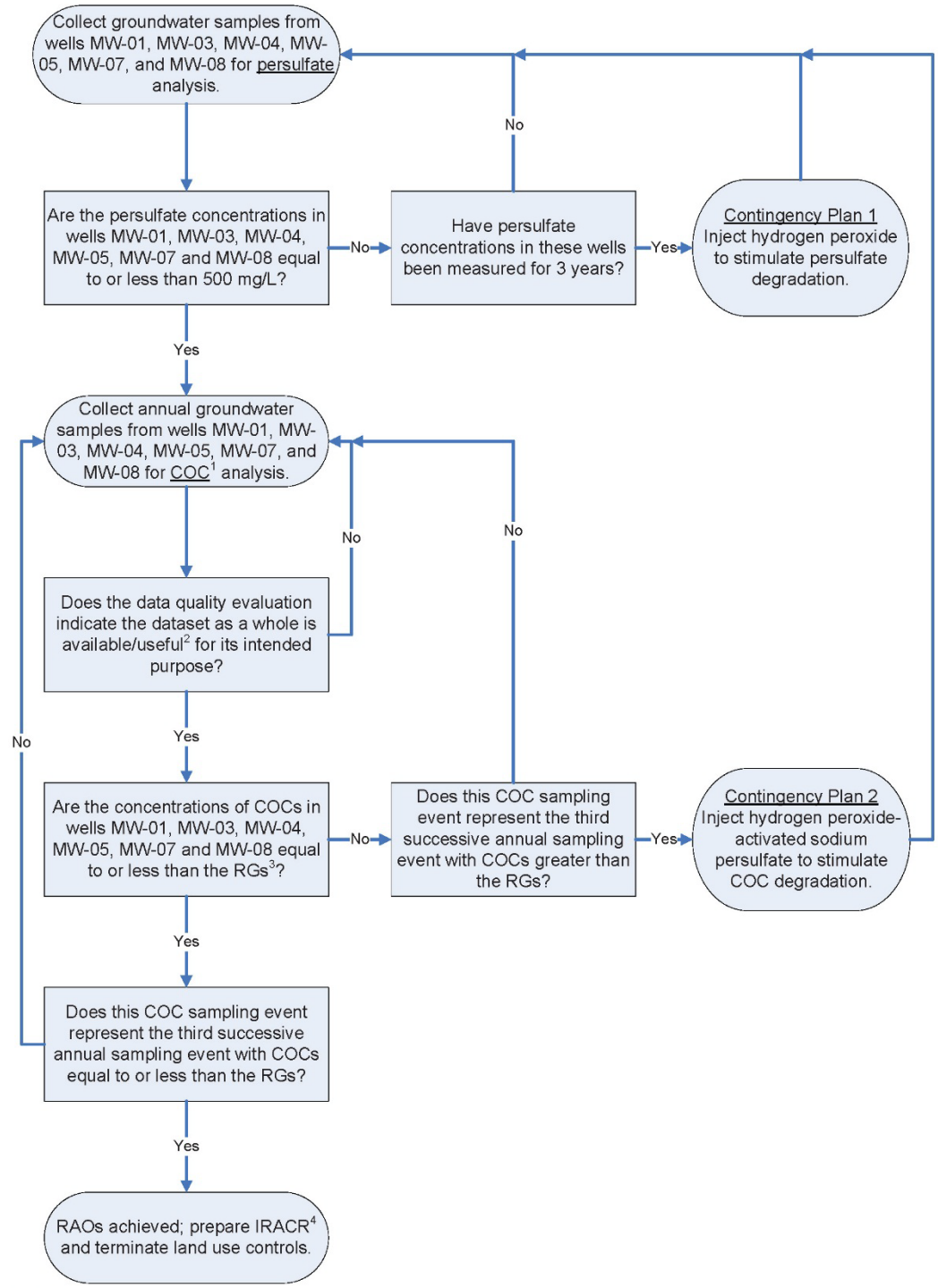
AOC E Record of Decision

Former Naval Ammunition Support Detachment (NASD)

Vieques, Puerto Rico

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Waste Management						
Management of non-hazardous solid waste onsite in containers and piles.	Non-hazardous solid waste staged onsite must not create a hazard or public nuisance.	Generation of non-hazardous solid waste that is managed onsite in containers or in piles.	Puerto Rico Non-Hazardous Solid Waste Regulation 531.H	2, CP-1, CP-2	Applicable	It is anticipated that non-hazardous solid wastes will be generated during the implementation of these alternatives. Wastes will be sampled to confirm characterization prior to disposal.

Attachment B
Long-term Monitoring Decision Tree



lotes:

'he decision makers associated with this decision tree are the Navy, ISEPA, and PREQB.

Contaminants of Concern (COCs): 1,2-dichloroethane (1,2-DCA); benzene; ıethyl tert-butyl ether (MTBE); 2-methylnaphthalene; naphthalene; xylenes :otal)

"Available" and "Useful" data are described in Worksheet #37

Remediation Goals (RGs): 1,2-DCA (3.8 µg/L); benzene (5 µg/L); MTBE 120 µg/L); 2-methylnaphthalene (27 µg/L); naphthalene (6.1 µg/L); total ylenes (10,000 µg/L)

IRACR = Interim Remedial Action Completion Report

Long-term Monitoring Decision Tree
AOC E Remedial Action
Atlantic Fleet Weapons Training Area – Vieques Former Naval Ammunition Support Detachment Vieques, Puerto Rico