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FINAL RECORD OF DECISION FOR SITE 47 MERCURIC NITRATE DISPOSAL AREA NSWC INDIAN HEAD MD

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Final

RECORD OF DECISION

for

Site 47—Mercuric Nitrate Disposal Area

Naval Support Facility Indian Head
Indian Head, Maryland

February 2013

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Acronyms and Abbreviations

4,4′-DDD	dichlorodiphenyldichloroethane
4,4′-DDE	dichlorodiphenyldichloroethylene
4,4′-DDT	dichlorodiphenyltrichloroethane
µg/L	microgram(s) per liter
AA	area of attainment
AAP	alkaline-activated sodium persulfate
ARAR	applicable or relevant and appropriate requirement
BERA	baseline ecological risk assessment
bgs	below ground surface
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	constituent of concern
COPC	constituent of potential concern
CSF	carcinogenic slope factor
CSM	conceptual site model
CT	carbon tetrachloride
CTE	central tendency exposure
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
ft/day	foot(feet) per day
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IC	institutional control
IRP	Installation Restoration Program
ISCO	*in situ* chemical oxidation
ISCR	*in situ* chemical reduction
LC	low concentration
LUCs	land use controls
MDE	Maryland Department of the Environment

MNA	monitored natural attenuation
mg/kg	milligram(s) per kilogram
Navy	Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NSF-IH	Naval Support Facility Indian Head
O&M	operation and maintenance
PA	Preliminary Assessment
PCE	tetrachloroethene
PETN	pentaerythritol tetranitrate
PRGs	preliminary remediation goals
RAO	remedial action objective
RBC	risk-based concentration
RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SERA	screening-level ecological risk assessment
SI	Site Inspection
SOD	soil oxidant demand
SRG	site remediation goal
SVOC	semivolatile organic compound
TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
UCL	upper confidence limit
VOC	volatile organic compound
ZVI	zero valent iron

SECTION 1

Declaration

1.1 Site Name and Location

Site 47, Mercuric Nitrate Disposal Area
Naval Support Facility, Indian Head
Indian Head, Maryland
CERCLIS ID No. MD 170024684

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) presents the Selected Remedy for Site 47, Mercuric Nitrate Disposal Area, at the Naval Support Facility Indian Head (NSF-IH) in Indian Head, Maryland. The locations of NSF-IH and Site 47 are shown in Figure 1-1. The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act, and, to the extent practical, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on information contained in the Administrative Record file for NSF-IH.

The response action presented in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The Department of the Navy (Navy), the lead agency for the site activities, and the U.S. Environmental Protection Agency Region III (EPA), in consultation with the Maryland Department of the Environment (MDE), selected the remedy.

1.3 Description of the Selected Remedy

The Selected Remedy for shallow groundwater is *in situ* chemical oxidation (ISCO) in the source zone area, monitored natural attenuation (MNA) in the remaining area where the site remediation goals (SRGs) are exceeded, and institutional controls (ICs) prohibiting residential development at the site and any use of the shallow groundwater until the SRGs are met, and restricting intrusive activities such as excavation. ISCO will be implemented in the source area where the concentrations of carbon tetrachloride (CT) and tetrachloroethene (PCE), the principal threats, exceed or are equal to 500 microgram(s) per liter (µg/L). Based on the human health and ecological risk assessments performed during the Remedial Investigation (RI) (CH2M HILL, 2003) and the Baseline Ecological Risk Assessment (BERA) (CH2M HILL, 2006), no constituents of concern (COCs) were identified for the surface soil, subsurface soil, surface water, and sediment; therefore, no action is warranted for these media. However, unacceptable risks were identified for human exposure to shallow groundwater.

The components of this remedy include the following:

- ISCO using alkaline-activated sodium persulfate (AAP) in the source area where the CT and PCE concentrations are greater than or equal to 500 µg/L.
- MNA for the remaining dissolved plume and the source area following the active treatment with AAP
- Short-term ISCO performance sampling events at baseline, and 2-, 6-, and 9-month post-ISCO.
- Long-term groundwater monitoring for 52 years or until SRGs are met.
- 5-year reviews until SRGs are met.
- ICs in the form of land and groundwater use restrictions as detailed in Section 2.12.2.

1.4 Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements (ARARs), is cost-effective, and utilizes permanent solutions and treatment technologies to the maximum extent possible. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy. Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action and every 5 years thereafter to ensure that the remedy will be protective of human health and the environment.

1.5 ROD Data Certification Checklist

The following information is presented in Section 2, the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for Site 47:

- COCs requiring remediation and their respective concentrations (Section 2.8)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (Sections 2.6 and 2.12.4).
- Baseline risk represented by all COCs (Sections 2.7.1 and 2.7.2).
- Cleanup levels established for constituents requiring remediation and the basis for these levels (Section 2.8).
- Key factor(s) that led to the selected remedy (Section 2.10).
- Principal threat wastes (Section 2.11)
- Estimated capital, annual operation and maintenance (O&M), and total present-worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.12.3).

1.6 Authorizing Signatures

Peter R. Nette

P. R. NETTE
Captain, U.S. Navy
Commanding Officer
NSA South Potomac

5 Nov 12
Date

K. Hodgkiss

Kathryn A. Hodgkiss, Acting Director
Hazardous Site Cleanup Division
USEPA (Region III)

2/5/2013
Date

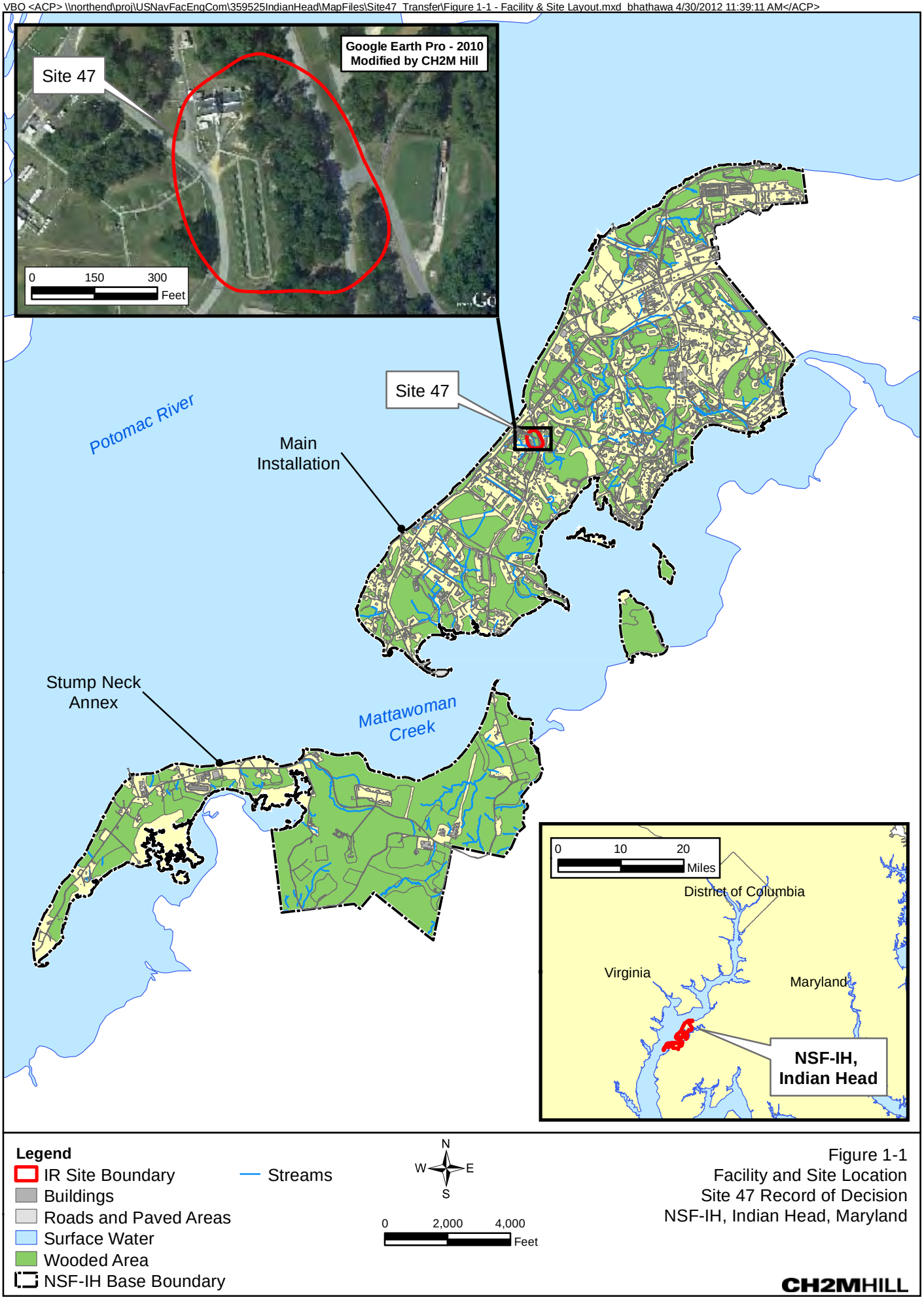

Figure 1-1
Facility and Site Location
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

CH2MHILL

SECTION 2

Decision Summary

2.1 Site Name, Location, and Description

NSF-IH is in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, DC. NSF-IH is a Navy facility consisting of the Main Installation on the Cornwallis Neck Peninsula and the Stump Neck Annex on the Stump Neck peninsula. The Main Installation contains approximately 2,500 acres and is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast. Included as parts of the Main Installation are Marsh Island and Thoroughfare Island, which are located in Mattawoman Creek. Site 47 is located in the central portion of the Main Installation (Figure 1-1).

The Navy is the lead agency for site activities and provides funding for site cleanups at NSF-IH. The EPA is the lead regulatory agency and MDE is a support regulatory agency for site activities.

2.2 Site History and Previous Investigations

2.2.1 Site History

Mercuric nitrate was used in Building 856 as a catalyst in the production of the missile propellant hydrazinium nitroformate and was disposed of at a location near the southeast corner of the building (Figure 2-1). The disposal area encompassed an area of approximately 24 square feet (4 feet by 6 feet). Mercuric nitrate was reportedly disposed from 1957 to 1965 (Naval Energy and Environment Support Activity, 1992). The disposal site was covered with limestone chips to neutralize the spent catalyst (composed of nitric acid). Evidence of the disposal area no longer exists. CT was used at the site, presumably as an inerting agent to keep the explosives dry and may have been poured into drains or stored in leaky drums. Additional information indicated that barium sulfate sludge may have been disposed of in a waste pit approximately 50 feet to the east of Building 856 between 1969 and 1974.

2.2.2 Previous Investigations

Preliminary Assessment

The objective of the Preliminary Assessment (PA) (Naval Energy and Environment Support Activity, 1992) was to document past and present operations and disposal practices at several sites and recommend further action if there was a potential threat to human health or the environment. The PA concluded that based on the soil characteristics and solubility of the mercuric nitrate and its salt precipitate, mercury may have leached into the shallow groundwater at the site. The PA recommended a Site Inspection (SI) to include soil sampling for Site 47.

Site Inspection

The objective of the SI was to determine if contamination was present in soil at Site 47 (Ensafe/Allen & Hoshall, 1994). Twelve surface soil samples were collected from locations near the former mercury disposal pit at Site 47 (Figure 2-2). The sampling results did not conclusively identify the location of the former mercuric nitrate disposal pit. As a result, it was recommended that an additional study be conducted to evaluate the nature and extent of contamination from VOCs, semivolatile organic compounds (SVOCs), and metals.

Remedial Investigation

The RI for Site 47 was performed in several phases between 1999 and 2002 (CH2M HILL, 2003). The objectives were to: 1) characterize the geologic and hydrogeology of the area underlying and surrounding the site; 2) characterize the nature and extent of site-related contaminants in concrete troughs, surface soil, sediment, and groundwater; 3) determine the rate of migration of site-related contaminants in the environment; and 4) identify actual or potential human or environmental receptors and potential contaminant migration pathways. Figures 2-2 and 2-3 shows the RI sampling locations for surface soil, subsurface soil, concrete, surface water, sediment (includes sewer sediment), and groundwater samples.

The RI concluded that neither further evaluation nor remedial action is warranted for surface water, sediment, surface soil, concrete, and subsurface soil. However, the investigation indicated that further evaluation and potential remedial action is warranted for groundwater; for the most part due to chlorinated VOCs above the risk screening levels. Figure 2-4 shows the interpolated CT and chloroform isoconcentration lines. Figure 2-5 shows the interpolated tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE) isoconcentration lines.

As part of the RI, a human health risk assessment (HHRA) and a screening ecological risk assessment (SERA) were conducted. The results of the HHRA and SERA are presented in Section 2.7, Summary of Site Risks. The RI recommended that a Feasibility Study (FS) be performed and additional data be collected to further delineate the nature and extent of contamination in groundwater at Site 47.

Pre-FS Investigation

In 2004, a pre-FS investigation was conducted to further assess the viability of MNA as a remedial alternative for the shallow groundwater (CH2M HILL 2008). Field activities included installation of three monitoring wells, collection and analyses of groundwater samples from five existing and three new monitoring wells for VOCs and MNA parameters, collection and analysis of groundwater samples from four monitoring wells for target analyte list (TAL) metals/cyanide, performance of slug tests at two existing and one newly installed well to assess the horizontal and vertical hydraulic conductivities of the clay layer, and analysis of a soil sample for soil oxidant demand (SOD) to assess the viability of potassium permanganate as an ISCO reagent.

In general, the results indicated that MNA is a viable alternative for CT and PCE, and their breakdown products. The MNA parameters indicated a reducing condition of the shallow groundwater that would promote the mobilization of metals from the aquifer materials. The slug test resulted in a horizontal hydraulic conductivity range of 0.6 foot per day (ft/day) to

19.7 ft/day; vertical hydraulic conductivities from the clay layer ranged from 5.2×10^{-5} ft/day to 4.6×10^{-4} ft/day. The SOD results indicated that the SOD of soil at the site was too high, so the use of potassium permanganate would not be a viable ISCO reagent.

Baseline Ecological Risk Assessment

A BERA was conducted in 2004 to further evaluate potential ecological risks from metals and polycyclic aromatic hydrocarbon contamination in surface soil (0 to 6 inches below ground surface [bgs]), sediment (0 to 6 inches bgs), and surface water in the intermittent streams at the site (CH2M HILL, 2006). The results showed that no unacceptable risks were associated with site-related chemicals in the surface soil, sediment, or surface water. Therefore, no further action was recommended with regard to ecological risks related to these media. The results of the BERA are presented in Section 2.7, Summary of Site Risks.

Bench-scale Study

A bench-scale study was conducted in 2007 to evaluate technologies including ISCO using AAP and catalyzed hydrogen peroxide, and *in situ* chemical reduction (ISCR) using various particle sizes of zero valent iron (ZVI) (CH2M HILL, 2008). The objectives of the bench-scale study were to: (1) evaluate the effectiveness of select ISCO and ISCR technologies in treating a mixture of CT and PCE in the shallow aquifer, (2) determine the site-specific demand of reagents, and (3) identify potential side effects of the select technologies that may not be compatible with the current site use. The bench-scale study concluded that AAP is the most effective treatment reagent for CT and PCE, reducing their concentrations by more than 98 percent. In addition, because AAP is compatible with the current site setting and land uses, it is implementable. A pilot study was recommended to evaluate the performance of AAP at the site.

Feasibility Study

An FS was completed to address potential sources of contamination at Site 47 and to evaluate remedial alternatives to mitigate potential hazards associated with the shallow groundwater (CH2M HILL, 2008). The FS report presents the preliminary screening of the remedial technologies and process options for each general response action developed to meet the remedial action objectives (RAOs) for Site 47 shallow groundwater. Table 4-1 in the FS report presents the screening of the groundwater technologies and process options. The retained technologies and process options were: no action, land use controls (LUCs), MNA, ISCO, and ISCR. Further screening of the retained technologies or options is also discussed for ISCO and ISCR because these technologies cover a broad range of reagents that may not all be appropriate for use in Site 47 shallow groundwater.

Based on the results of the bench-scale study noted above, ISCR was eliminated because ISCR technologies using various particle forms of ZVI were found to be inefficient for treating both CT and PCE that are inferred to be present as dense non-aqueous phase liquid (DNAPL). Furthermore, ZVI application via mixing entails significant and prolonged interference with the daily operations of the facility. The technologies and process options that were retained for the remedial alternative assembly based on the bench-scale study were: no action, LUCs, ISCO technology using AAP as an oxidant, and MNA.

As a result, the two alternatives evaluated in the FS were (1) no action and (2) source area treatment using AAP, MNA, and LUCs (CH2M HILL, 2008). In the FS, COCs for the shallow groundwater were identified based on an assessment of a dataset that included data from the pre-FS (CH2M HILL, 2005), which was completed after the RI. The results for the shallow groundwater HHRA are presented in Section 2.7 of this ROD.

Pilot Study

A pilot study was conducted in 2009 and 2010 to accomplish the following: (1) to develop the design parameters for full-scale implementation of AAP; (2) to assess potential impacts of AAP on current site uses (explosives research and storage area); and (3) to assess the compatibility of AAP with MNA (CH2M HILL, 2011). Six monitoring wells (IS47MW19 through IS47MW24) and 28 nested injection wells (IS47IW01S through IS47IW14S and IS47IW01D through IS47IW14D) were installed to support the pilot study, which covered an area of approximately 3,500 square feet within the inferred DNAPL area (Figure 2-6). A total of 85,408 gallons of AAP, at concentrations ranging between 55 and 80 grams per liter, was injected into 14 pairs of shallow and deep injection wells. The AAP performance was evaluated after a baseline monitoring event and 2-month and 6-month post-injection events. The overall results indicated that AAP reduced CT and PCE concentrations over time. As of July 2010, CT and PCE concentrations in the saturated soil were reduced by approximately 90 percent and 61 percent, respectively; the reductions in CT and PCE concentrations in groundwater were observed to be 80 percent and 45 percent, respectively. The evaluation of CT and PCE reduction in groundwater was based on data that was collected from all wells except monitoring well IS47MW22 because of fluctuating concentrations and irregular trend patterns, thought to be attributed to residual DNAPL dissolution and mass transfer in that well. Figures 2-7 and 2-8 show the two- and three-dimensional plumes for CT at baseline and 6 months post-injection, respectively. Figures 2-9 and 2-10 show the two- and three-dimensional plumes for PCE at baseline and 6 months post-injection, respectively.

Proposed Plan

A Proposed Plan was completed to present the remedial alternatives evaluated and recommended for addressing contaminated shallow groundwater at Site 47 (CH2M HILL, 2012). The recommended alternative was AAP in the source area where CT and PCE are greater than 500 µg/L, MNA in the remaining area where the SRGs are exceeded, and ICs prohibiting residential development at the site and any use of the shallow groundwater until the SRGs are met, and restricting intrusive activities such as excavation. No further remedial action was presented for surface soil, subsurface soil, surface water, and sediment because no COCs were identified from the HHRA and SERA during the RI, or from the BERA.

2.2.3 Enforcement Activities

In September 1995, the NSF-IH facility, including Site 47, was placed on the National Priorities List. The Federal Facility Agreement provides for CERCLA-directed enforcement activities at Site 47. As a result, an RI, FS, and Proposed Plan have been completed for the Site 47.

2.3 Community Participation

The NSF-IH Restoration Advisory Board is made up of representatives from the community, EPA, MDE, and the Navy. Meetings are held two times a year to provide a forum for the exchange of information among all parties regarding Installation Restoration Program (IRP) activities.

In accordance with the requirements established in Sections 113 and 117(a) of CERCLA and the NCP at 40 Code of Federal Regulations (CFR) §300.430(f)(2), the RI report (CH2M HILL, 2003), FS report (CH2M HILL, 2008), and Proposed Plan (CH2M HILL, 2011) were made available to the public in December 2003, October 2008, and April 12, 2012, respectively. These documents, which are included in the Administrative Record file, can be found in the Information Repositories maintained at the following locations:

Indian Head Town Hall	**Charles County Public Library**	**Naval Support Facility Indian Head General Library**
4195 Indian Head Hwy. Indian Head, MD 20640	2 Garrett Ave. La Plata, MD 20646-5959	Building 620 (The Crossroads) 101 Strauss Avenue, Indian Head, MD 20640
(301) 743-5511 Hours: Monday through Friday 8:30 a.m. to 4:30 p.m.	(301) 934-9001; (301) 870-3520 Hours: Monday through Thursday 9 a.m. to 8 p.m. Friday and Sunday 1 to 5 p.m. Saturday 9 a.m. to 5 p.m.	(301) 744-4744 Hours: Monday through Friday 9 a.m. to 5:30 p.m. Saturday and Sunday - closed

The notice of the availability of the Proposed Plan was published in the *Maryland Independent* on April 11, 2012. A public comment period was held from April 12, 2012 to May 14, 2012. In addition, a public meeting was held on April 12, 2012 to present the Proposed Plan to a broader community audience.

At this meeting, representatives from the Navy, EPA, and MDE answered questions about the site and the remedial alternative. No written comments were received during the public comment period.

2.4 Scope and Role of Response Action

Site 47 is one of many sites in the IRP that are part of the comprehensive environmental investigation and cleanup activities currently being performed at NSF-IH under the CERCLA program. The status of all the IRP sites at NSF-IH can be found in the Site Management Plan (Tetra Tech, 2011), which is available in the Administrative Record. This ROD documents the final remedial action for Site 47 and does not include or affect any other sites at the facility.

2.5 Site Characteristics

Characteristics of the site, the nature and extent of contamination, and the human health and ecological risk assessments are presented in greater detail in the RI report (CH2M HILL, 2003) and in the FS report (CH2M HILL, 2008), and are summarized in the following sections.

2.5.1 Geology and Hydrogeology

Soil at Site 47 consists of sand and silty sand from the ground surface to an approximate depth of 7 to 24 feet bgs, depending on the surface elevation and location. Underlying the sand and silty sand is a dense, gray clay that appears to be more than 30 feet thick. The water table elevation ranges from 34.4 feet to 37.0 feet above mean sea level. Groundwater flows across the site to the southeast toward the Site 12 Pond and Mattawoman Creek.

2.5.2 Conceptual Site Model

The conceptual site model (CSM) integrates information regarding the physical characteristics of the site, potentially exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify exposure routes and receptors evaluated in the risk assessment. A well-defined CSM allows for a better understanding of the risks at a site and aids in evaluating the potential need for remediation. The potential source of contamination is the materials disposed of at the site, which could leach into the soil, and then leach from the soil to the shallow groundwater.

2.5.2.1 Human Health Receptors

Figure 2-11 presents the CSM for human receptors at Site 47. The site is located in the restricted area of NSF-IH. It is currently used as an industrial area. Human receptors under the current land use scenario are industrial site workers, maintenance workers, and trespassers. The current receptors could be exposed to surface soil, surface water, and/or sediment. Human receptors under the future land use scenario are industrial workers, maintenance workers, trespassers, adult and child residents, and construction workers. It was conservatively assumed that the site could be developed and used for residential activities in the future. Hypothetical future residential use of the site was evaluated to determine if land and groundwater use restrictions would be necessary at the site. However, the site is an industrial facility, and it is unlikely that the land use of the industrial facility will change in the future.

All potential future receptors could be exposed to surface and subsurface soil. Future industrial site workers, maintenance workers, and trespassers could be exposed to surface water and sediment. Although groundwater from the surficial aquifer is not anticipated to be used as a potable water supply at the base, future residents could be exposed to groundwater. Additionally, future construction workers could be exposed to groundwater during construction activities. In the future, the concrete troughs may be excavated, and construction workers may be exposed to the concrete debris during excavation activities through dermal contact and inhalation of dust.

2.5.2.2 Ecological Receptors

Figure 2-12 presents the CSM for ecological receptors at Site 47. Receptors include soil invertebrates and terrestrial wildlife in the upland portion of the site and benthic invertebrates, water column invertebrates, and amphibians in the downgradient stream. Receptors may be exposed to chemicals via direct contact with or ingestion of surface soil, surface water, or sediment and via trophic transfer through the food chain.

The data gathered in the RI and BERA suggested that concentrations of lead, mercury, silver, zinc, and polycyclic aromatic hydrocarbons are elevated in surface soils at Site 47,

possibly from past disposal activities (mercury is known to be present from past disposal). The data indicated that some contaminant transport has likely occurred through surface runoff along the main drainage ditch and into the stream downgradient of the site, as identified by the elevated concentrations of mercury and silver in the stream sediments. The extent of contaminant migration appears to be limited, however, because the farthest downgradient sample (off the western edge of Caffee Road) contained concentrations of constituents of potential concern (COPCs) below risk screening levels. The reach of the stream downstream of Caffee Road was remediated for mercury contamination associated with Site 8 in 1994. Therefore, although site-related chemicals from Site 47 may have been transported beyond Caffee Road, the removal action conducted for Site 8 would have remediated any Site 47-related chemicals in the sediments as well.

2.5.3 Nature and Extent of Contamination

The nature and extent of contamination for surface soil at Site 47 were determined based on data from the SI and RI. The summary provided below for surface soil is described in detail in Section 6 of the RI report (CH2M HILL, 2003). The nature and extent of contamination for subsurface soil, concrete, surface water, and sediment were determined based on data from the RI. The media summarized below are described in detail in Section 6 of the RI report (CH2M HILL, 2003). The nature and extent of contamination for the shallow groundwater were determined based on data from the RI and pre-FS investigation (CH2M HILL, 2005). The summary provided below for the shallow groundwater is described in detail in Sections 2.2.1 and 2.2.2 of the FS report (CH2M HILL, 2008). Detected constituents in all media were evaluated in the HHRA (Section 2.7.1) whereas detected constituents in surface soil, sediment, and surface water were evaluated in the SERA and BERA (Section 2.7.2). Figure 2-2 shows the locations of the surface soil, subsurface soil, concrete, surface water, and sediment samples. Figure 2-3 shows the locations of the groundwater samples.

Surface Soil

Surface soil sampling activities conducted at Site 47 consisted of collecting 12 samples (47SA01 through 47SA12) as part of the SI, and 21 samples (SS-01 through SS-12 and IS47SS14 through IS47SS22) as part of the RI.

VOCs were detected in 12 of 33 samples, with most of the detections from the north side of Building 856, and two locations in an area downslope of Building 856, east of Building 1794. One or more SVOCs were detected in each of the 33 samples, with the highest concentrations in samples collected from southwest of Building 856, and one sample from west of Building 766.

Metals were detected in all 33 samples. With a few exceptions, one or more of the surface soil samples contained one or more metals that exceeded the background 95 percent upper confidence limit (UCL) (Tetra Tech, 2002). Lead, mercury, and silver were detected in 32 out of 33, 26 out of 33, and 25 out of 33 samples, respectively. The highest concentrations were identified to the north of Building 856 and south of the southeast corner of Building 856. Because the detections were so widespread, a spatial trend was not apparent.

Explosives were analyzed in 16 of the 21 samples collected during the RI; they were not analyzed in samples collected during the SI. Nitroglycerin was detected in three samples (SS-02, SS-05, and SS-07) and nitrocellulose was detected in one sample (SS-06). Although all

of the samples with detections were collected within 25 feet of Building 856, the results exhibited no spatial trend of the explosive contamination because detections existed on the north, south, and southeast sides of the building.

Subsurface Soil

Nineteen subsurface soil samples (IS47SB01 through IS47SB15 and RI47SO13 through RI47SO16) were collected as part of the RI and analyzed for the following: 8 samples for VOCs and SVOCs, 13 for metals (of which 4 were analyzed for cyanide), 4 for explosives and perchlorate, and 6 for total organic carbon. VOCs were detected in 3 of 8 samples. One of the samples was collected south of the magazines between Buildings 854 and 856. One or more SVOCs were detected in 6 of 8 samples. Several metals were detected at each sample location; however, seven metals exceeded their respective background 95 percent UCL at five locations. Mercury was detected in four samples collected from the reported location of mercuric nitrate disposal. Explosives and perchlorate were not detected in any of the four samples analyzed. In addition, twelve subsurface soil samples (IS47SB20 through IS47SB25 and IS47SB20A through IS47SB25A) were collected in support of the pilot study. These data were not used for the nature and extent of contamination, but rather to evaluate the treatment technology and evaluate its effectiveness as a full-scale remedy.

Concrete

Two concrete core samples (CO-01 and CO-02), drilled 3 to 4 inches deep, were collected as part of the RI. The samples were collected near the corner of Building 856 from within concrete surface conduits coming out of Building 856 and into Building 856A. The samples were analyzed for SVOCs, metals, and explosives. SVOCs and explosives were not detected in either sample. Although several metals were detected, only lead was detected at concentrations (1,220 milligrams per kilogram [mg/kg] and 2,110 mg/kg) that may represent a disposal problem if the concrete is removed and disposed of. In that case, the concentrations can be evaluated in terms of the disposal requirements of the destination disposal facility.

Surface Water

Eleven surface water samples (IS47SW01, IS47SW02, IS47SW05 through IS47SW08, IS47SW10 through IS47SW12, RI47SW03, and RI47SW04) were collected as part of the RI. Samples were collected from the main drainage ditch, from swales north of Building 1769, from a swale east of Building 854, from swales east and northeast of Site 47, and from the Site 8 swale. VOCs were analyzed in all 11 samples and 2 VOC compounds were detected in 2 of the samples. Two of the 11 samples were also analyzed for target compound list (TCL) SVOCs, explosives, perchlorate, and metals (including cyanide). Two SVOC compounds and several metals were detected in both samples at concentrations below risk screening levels. Explosives and perchlorate were not detected in either sample.

Sediment

A total of seven sediment samples were collected, six samples from nearby streams (SD-01 through SD-04, IS47SD05, and IS47SD06) and one sample from an industrial wastewater discharge manhole (IW-91). The samples were analyzed as follows: all samples for VOCs, SVOCs, metals, and explosives; five samples for cyanide, nitroglycerine, nitroguanidine, and pentaerythritol tetranitrate (PETN); and two samples for perchlorate.

One VOC (TCE) compound was detected, at only one location. Several SVOCs were detected in all samples; those with elevated concentrations were collected in the drainage swale near Building 856. Numerous metals were detected, with the majority of the highest concentrations detected at location SD-01, which was next to a pipe below a small bridge that allows vehicular access to Building 856. Cyanide was detected at locations SD-02, SD-03, and SD-04, with a maximum concentration of 34 mg/kg. Except for nitroglycerine, which was detected in three of five samples, explosives, nitroguanidine, PETN, and perchlorate were not detected.

Groundwater

Groundwater data for nature and extent analysis during the RI were obtained using three types of sampling methods: membrane interface probe/electrical conductivity, direct-push technology (DPT), and permanent monitoring wells. A total of 39 membrane interface probe/electrical conductivity locations (MIP-1 through MIP-39) were profiled to better define the area of VOC contamination. A total of 43 *in situ* groundwater samples were collected using DPT (IS47GW01 through IS47GW12, RI47GW13 through RI47GW22, IS47GW23 through IS47GW42, and RI47SP01); 30 samples were analyzed for TCL VOCs, 10 samples for low concentration (LC) VOCs, and 12 samples for dissolved TAL metals. Fifteen permanent monitoring wells (IS47MW01 through IS47MW15) were installed. Samples were collected and analyzed for TCL VOCs and SVOCs, LC VOCs, TAL metals, cyanide, explosives, nitroglycerin, nitroguanidine, PETN, and MNA parameters. During the pre-FS investigation, eight wells were sampled for VOCs, and four monitoring wells were sampled for TAL metals/cyanide analysis.

High concentrations of chlorinated VOCs, specifically CT, PCE and TCE, and their respective breakdown products (chloroform or trichloromethane, methylene chloride or dichloromethane, and chloromethane) as well as 1,2-dichloroethane were detected in the immediate vicinity of Building 856. The concentrations of CT and PCE were at DNAPL levels (i.e., greater than 1 percent of the effective solubility limit [EPA, 2004b])[1], indicating a potential source in this area. Figure 2-6 shows the approximate boundaries of the suspected DNAPL area. Observed concentrations of CT and chloroform were highest east of Building 856 at the approximate location of the reported barium pit.

Approximately 20 metals were detected in total and dissolved groundwater samples. Ten of the metals (barium, calcium, chromium, cobalt, copper, magnesium, nickel, sodium, vanadium, and zinc) were detected at concentrations above their respective background 95 percent UCL. In general, increased concentrations of metals were observed in both total and dissolved samples in locations where concentrations of VOCs were elevated; this suggested potential metal mobilization from the aquifer materials because of the aquifer's reducing conditions.

2.6 Current and Potential Future Land and Resource Uses

Site 47 is located in a restricted area where access is tightly controlled and allowed only on an as-needed basis. The buildings within the site currently are used as offices and laboratories. The future use of the site is anticipated to remain industrial. No other land use

[1] The 1 percent pure solubility for CT and PCE are 7,930 µg/L and 2,000 µg/L, respectively

for Site 47 is planned by the Navy. It is highly unlikely that Site 47 would be developed for residential use. However, hypothetical future residential use of the site, including the groundwater resource, was evaluated in the risk assessment to assess whether restrictions would be necessary at the site. Shallow groundwater beneath the site is not used for any purpose. Although the Navy has no plans to develop the groundwater resource in the future, the shallow groundwater is considered to be a potential potable water source, and returning that groundwater to its potential beneficial use is an RAO for the site.

2.7 Summary of Site Risks

Detailed discussions of risks and the risk evaluation process are presented in the RI report (CH2M HILL, 2003), BERA report (CH2M HILL, 2006), and FS report (CH2M HILL, 2008).

2.7.1 Human Health Risk Assessment

As part of the RI, a baseline HHRA was performed for soil (surface soil, and combined surface and subsurface soil), surface water, sediment, concrete, and groundwater to evaluate the current and future effects of constituents in site media on human health. The baseline HHRA for groundwater was updated as part of the FS. A detailed discussion of the HHRA is provided in Section 8.2 in the RI report (for soil, surface water, concrete, and sediment) and Section 2.3 of the FS report (for groundwater).

The potential receptors evaluated in the HHRA were as follows:

- For current uses—adolescent trespasser/visitor (surface soil, surface water, and sediment), industrial worker (surface soil), and other worker (surface water, and sediment)
- For future uses—adult, child, and lifetime resident (soil and groundwater), adolescent trespasser/visitor (surface soil, surface water, and sediment), industrial worker (soil), construction worker (soil, concrete, and groundwater), and other worker (surface water, and sediment)

The HHRA was composed of four parts, as discussed below – identification of COPCs, exposure assessment, toxicity assessment, and risk characterization.

Identification of COPCs

The identification of COPCs was a conservative screening process that identified chemicals that may be present at the site at concentrations that could result in unacceptable risks to exposed receptors. The maximum detected concentration of each constituent in each medium (surface and subsurface soil, surface water, groundwater, sediment, and concrete) was compared to a human health risk-based screening value to identify the COPCs. If the maximum detected concentration of a constituent exceeded the screening value, the constituent was identified as a COPC and retained for further evaluation. The EPA Region III risk-based concentrations (RBCs) for residential receptors from the current version of the EPA Region III RBC table at the time the RI was prepared (EPA, 2003) were used as the screening levels to identify COPCs in the RI. The EPA tap water RBCs from the current version of the EPA Region III RBC table at the time the FS was prepared (EPA, 2004) were used as the screening levels to identify the COPCs for groundwater in the FS. The residential soil RBCs were used to screen the soil data; the ambient air RBCs were used to

screen the soil data for the soil-to-air exposure pathway; the tap water RBCs were used to screen the groundwater data; 10 times the industrial soil RBCs were used to screen the sediment and concrete data; and 10 times the tap water RBCs were used to screen the surface water data, as exposure to these media is much less than exposure to soil and groundwater. The RBCs that are based on cancer risk are conservatively set to represent an excess lifetime cancer risk (ELCR) of $1x10^{-6}$, or a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. The RBCs that are based on non-cancer effects are based on a target hazard index (HI) of 1. Therefore, to conservatively account for exposure to more than one non-cancer constituent that affects the same target organ (i.e., liver), the EPA Region III RBCs that were based on non-cancer effects were divided by 10 (EPA, 1993). Constituents eliminated from further evaluation at this step present minimal risks to exposed human receptors.

Section 8.3.3 and Table 8-2 of the RI report discuss the identification of COPCs for Site 47 soil, sediment, surface water, and concrete. Appendix D and Table D-1.2 of the FS report discusses the identification of COPCs for the Site 47 groundwater. The HHRAs identified the following COPCs for each media:

- Groundwater: 14 VOCs, 2 SVOCs, 14 metals
- Soil: 1 VOC, 5 SVOCs, 10 metals
- Sediment: 6 metals, 1 explosive
- Surface Water: 1 metal
- Concrete: 2 metals

Exposure Assessment

The exposure assessment defines and evaluates the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, identify potentially exposed populations, and estimate chemical intakes under the identified exposure scenarios. Actual or potential exposures are based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has three components: a source of chemicals that can be released into the environment, a route of contaminant transport through an environmental medium, and an exposure or contact point for a human receptor (Figure 2-11).The exposure pathways and human receptors evaluated in the HHRA were identified in Section 2.5.2.1, and Figure 2-11, the CSM for human receptors. Pathway-specific information for these receptors, such as the values of exposure parameters used to quantify exposure, is presented in Section 8.4.3 of the RI report.

Toxicity Assessment

Toxicity assessment weighs the available evidence regarding the potential for a particular chemical to cause adverse effects in exposed individuals and provides a numerical estimate of the relationship between the extent of exposure and possible severity of adverse effects. Toxicity assessment consists of two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining the potential adverse effects from exposure to a chemical. Dose-response assessment is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g.,

non-cancer reference doses [RfDs] and carcinogenic slope factors [CSFs]) are derived. These toxicity values are used in conjunction with the exposure assessment to estimate non-cancer hazards and cancer risks associated with exposure to the site media.

EPA has assessed the toxicity of many chemicals and has published the resulting toxicity information and toxicity values in the Integrated Risk Information System and Health Effects Assessment Summary Tables databases. Additionally, toxicity information is available from EPA's National Center for Environmental Assessment.

Health effects are divided into two broad groups: non-cancer effects and cancer effects. This division is based on the different mechanisms of action currently associated with each category. Chemicals causing non-cancer health effects were evaluated independently from those having cancer effects. Some chemicals may produce both non-cancer and cancer effects, and were evaluated in both groups. Non-cancer health effects are evaluated using the RfDs. Cancer risks are evaluated using CSFs. Section 8.5 in the RI report provides more detail about the toxicity assessment.

Risk Characterization - Methodology

The risk characterization summarizes and combines results of the exposure and toxicity assessments to characterize baseline risks. For carcinogens, risk is generally expressed as the incremental probability of an individual developing cancer over a lifetime of exposure to the carcinogen. ELCR is calculated from the following equation:

$$ELCR = CDI \times CSF$$

where:

ELCR = a unitless probability (for example, 33 percent) of an individual's developing cancer that is in addition to the incidence of cancer in the general population unaffected by these releases

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

CSF = carcinogenic slope factor, (cancer potency factor) expressed as $(mg/kg\text{-}day)^{-1}$

These risks are probabilities that are usually expressed in scientific notation. An ELCR of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure (RME) estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. The RME is the highest exposure that is reasonably expected to occur at a site. This is referred to as an ELCR because exposure to site conditions results in an additional risk in addition to the risks of cancer from other causes, such as smoking. EPA's generally acceptable ELCR range for site-related exposure is 1E-04 to 1E-06 (1 in 10,000 to 1 in 1,000,000).

The potential for non-cancer effects is evaluated by comparing an exposure level over a specified time period with an RfD, the dose at which no adverse health effects are expected to occur, derived for a similar exposure period. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ of less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD and that toxic non-cancer effects from that chemical are unlikely. The HI is generated by adding the HQs for all COPCs that affect the same target organ (e.g., liver) or that act through the same mechanisms of action within a medium or

across all media to which a given individual may reasonably be exposed. An HI of less than 1 for each target organ indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic non-cancer effects from all contaminants are unlikely. An HI greater than 1 indicates that site-related exposures may present an unacceptable risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

CDI and RfD are expressed in the same units and represent the same exposure period (chronic, subchronic, or short term). The CDI for HQ calculations may not be the same as that used in the ELCR calculations.

A detailed discussion of the risk characterization is provided in Section 8.6.1 of the RI report. Section 8.7 in the RI report presents the uncertainty analysis for the HHRA. The uncertainties associated with each component of risk assessment (COPC identification, exposure assessment, toxicity assessment, risk characterization) ultimately contribute to uncertainty in risk assessment. Uncertainty associated with COPC identification is associated with the data used in the HHRA and the methodology used to identify the COPCs. Background data were not used to identify COPCs, and therefore, some of the COPCs may not necessarily be associated with historic site use and may be associated with background conditions. The uncertainty in associated with the data is minimal, based on the amount of data available for the site and because the data have been validated. The general assumptions used in the COPCs selection are conservative to ensure the estimation of highest possible risk. Uncertainty associated with the exposure assessment will generally result in overestimation of risk as the exposure factors used for quantitation of exposure are conservative and reflect worst-case or upper-bound assumptions on the exposure. Additionally, exposure to the soil, concrete, groundwater and sediment is assumed to occur at the areas with the highest detected concentrations, which is a much smaller area than a receptor's area of operations during work hours or activity duration. Uncertainty associated with the toxicity assessment also most likely results in overestimation of the risks and hazards since many uncertainty and modifying factors are used to derive the toxicity factors used in the HHRA. The addition of the estimated risks and HIs across pathways and chemicals contributes to uncertainty based on the interaction of chemicals such as additivity, synergism, potentiation, and susceptibility of exposed receptors.

RME non-cancer hazards and cancer risks were calculated for all receptors identified in the exposure assessment. Central tendency exposure (CTE) hazards were calculated when the RME hazards were above 1, CTE cancer risks were calculated when the RME cancer risks were above 10^{-4}. The CTE is an estimate of the average exposure that could be experienced by a receptor at the site.

Risk Characterization - Results

The risk assessment calculation tables are provided in Appendix H of the RI for the soil, surface water, and sediment, and in Appendix D of the FS report for groundwater. The Table 9 series in Appendix H of the RI and in Appendix D of the FS summarize the potential hazards and risks to each receptor for soil, surface water, and sediment, and groundwater,

respectively. The Table 10 series in both appendices show only those pathways with total HIs greater than 1.0 or total carcinogenic risks greater than 10-5.

The HHRA concluded that under current site use conditions, surface soil does not pose unacceptable risks (both non-cancer and cancer) to adolescent trespassers/visitors or industrial workers, and surface water and sediment do not pose unacceptable risks to adolescent trespassers/visitors and maintenance workers. Under future land use conditions, soil does not pose unacceptable risks (both non-cancer and cancer) to any of the potential receptors. Additionally, exposure to the concrete by construction workers does not result in any unacceptable risks.

The HHRA for groundwater in the FS concluded that under future site use conditions, potable use of shallow groundwater would pose unacceptable risks (both non-cancer and cancer) to residents, and contact with groundwater in an excavation by construction workers would pose unacceptable risks to construction workers.

Table 2-1 summarizes the results of the HHRA. The main risk drivers in the shallow groundwater are:

- VOCs (primarily CT, chloroform, PCE, TCE) and metals (primarily arsenic, cyanide, iron, thallium, and vanadium) through ingestion and dermal contact
- VOCs (primarily 1,2-dichloroethane, CT, chloroform, and PCE) through inhalation

2.7.2 Ecological Risk Assessment

A SERA was conducted as part of the Site 47 RI to estimate the risks the site poses to ecological receptors. The SERA provided a conservative assessment of potential ecological risk. The methodology and detailed results of the SERA are provided in Section 9 of the RI report. The results of the SERA indicated there were potentially unacceptable risks to ecological receptors from site-related chemicals. COPCs for each receptor group are listed below:

- Soil Invertebrates and Plants. HQs for PCE, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, pentachlorophenol, phenanthrene, pyrene, aluminum, cadmium, chromium, copper, cyanide, iron, lead, mercury, silver, vanadium, and zinc exceeded 1.
- Insectivorous Terrestrial Birds. HQs for aluminum, cadmium, chromium, cobalt, copper, lead, mercury, selenium, vanadium, and zinc exceeded 1.
- Herbivorous Birds. HQs for aluminum, chromium, lead, mercury, and zinc exceeded 1.
- Carnivorous Birds. HQs for aluminum, lead, and mercury exceeded 1.
- Omnivorous Terrestrial Mammals. HQs for aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, mercury, selenium, silver, thallium, vanadium, and zinc exceeded 1.

- Carnivorous Terrestrial Mammals. HQs for aluminum, iron, lead, mercury, and vanadium exceeded 1.

Data Collected to Fill Data Gaps

After the SERA was completed, a data gap was identified and additional samples were collected to fill this data gap. Because some contaminants were detected above screening levels in soil in the main drainage ditch, and the nature and extent of contamination along the ditch had not been fully defined, sediment and surface water samples were collected in the stream downgradient of the site. The purpose of the supplemental investigation was to determine if contamination has been transported south along the drainage ditch by surface water runoff into the stream. Sampling downstream of Caffee Road was unnecessary in defining the nature and extent of contamination related to Site 47 because this reach of the stream was remediated as a result of contamination associated with Site 8.

Sediment and Surface Water in the Stream

The stream at Site 47 is very shallow, bordering on intermittent, and as such provides no viable habitat for fish or aquatic birds. However, it does provide habitat for amphibians and aquatic invertebrates. Two metals (mercury and silver) and two SVOCs (diethylphthalate and phenanthrene) were identified as COPCs for the sediments. Four metals (aluminum, iron, manganese, and zinc) were identified as COPCs for surface water in the stream. The only upper-trophic-level receptor group evaluated for this area was semiaquatic mammals, represented by raccoon, for which no risks were identified.

Baseline Ecological Risk Assessment

Because the SERA identified several COPCs that could pose risks to invertebrates, plants, herbivorous birds and mammals, carnivorous terrestrial birds and mammals, and omnivorous mammals, a BERA was conducted to collect site-specific risk data and refine the risk estimates for the COPCs. The detailed methodology and results of the BERA are presented in CH2M HILL (2006).

The results of the BERA showed that: (1) the COPCs in the surface soil at Site 47 do not pose unacceptable risk to soil invertebrates, birds, and mammals; (2) sediment at the site appears to be toxic to benthic invertebrates; however, the cause of the toxicity does not seem to be related to COPCs identified in the sediment, surface soil, or groundwater at the site (see further discussion below regarding supplemental sampling); and, (3) the concentrations of aluminum, iron, and manganese in the surface water at the site could pose an unacceptable risk to larval amphibians or water column organisms; however, the presence of these metals appears to be related to the natural background levels of these metals in soils and groundwater at NSF-IH. Sections 5.2 and 5.3 of the BERA report present the uncertainty and conclusions, respectively.

Following the BERA, a supplemental sampling and chemical analysis of site sediments was conducted because of the uncertainty surrounding the cause of the toxicity observed in the laboratory bioassays and the potential lack of a connection between the toxicity and site-related chemicals, as described in Section 4.3 of the BERA report. To address this uncertainty and aid in risk management for the site, five additional sediment samples were collected from the drainage ditch and analyzed for a full suite of analytical parameters. The results of this sampling event are documented in a technical memorandum, *Site 47*

Supplemental Baseline Ecological Risk Assessment Investigation Results, Naval Support Facility, Indian Head (Appendix F of the BERA Report). Four pesticide compounds (dichlorodiphenyldichloroethane [4,4'-DDD], dichlorodiphenyldichloroethylene [4,4'-DDE], dichlorodiphenyltrichloroethane [4,4'-DDT], and endrin ketone) were detected in the sediment samples at concentrations that exceeded ecological screening values. The detected concentrations did not reflect concentrations expected from potential releases from Site 47. These results suggested that pesticides might be the causal agents responsible for the observed toxicity.

In summary, only risks to potential receptors were identified from exposure to sediment of the drainage ditch; however, these risks are not directly related to contaminants from Site 47 because the toxicity could not be attributed to COPCs identified in the sediment, surface soil, or groundwater at the site. Moreover, the drainage ditch is relatively small and provides only low-quality aquatic and terrestrial habitat. Therefore, no further action is proposed for Site 47 with regard to ecological risk. Table 2-2 summarizes the results of the BERA for Site 47.

2.8 Remedial Action Objectives

Based on the evaluation of site conditions, an understanding of the contaminants, the physical properties in media of concern, the results of the risk assessments, and an analysis of ARARs, the following RAOs for Site 47 shallow groundwater were developed:

- Prevent unacceptable risks to human receptors from exposure to contaminants in the shallow groundwater.
- Prevent migration of the contaminants in the shallow groundwater at unacceptable concentrations (above SRGs) from Site 47 to uncontaminated media.
- Return the shallow groundwater to its beneficial use to the extent practicable.

To achieve the RAOs, risk-based preliminary remediation goals (PRGs), and subsequently SRGs, were developed for the COCs in groundwater. PRGs were calculated for potential future residents (adult, child, and lifetime) and construction worker, although it is unlikely that the site will become a residential area. Future potable use of groundwater in the area around Site 47 is unlikely, as documented in the RI report (CH2M HILL, 2003). Appendix D of the FS report presents detailed calculations of the PRGs for groundwater. The PRGs were then compared to the facility-wide background concentrations and maximum contaminant levels (MCLs) for all COCs to determine the SRGs. To be conservative, the PRGs for the construction workers scenario were not carried forward to the SRG determination. Because a maximum contaminant level is not available for 1,1,2,2-tetrachloroethane, a health advisory value equivalent to a concentration at $1x10^{-4}$ cancer risk was used. Table 2-3 summarizes the selection of the SRGs for the COCs in shallow groundwater. Section 3.4 of the FS report presents details on development of the SRGs.

Although SRGs were established for all COCs, groundwater remediation will target only those COCs whose maximum detected concentration exceeded the SRGs. If the maximum concentration was greater than the SRG, the COC was retained for remediation; if the maximum concentration was less than the SRG, the COC was eliminated from requiring

remediation. As a result of this comparative analysis, all COCs that require remediation are shown on Table 2-4. Although current concentrations of vinyl chloride do not exceed SRGs, it is included in Table 2-4 because it is a degradation product of other COCs, and concentrations could temporarily rise during remediation. The area of attainment (AA) is defined as the area over which the RAOs, and, therefore, the SRGs, are to be met. Figures 2-6 and 2-13 show the AA. The area of the AA covers approximately 215,400 square feet (4.94 acres).

The AA consists of a source area and dissolved plume area. The source area is defined by the potential presence of separate-phase[2] contaminants or the area where the aqueous phase concentrations of the primary contaminants, PCE or CT, were greater than 500 µg/L. The target concentration of 500 µg/L was selected during the remedial alternative development in the FS. A modeling exercise was conducted to estimate the remediation timeframe and uncertainties with relying on MNA processes as a sole remedy. The projected remedial timeframes indicated that sole reliance on MNA processes to treat the DNAPL source zone was not feasible; therefore, active source area treatment was recommended to expedite the overall remediation timeframe. A target concentration for CT and PCE to be reached during active source area treatment, which would result in a reasonable remediation timeframe (less than 30 years) if MNA processes were used as a polishing step to achieve the SRGs, was calculated. It was determined that a target concentration of 500 micrograms per liter (µg/L) for both CT and PCE would allow MNA processes to achieve the SRGs within 52 years. Although 52 years is longer than the ideal 30-year remediation timeframe, the Navy and regulators agreed that 52 years was a reasonable remediation timeframe for Site 47.

Within the source area is the residual DNAPL area with CT and PCE concentrations higher than 10,000 µg/L. The source area is in the immediate vicinity of monitoring wells IS47MW03 and IS47MW04. The dissolved plume area is the area outside the source area where concentrations of CT and PCE were less than 500 µg/L but exceeded the SRGs and where concentrations of other COCs requiring remediation exceeded the SRGs. Figure 2-13 shows the source area and the dissolved plume area for Site 47 shallow groundwater. The source area and inferred residual DNAPL area encompass approximately 12,541 square feet (0.19 acres) and 2,075 feet (0.05 acre), respectively. Using an average contaminated zone thickness of 12 feet, the bulk volume of contaminated media within the AA, the source area, and the inferred residual DNAPL area cover 2.6 million cubic feet, 74,603 cubic feet, and 6,350 cubic feet, respectively. The volumes of contaminated groundwater calculated using an effective porosity of 0.3 (assumed for the lithology present) are 5.8 million gallons, 167,421 gallons, and 14,250 gallons, respectively.

2.9 Summary Descriptions of Remedial Alternatives

A detailed description of each remedial alternative is provided in Section 5.1 of the FS report. A summary of the two alternatives is presented below. The summary of estimated remediation costs and timeframes is presented in Appendix F of the pilot study report.

Alternative 1—No Action: This alternative is required by NCP §300.430(e)(3)(ii) to be evaluated as a baseline. Under this alternative, no remediation is planned.

[2] The separate-phase CT and PCE may be trapped below the water table by capillarity and surface tension forces.

Alternative 2—Source Area Treatment Using ISCO, MNA, and ICs: This alternative consists of:

- ISCO using AAP in the source area where CT and PCE concentrations are greater than or equal to 500 µg/L.
- MNA for the remaining dissolved plume and the source area following the active treatment with AAP.
- Short-term ISCO performance sampling at baseline and 2-, 6-, and 9-month post-ISCO.
- Long-term groundwater monitoring for 52 years or until SRGs are met.
- 5-year reviews until SRGs are met.
- ICs in the form of land and groundwater use restrictions as detailed in Section 2.12.2.

These components represent a conceptual approach to Alternative 2. The design for the selected remedy, IC plan, and long-term monitoring plan will be prepared after the ROD has been signed.

2.10 Summary of Comparative Analysis of Alternatives

The NCP outlines the approach for comparing remedial alternatives at 40 CFR §300.430(f)(5)(i). Evaluation of the alternatives uses "threshold," "primary balancing," and "modifying" criteria. To be considered for remedy selection, an alternative must meet the following threshold criteria:

- Overall protection of human health and the environment - This criterion addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or ICs.
- Compliance with ARARs - Section 121(d) of CERCLA and 40 CFR §300.430(f)(1)(i)(A) require that remedial actions at CERCLA sites at least attain federal and state ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4).

The primary balancing criteria are then considered to determine which alternative provides the best combination of attributes. The primary balancing criteria are:

- Long-term effectiveness and permanence - This criterion refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. It also considers residual risk that will remain onsite following remediation and the adequacy and reliability of controls.
- Reduction in toxicity, mobility, or volume through treatment - This criterion refers to the anticipated performance of the treatment technologies that may be included as part of the remedy.
- Implementability - This criterion addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability

of services and materials, administrative feasibility, and coordination with other entities are considered.

- Short-term effectiveness - This criterion addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.
- Cost – This criterion refers to costs associated with construction and operation of the remedy; these include capital costs, operation and maintenance costs, and present-worth costs.

The alternatives are evaluated further against the two modifying criteria:

- Acceptance by the state
- Acceptance by the community

A comparative analysis for the threshold and primary balancing criteria was conducted in the FS for the two remedial alternatives based on the criteria set forth by the NCP. Alternative 2 is protective of human health and the environment and complies with the site-specific ARARs. Alternative 1 is neither protective of human health and the environment nor complies with ARARs. Because Alternative 1 does not satisfy the threshold criteria, it will not be evaluated using the remaining criteria.

Alternative 2 achieves long-term effectiveness and permanence, and will reduce the toxicity, mobility, or volume of contaminants through treatment. Alternative 2 offers adequate protection of human health and the environment through active source treatment and implementation of ICs. Alternative 2 is projected to achieve the source treatment goal within 2 years and comply with SRGs in 52 years, making the alternative in compliance with the relevant location-, action-, and chemical-specific ARARs. Alternative 2 significantly decreases the magnitude of residual risk within an acceptable timeframe. Although Alternative 2 may pose an adverse short-term safety risk to remediation workers due to handling of high volumes of chemicals, the remedy aggressively reduces the toxicity, mobility, and volume of contamination through treatment. The short-term risks can be minimized and/or negated with proper safety training and controls. Alternative 2 is readily implementable at the site because it is a conventional remedy, and has been used successfully at numerous other National Priorities List sites.

MDE has been involved throughout the decision making process at Site 47. Alternative 2 is acceptable to MDE. During the public comment period, the community did not provide any comments or voice any objections to the preferred alternative or the other alternative considered.

Table 2-5 presents the comparative analysis for the threshold and primary balancing criteria for the two RAs. Section 6 of the FS report provides a detailed description of the comparative analysis of the remedial alternatives.

2.11Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to address "principal threats" posed by a site wherever practicable (40 CFR Section 300.430 (a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. A source material is one that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or act as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material. Because the concentrations of chlorinated VOCs are at DNAPL levels, they may be viewed as source material and represent principal threats in the shallow groundwater.

The CT that is inferred to be present as DNAPL represents the principal threat for the shallow groundwater at Site 47. The DNAPL is "highly toxic" and serves as a continuing source for the contamination in the shallow groundwater. The selected remedy includes a treatment technology that will be used to permanently reduce the toxicity, mobility, and volume of the DNAPL, if present, to the maximum extent practicable.

2.12 Selected Remedy

The Selected Remedy for Site 47 is Alternative 2 – Source Zone Treatment using ISCO, MNA, and ICs. Figure 2-13 shows the AA, the proposed remedial action area, and the IC boundary.

2.12.1 Summary of the Rationale for the Selected Remedy

The rationale for choosing the Selected Remedy was based on its effectiveness demonstrated during the bench-scale study and pilot study. These studies indicated that ISCO using AAP is effective in reducing COC concentrations, compatible with natural attenuation processes, limits negative effects on mission operations, and will achieve RAOs in a reasonable timeframe. Additional details for selecting Alternative 2 are also documented in Section 2.10.

2.12.2 Description of the Selected Remedy

The components of this alternative include the following:

- ISCO using AAP in the source area where CT and PCE concentrations are greater than or equal to 500 µg/L.
- MNA for the remaining dissolved plume and the source area following the active treatment with AAP.
- Short-term ISCO performance sampling at baseline and 2-, 6-, and 9-month post-ISCO. Short-term performance sampling results will be evaluated to determine the effectiveness of ISCO in addressing contamination in the shallow groundwater; identify metal mobilization potential downgradient of the site; and assess natural attenuation parameters for attenuation potential of COCs. Based on the outcome of the evaluation,

the Navy and EPA, in consultation with MDE may consider whether additional action is needed to ensure that SRGs are achieved.

- Long-term groundwater monitoring for 52 years or until SRGs are met. Following that, cumulative residual risk will be estimated when the SRGs are met to confirm that public health is sufficiently protected. The long-term monitoring program would consist of performance monitoring of the ISCO within the source area during the first 2 years, and of the MNA for the remaining 50 years. The cost estimate assumed that the groundwater monitoring would be conducted on a quarterly basis from years 1 to year 3, and annually from year 4 to year 52.
- 5-year reviews until SRGs are met.
- ICs in the form of land and groundwater use restrictions. Also, any future building construction would require an evaluation of potential human health risks from vapor intrusion. The site will be designated as "restricted use" area in the NSF-IH system, which would remain in place until groundwater monitoring indicates that the SRGs have been met. This designation would place restrictions on intrusive activities such as excavation, and prohibit residential development and any use of the shallow groundwater. The IC area encompasses the AA, which is depicted on Figure 2-13. The requirements of the ICs will be integrated into the Comprehensive Work Approval Process (CWAP) system and made into one of the criteria in the CWAP approval for any future work at the site. The ICs will remain in effect as long as contaminants remain at the site at levels that do not allow for unlimited use and unrestricted exposure.

The Navy will be responsible for implementing, maintaining, periodic reporting on, and enforcing the ICs in accordance with the IC plan. Although the Navy may transfer these responsibilities to another party by contract, property transfer agreement, or other means, the Navy shall remain ultimately responsible for the remedy integrity and shall: 1) perform CERCLA 121(c) 5-year reviews; 2) notify the appropriate regulators and/or local government representatives of any known IC deficiencies or violations; 3) provide access to the property to conduct any necessary responses; 4) retain the ability to change, modify, or terminate ICs and any related deed or lease provisions; and 5) ensure that IC objectives are met to maintain remedy protectiveness.

2.12.3 Summary of Estimated Remedy Costs

Estimated costs for the Selected Remedy are summarized in Tables 2-6 and 2-7. The capital cost of approximately $2.71 million is associated with submitting the work plans, installing new groundwater monitoring wells, injection of AAP, baseline and short-term performance monitoring, and land-use control plan as part of the ICs. O&M activities are mostly associated with the long-term groundwater monitoring to assess the performance of the ISCO technology and the rate of natural attenuation. Periodic costs incurred are primarily associated with the 5-year reviews. The present-worth lifetime O&M cost is approximately $1.46 million, and the total present-worth value of this alternative is estimated at $4.16 million (Table 2-7).

2.12.4 Estimated Outcomes of Selected Remedy

No future land use changes are projected for Site 47. No community impacts from the selected remedy are expected. The anticipated environmental benefit of the Selected Remedy is to achieve the RAOs. The shallow groundwater at Site 47 is currently not used as potable water and will not likely be used as a potable water supply in the future. Table 2-8 summarizes the outcomes of the Selected Remedy.

2.13 Statutory Determinations

Remedial actions must meet the statutory requirements of Section 121 of CERCLA. Remedial actions undertaken at National Priorities List sites must achieve adequate protection of human health and the environment, comply with the ARARs of both federal and state laws and regulations, be cost-effective, and use, to the maximum extent practicable, permanent solutions and alternative treatment or resource recovery technologies. In addition, CERCLA states a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, and/or mobility of hazardous waste as the principal element and a bias against offsite disposal of untreated wastes. The following discussion summarizes the statutory requirements that are met by the Selected Remedy.

2.13.1 Protection of Human Health and the Environment

The Selected Remedy is considered protective of human health and the environment. This alternative would actively treat the COC mass in the source area and, therefore, minimize the migration of unacceptable COC concentrations into potentially affected uncontaminated media that may occur via natural groundwater flow pattern. Following the completion of the active treatment, natural attenuation processes would be used as the primary treatment mechanism to degrade the COCs to achieve the SRGs. Under this alternative, the RAOs and, therefore, the SRGs, would be achieved.

2.13.2 Compliance with ARARs

The Selected Remedy will comply with the chemical, location-, and action-specific ARARs identified in Tables 2-9, 2-10, and 2-11, respectively— specifically, the action-specific application of chemicals into the subsurface, which will be achieved through best management practices and compliance with state guidance.

2.13.3 Cost Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (40 CFR §300.430(f)(1)(ii)(D)). This conclusion was reached by evaluating the overall effectiveness of the alternative that satisfied the threshold criteria. Overall effectiveness was evaluated by assessing the five balancing criteria in combination. Overall effectiveness was then compared to cost to assess cost-effectiveness. The relationship of the overall effectiveness of the Selected Remedy was found to be proportional to its cost, and, therefore, represents a reasonable value for the money to be spent.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

The Selected Remedy fully satisfies the long-term effectiveness and permanence criterion, while treating the source materials constituting principal threats at the site. Based on the results of the pilot study, AAP will decrease the concentrations of the COCs in the shallow groundwater.

The Navy, EPA, and MDE have concluded that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practical manner at Site 47. The Navy, EPA, and MDE believe that the Selected Remedy provides the best balance of tradeoffs in terms of the balancing criteria, while also considering state and community acceptance.

2.13.5 Preference for Treatment as a Principal Element

The Selected Remedy addresses principal threats posed by the site through the use of treatment technologies. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

2.13.6 5-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, pursuant to 40 CFR §300.430(f)(4)(ii), the Navy will conduct a statutory remedy review within 5 years after initiating the remedial action and every 5 years thereafter to ensure that the remedy continues to provide adequate protection of human health and the environment.

2.14 Documentation of Significant Changes

The Selected Remedy is the same alternative as the recommended alternative in the Proposed Plan that was presented at a public meeting on April 12, 2012.

TABLE 2-1

HHRA Risk Characterization Results Summary

Site 47 Record of Decision

NSF-IH, Indian Head, Maryland

Receptor	Current Land Use		Future Land Use	
	Carcinogenic Risk	Non-Carcinogenic Hazard	Carcinogenic Risk	Non-Carcinogenic Hazard
Shallow Groundwater				
Construction Worker	NA	NA	Not Acceptable (CR = 3.5E-04)	Not Acceptable (HI = 265)
Adult Resident	NA	NA	Not Acceptable (CR = 1.6E-01)	Not Acceptable (HI = 6,486)
Child Resident	NA	NA		Not Acceptable (HI = 4,199)
Surface Soil				
Industrial Worker	Acceptable (CR = 1.8E-05)	Acceptable (HI = 0.4)	NA	NA
Trespasser/Visitor Adolescents	Acceptable (CR = 7.6E-06)	Acceptable (HI = 1.2; considered acceptable because no individual target organ HI > 1)	Acceptable (CR = 7.6E-06)	Acceptable (HI = 1.2; considered acceptable because no individual target organ HI > 1)
Soil (Combined Surface and Subsurface Soil)				
Construction Worker	NA	NA	Acceptable (CR = 8.2E-07)	Acceptable (HI = 0.9)
Industrial Worker	NA	NA	Acceptable (CR = 2.4E-05)	Acceptable (HI = 1.4; considered acceptable because no individual target organ HI > 1)
Adult Resident	NA	NA	Acceptable (CR = 2.9E-05)	Acceptable (HI = 0.7)
Child Resident	NA	NA		Acceptable (HI = 2.5; considered acceptable because no individual target organ HI > 1)
Surface Water				
Other Worker	Acceptable (CR = 4.1E-07)	Acceptable (HI = 0.003)	Acceptable (CR = 4.1E-07)	Acceptable (HI = 0.003)
Trespasser/Visitor Adolescents	Acceptable (CR = 4.2E-07)	Acceptable (HI = 0.007)	Acceptable (CR = 4.2E-07)	Acceptable (HI = 0.007)
Sediment				
Other Worker	Acceptable (CR = 1.5E-05)	Acceptable (HI = 0.5)	Acceptable (CR = 1.5E-05)	Acceptable (HI = 0.5)
Trespasser/Visitor Adolescents	Acceptable (CR = 2.9E-06)	Acceptable (HI = 0.6)	Acceptable (CR = 2.9E-06)	Acceptable (HI = 0.6)
Concrete Troughs				
Construction Worker	NA	NA	Acceptable (CR = 3.4E-08)	Acceptable (HI = 0.005)

Notes:

HI - hazard index

CR - cancer risk

NA - Not evaluated because it is not applicable, pathway incomplete

Acceptable - HI < 1 and/or target organ HI < 1 for non-carcinogenic hazard and carcinogenic risks below range of $1x10^{-4}$ to $1x10^{-6}$

Risk values are taken from the RME evaluation; numbers indicate the total risk from ingestion, dermal contact, and inhalation

Exposure to lead – evaluated for groundwater, soil, sediment, and concrete troughs using adult lead model for industrial workers and Integrated Exposure Uptake Biokinetic model for child residents; findings indicated no adverse effects associated with lead in soil, sediment, and concrete troughs. Lead was identifed as a contaminant of potential concern in groundwater and exceeded the screening level.

TABLE 2-2
ERA Risk Characterization Results Summary
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Receptor	Risk
Surface Soil	
Soil invertebrates	Acceptable
Terrestrical plants	Acceptable
Herbivorous birds and mammals	Acceptable
Insectivorous birds and mammals	Acceptable
Carnivorous birds and mammals	Acceptable
Surface Water	
Aquatic plants	Acceptable
Invertebrates and larval amphibians	Potentially unacceptable from aluminum, iron, and manganese - likely due to background conditions, not site-related.
Sediment	
Benthic invertebrates	Unacceptable - not attributed to other site-relatated COPCs, likely due to historic permitted use of pesticides, no evidence of site-related release.

TABLE 2-3
Summary of SRGs in Shallow Groundwater
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

COC	Facility-wide Background Concentration (µg/L)	EPA MCL (µg/L)	Human Health Risk-Based PRG (µg/L)	
			Residential	Construction Worker
VOCs				
Carbon disulfide	NA	NA	1,324	NA
Carbon tetrachloride	NA	5	0.057	63.3
Chloroform	NA	80[a]	24	2,437
1,2-Dichloroethane	NA	5	0.084	NA
cis-1,2-Dichloroethene	NA	70	72	NA
1,1,2,2-tetrachloroethane	NA	20[b]	0.06	NA
Tetrachloroethene	NA	5	0.015	455
Trichloroethene	NA	5	0.065	NA
Vinyl Chloride	NA	2	0.004	NA
Inorganics				
Arsenic	ND	10	0.044	NA
Iron	49,869	NA	4,662	NA
Thallium	NA	2	0.18	NA
Vanadium	20.9	NA	12.4	111

Notes:

COC - constituent of concern

SRG - site remediation goal

PRG - preliminary remediation goal

µg/L - microgram(s) per liter

MCL - maximum contaminant level

ND - not detected

NA - no standard available or not applicable

Bold font indicates the SRG

[a] Under review. Value is as total trihalomethanes

[b] Health advisory value, concentration at 1E-04 cancer risk

TABLE 2-4
COCs Requiring Remediation
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

COC	Maximum Concentration (µg/L)	Frequency of Detection	SRG (µg/L)	Basis	Source Area Remediation?	Dissolved Plume Area Remediation?
Carbon disulfide	4,700	7/24	1,324	PRG	Yes	No
Carbon tetrachloride	100,000	8/25	5	MCL	Yes	Yes
Chloroform	39,000	11/25	80	MCL	Yes	Yes
1,2-Dichloroethane	61	7/25	5	MCL	Yes	Yes
cis-1,2-Dichloroethene	120	9/25	72	PRG	Yes	Yes
1,1,2,2-tetrachloroethane[1]	8	2/24	20	PRG	Yes	No
Tetrachloroethene	2,700	9/25	5	MCL	Yes	Yes
Trichloroethene	210	10/25	5	MCL	Yes	Yes
Vinyl Chloride[2]	2	2/25	2	MCL	Yes	No
Arsenic	147	8/14	10	MCL	Yes	Yes
Iron	61,100	13/14	49,869	Background	Yes	Yes
Thallium	6.5	4/14	2	MCL	Yes	Yes
Vanadium	239	4/14	20.9	Background	Yes	Yes

Notes:

Information was generated from monitoring well data collected through the pre-FS investigation (April 2001, June 2002, September 2002, July 2004)

[1] Although the maximum concentration for 1,1,2,2-tetrachloroethane does not exceed the SRG, the constituent is retained as a COC requiring remediation in the source area because it drives the technology for the active remediation and the chemical oxidant being used.

[2] Vinyl chloride is included as a COC requiring remediation because it is a degradation product of other COCs (Refer to Section 2.8)

COC - constituent of concern

SRG - site remediation goal

PRG - preliminary remediation goal

µg/L - microgram(s) per liter

MCL - maximum contaminant level

ND - not detected

NA - no standard available or not applicable

TABLE 2-5
Comparative Analysis of Remedial Alternatives
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Source Area Treatment Using ISCO, MNA, and ICs
Overall Protection of Human Health and the Environment	Not protective of human health and the environment	Adequate protection of human health and the environment through active source treatment and ICs.
Compliance With ARARs	Not applicable	Projected to achieve the source treatment goal of 500 µg/L in 2 years and comply with SRGs in 52 years. In compliance with location- and action-specific ARARs.
Long-Term Effectiveness and Permanence	There would be no reduction in risk to human or ecological receptors under this alternative.	Magnitude of residual risk would diminish significantly within shorter timeframe. Adequacy and reliability of controls are high.
Reduction of Toxicity, Mobility, or Volume Through Treatment	This alternative does not include treatment.	Aggressively reduce the toxicity, mobility, and volume of contamination through treatment.
Short-Term Effectiveness	No impact to community, workers, and the environment from remedial activities because this alternative involves doing nothing. RAOs and SRGs cannot be achieved within a reasonable time frame.	May pose adverse safety risk to remediation workers because of the high volume chemical handling. Risks to magazines because of the heat or gas generation will be minimal because of the use of the soil gas monitoring and the passive soil venting network and if explosives can be relocated during the injection activities, the risks are no longer applicable. Projected to achieve the source treatment goal of 500 µg/L in 2 years.
Implementability	Has no ability to monitor the effectiveness of this remedy and ability to obtain approvals from other agencies is unlikely	Readily implementable and have been demonstrated promising in full-scale application for DNAPL treatment.
Cost	$0	Capital: $2,707,474 Lifetime Present Worth O&M: $1,456,192 Total Present Worth: $4,163,667 Cost is based on 52-year time frame assumption.

Notes
ICs - institutional controls
ISCO - *in situ* chemical oxidation
MNA - monitored natural attenuation
RAOs - remedial action objectives
SRGs - site remediation goals
ARARs - applicable or relevant and appropriate requirements
DNAPL - dense non-aqueous phase liquid
µg/L - microgram(s) per liter

Table 2-6
Cost Estimate of Remedial Alternative 2
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

REMEDIAL ALTERNATIVE 2 Source Treatment Using ISCO, MNA, and ICs	LOCATION: Site 47 Mercuric Nitrate Disposal Area NSF-IH, Indian Head, Maryland						MEDIA: Groundwater		Construction time: 17 weeks Operation time: 52 years Post Remediation Monitoring: included in the operation time			
Cost Component	**Qty**	**Unit**	**Cost Source**	**Estimated Activity Duration (day)**	**Labor Unit Cost**	**Labor Total Cost**	**Equipment Unit Cost**	**Equipment Total Cost**	**Material Unit Cost**	**Material Total Cost**	**Subcontractor**	**Total Cost**
CAPITAL COSTS												
Construction Cost												
Site Preparation				**5**								**$15,017.50**
Site Clearing (very minimal - by hand)	0.5	acre	M 02230 200 0100	1	$1,725.00	$862.50	$0.00	$0.00	$0.00	$0.00	$0.00	$862.50
Survey (elevation and coordinates of new MWs - 2 man crew)	1	lump sum	PHRA Quote	1	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,855.00	$1,855.00
Personnel and Equipment Decon Setups (1 during drilling, 1 during Phase I	3	ea	Professional Judgment	3	$1,600.00	$4,800.00	$500.00	$1,500.00	$2,000.00	$6,000.00	$0.00	$12,300.00
Remediation Activities				**83**								**$1,044,097.48**
Phase I												
Installation of MWs (see Alt 2 Breakdown)	8	wells	BOA rates	10	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$29,612.48	$29,612.48
Installation of Horizontal Injection Wells, Phase 1 (See Alt 2 Breakdown)	2	wells	DTD Quote	7	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$117,620.00	$117,620.00
Air knifing	4	days	DTD Quote	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$8,900.00	$8,900.00
Phase I ISCO System (see Alt 2 Breakdown)												
Injection Activities	1	lump sum	Cost derived from Pilot Test	25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$325,307.50	$325,307.50
Continuous Conductivity Profiling Each Phase	2	days	Vironex Quote	2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$6,000.00	$6,000.00
Phase II												
Installation of Horizontal Injection Wells, Phase 2 (See Alt 2 Breakdown)	3	wells	DTD Quote	12	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$220,900.00	$220,900.00
Air knifing	2	days	DTD Quote	2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$4,450.00	$4,450.00
Phase I & Phase II ISCO System (see Alt 2 Breakdown)												
Injection Activities	1	lump sum	Cost derived from Pilot Test	25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$325,307.50	$325,307.50
Continuous Conductivity Profiling Each Phase	2	days	Vironex Quote	2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$6,000.00	$6,000.00
Construction Oversight												**$231,732.00**
Field Superintendent/Safety Engineer	17.0	weeks	CH2M HILL Rate		$6,642.00	$112,914.00	$0.00	$0.00	$0.00	$0.00	$0.00	$112,914.00
Field Engineer	17.0	weeks	CH2M HILL Rate		$5,166.00	$87,822.00	$0.00	$0.00	$0.00	$0.00	$0.00	$87,822.00
Ambient Air Monitoring Specialist - during well installation	6.0	weeks	CH2M HILL Rate		$5,166.00	$30,996.00	$0.00	$0.00	$0.00	$0.00	$0.00	$30,996.00
Lodging and Per diem	205	day/3 persons			$0.00	$0.00	$0.00	$0.00	$150.00	$30,750.00	$0.00	$30,750.00
Vehicle Rental and Fuel - 2 vehicles	88	days			$0.00	$0.00	$155.00	$13,640.00	$50.00	$4,400.00	$0.00	$18,040.00
Temporary Facility and Control												**$17,255.00**
Trailer, porto toilet, fence, barrier	17	weeks			$0.00	$0.00	$1,015.00	$17,255.00	$0.00	$0.00	$0.00	$17,255.00
SUBTOTAL FIELD CONSTRUCTION COST												**$1,356,891.98**
Contractor Overhead and Profit												**$203,533.80**
Home office cost, etc.	1	lump sum	15% of total construction cost									$203,533.80
General Conditions												**$94,982.44**
Decontamination, temp. facilities, sed. & erosion control, temp. fence, etc.	1	lump sum	7% of total construction cost									$94,982.44
Mob/Demob												**$135,689.20**
Mob/demob of personnel, equipment, and material	1	lump sum	10% of total construction cost									$135,689.20
SUBTOTAL CONSTRUCTION COST												**$1,791,097.41**
Institutional Controls/Planning												**$5,000.00**
Site-Specific LUC	1	lump sum	Professional Judgment		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Permitting												**$5,000.00**
Injection and GW Permits	1	lump sum	Professional Judgment		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Pre-construction Submittals												**$161,198.77**
Basis of Design Report	1	lump sum	3% of total construction cost									$53,732.92
UFP SAP (3 versions)	1	lump sum	3% of total construction cost									$35,821.95
Health and Safety Plan	1	lump sum	1% of total construction cost									$17,910.97
Drawings, Specification, & Cost Estimate	1	lump sum	3% of total construction cost									$53,732.92
SUBTOTAL CAPITAL COST												**$1,962,296.18**
Scope Contingency	10%											**$196,229.62**
Bid Contingency	10%											**$196,229.62**
TOTAL CAPITAL COST												**$2,354,755.42**

Table 2-6
Cost Estimate of Remedial Alternative 2
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

REMEDIAL ALTERNATIVE 2 Source Treatment Using ISCO, MNA, and ICs	LOCATION: Site 47 Mercuric Nitrate Disposal Area NSF-IH, Indian Head, Maryland						MEDIA: Groundwater		Construction time: 17 weeks Operation time: 52 years Post Remediation Monitoring: included in the operation time			
Cost Component	**Qty**	**Unit**	**Cost Source**	**Estimated Activity Duration (day)**	**Labor Unit Cost**	**Labor Total Cost**	**Equipment Unit Cost**	**Equipment Total Cost**	**Material Unit Cost**	**Material Total Cost**	**Subcontractor**	**Total Cost**
SAMPLING AND ANALYSIS (PER EVENT)												
ISCO Sampling Event												
Saturated Soil Sampling												**$17,441.47**
Sample collection - DPT Drilling	2	days	BOA rates	2	$792.40	$1,584.79	$0.00	$0.00	$0.00	$0.00	$5,975.00	$7,559.79
Lab Analysis												
VOCs (8 locations @ 4 samples/location, 10% QC samples)	36	samples	IP/FP		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,451.68	$3,451.68
TOC (8 locations)	8	locations	IP/FP		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$472.40	$472.40
Disposable and decon materials per sample	44	samples	E 33 02 0401, 33 02 0402, 33 02 0561		$110.50	$4,862.00	$0.00	$0.00	$24.90	$1,095.60	$0.00	$5,957.60
Groundwater Sampling 2-Month Post-Injection Events												**$48,765.12**
Sample Collection												
Sample collection - 2 crew, 10 hrs/day, $50/hr, 22 wells	10	days	Professional Judgment	10	$2,500.00	$25,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$25,000.00
Disposable and decon materials per sample location	22	locations	E 33 02 0401, 33 02 0402, 33 02 0561		$110.50	$2,431.00	$0.00	$0.00	$24.90	$547.80	$0.00	$2,978.80
Equipment Rental	10	days	E 33 02 0573, 33 02 0578		$601.40	$6,014.00	$227.68	$2,276.80	$0.00	$0.00	$0.00	$8,290.80
Lab Analysis												
TAL Metals by CLP (ILM04) (filtered)	24	samples	BOA rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,286.08	$3,286.08
TAL Metals by CLP (ILM04) (unfiltered)	24	samples	BOA rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,286.08	$3,286.08
TCL Volatiles by CLP (OLM04)	24	samples	BOA rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,280.00	$2,280.00
Chloride, nitrite/nitrate, sulfate (300.0)	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,171.68	$1,171.68
TOC	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,471.68	$1,471.68
Data Management and Evaluation	20	hours	CH2M HILL Rate		$50.00	$1,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,000.00
Long-Term Groundwater Monitoring Events												**$55,076.44**
Sample Collection												
Sample collection - 2 crew, 10 hrs/day, $50/hr, 15 wells	10	days	Professional Judgment	10	$2,500.00	$25,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$25,000.00
Disposable and decon materials per location	22	locations	E 33 02 0401, 33 02 0402, 33 02 0561		$110.50	$2,431.00	$0.00	$0.00	$24.90	$547.80	$0.00	$2,978.80
Equipment Rental	10	days	E 33 02 0573, 33 02 0578		$601.40	$6,014.00	$227.68	$2,276.80	$0.00	$0.00	$0.00	$8,290.80
Lab Analysis												
TAL Metals by CLP (ILM04) (filtered)	24	samples	BOA rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,286.08	$3,286.08
TAL Metals by CLP (ILM04) (unfiltered)	24	samples	BOA rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,286.08	$3,286.08
TCL Volatiles by CLP (OLM04) (only pre & post injection)	24	samples	BOA rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,280.00	$2,280.00
PLFA, QPCR	3	samples	Microbial Insights Quote		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,875.00	$1,875.00
Chloride, nitrite/nitrate, sulfate (300.0)	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,171.68	$1,171.68
Methane, ethane, ethene (RSK-175)	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,426.16	$2,426.16
Alkalinity (310.1)	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$316.32	$316.32
TOC	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,471.68	$1,471.68
Field parameters (covered in equipment rental)	24	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$693.84	$693.84
Data Management and Evaluation	40	hours	CH2M HILL Rate		$50.00	$2,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00
PERIODIC COST												
Five-Year Review												**$7,000.00**
Report	1	lump sum	Professional Judgment		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Field Inspection	1	lump sum	Professional Judgment		$2,000.00	$2,000.00	$0.00			$0.00	$0.00	$2,000.00
Site Closure												**$25,000.00**
Report development	1	lump sum	Professional Judgment		$25,000.00	$25,000.00	$0.00		$0.00	$0.00	$0.00	$25,000.00

DESCRIPTION AND ASSUMPTIONS OF ALTERNATIVE:

1.) Implement ISCO using alkaline activated sodium persulfate in the source area. The source are is defined as the area where CT is greater then
2.) Phase I: Installation of two horizontal extaction wells in the north-to-south periphery of the North Area. The two horizontal extraction wells will be
3.) Phase II: Two horizontal extraction wells and one horizontal injection well will be installed within the South Area (underneath the magazine
4.) Sampling of GW in 22 monitoring wells (8 new wells [IS47MW25 -IS47MW32]; 14 existing wells [IS47MW01 through IS47MW06, IS47MW10, IS47MW12, IS47MW19 through IS47MW24]) for VOCs, field parameter (DO, pH, temp, specific conductance, ORP), un/filtered metals, & H2O
5.) EC profiling at 8 locations immediately after injection during each Phase.
6.) Injection wells monitored during injection events to determine flow rate and pressure, allowing for determination of
7.) Groundwater would be monitored quarterly during Years 1 through 3, and annually during Years 4 through 52.
8.) Data interpretation and report would be prepared following a sampling event.

Table 2-7
Present Worth for Remedial Alternative 2
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

REMEDIAL ALTERNATIVE 2	Media	LOCATION:	Construction time:	17 weeks
Source Area Treatment Using ISCO, MNA, and ICs	Shallow Groundwater	Site 47 Mercuric Nitrate Disposal Area NSF-IH, Indian Head, Maryland	Operation time:	52 years
			Post Remediation Monitoring:	included in the operation time

PRESENT WORTH CALCULATION

Discount Rate: 5.2% **O&M and Period Cost Contingency:** 20%

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
0	$2,707,474	Baseline (soil & groundwater sampling), Phase I ISCO, 2- and 6-Month Post-Injection Sampling Events, Rebaseline event, Phase II ISCO, 2- and 6-Month Post-Injection Sampling Events	Capital	1.00	$2,707,474
1	$220,306	Quarterly sampling events (4)	O&M	1.05	$209,416
2	$220,306	Quarterly sampling events (4)	O&M	1.11	$199,065
3	$220,306	Quarterly sampling events (4)	O&M	1.16	$189,225
4	$55,076	Annual sampling event	O&M	1.22	$44,968
5	$62,076	Annual sampling event and five-year review	O&M, Periodic	1.29	$48,178
6	$55,076	Annual sampling event	O&M	1.36	$40,632
7	$55,076	Annual sampling event	O&M	1.43	$38,624
8	$55,076	Annual sampling event	O&M	1.50	$36,715
9	$55,076	Annual sampling event	O&M	1.58	$34,900
10	$62,076	Annual sampling event and five-year review	O&M, Periodic	1.66	$37,391
11	$55,076	Annual sampling event	O&M	1.75	$31,535
12	$55,076	Annual sampling event	O&M	1.84	$29,976
13	$55,076	Annual sampling event	O&M	1.93	$28,495
14	$55,076	Annual sampling event	O&M	2.03	$27,086
15	$62,076	Annual sampling event and five-year review	O&M, Periodic	2.14	$29,020
16	$55,076	Annual sampling event	O&M	2.25	$24,475
17	$55,076	Annual sampling event	O&M	2.37	$23,265
18	$55,076	Annual sampling event	O&M	2.49	$22,115
19	$55,076	Annual sampling event	O&M	2.62	$21,022
20	$62,076	Annual sampling event and five-year review	O&M, Periodic	2.76	$22,522
21	$55,076	Annual sampling event	O&M	2.90	$18,995
22	$55,076	Annual sampling event	O&M	3.05	$18,056
23	$55,076	Annual sampling event	O&M	3.21	$17,163
24	$55,076	Annual sampling event	O&M	3.38	$16,315
25	$62,076	Annual sampling event and five-year review	O&M, Periodic	3.55	$17,480
26	$55,076	Annual sampling event	O&M	3.74	$14,742
27	$55,076	Annual sampling event	O&M	3.93	$14,013
28	$55,076	Annual sampling event	O&M	4.13	$13,321
29	$55,076	Annual sampling event	O&M	4.35	$12,662
30	$62,076	Annual sampling event and five-year review	O&M, Periodic	4.58	$13,566
31	$55,076	Annual sampling event	O&M	4.81	$11,441
32	$55,076	Annual sampling event	O&M	5.06	$10,876
33	$55,076	Annual sampling event	O&M	5.33	$10,338
34	$55,076	Annual sampling event	O&M	5.60	$9,827
35	$62,076	Annual sampling event and five-year review	O&M, Periodic	5.90	$10,529
36	$55,076	Annual sampling event	O&M	6.20	$8,880
37	$55,076	Annual sampling event	O&M	6.53	$8,441
38	$55,076	Annual sampling event	O&M	6.86	$8,024
39	$55,076	Annual sampling event	O&M	7.22	$7,627
40	$62,076	Annual sampling event and five-year review	O&M, Periodic	7.60	$8,171
41	$55,076	Annual sampling event	O&M	7.99	$6,892
42	$55,076	Annual sampling event	O&M	8.41	$6,551
43	$55,076	Annual sampling event	O&M	8.84	$6,227
44	$55,076	Annual sampling event	O&M	9.30	$5,919
45	$62,076	Annual sampling event and five-year review	O&M, Periodic	9.79	$6,342
46	$55,076	Annual sampling event	O&M	10.30	$5,349
47	$55,076	Annual sampling event	O&M	10.83	$5,084
48	$55,076	Annual sampling event	O&M	11.40	$4,833
49	$55,076	Annual sampling event	O&M	11.99	$4,594
50	$62,076	Annual groundwater sampling, and five-year review	O&M, Periodic	12.61	$4,922
51	$55,076	Annual sampling event	O&M	13.27	$4,151
52	$87,076	Annual sampling event, five-year review, and site closure	O&M, Periodic, Site Closure	13.96	$6,239

CAPITAL COST	**$2,707,474**		
2011 Dollar LIFETIME O&M	**$3,461,663**	**Lifetime Present Worth O&M**	**$1,456,192**
TOTAL IMPLEMENTATION COST	**$6,169,137**	**TOTAL PRESENT WORTH**	**$4,163,667**

TABLE 2-8
Expected Outcomes of the Selected Remedy
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Risk	RAO	Remedy Component	Metric/Cleanup Level	Expected Outcome
Ingestion of VOCs (primarily CT, CF, PCE) and metals (primarily arsenic, cyanide, iron, thallium, vanadium) in shallow groundwater Dermal contact of VOCs (primarily CT, CF, PCE) in shallow groundwater Inhalation of VOCs (primarily 1,2-DCA, CT, CF, PCE) in shallow groundwater	To prevent unacceptable risk to human receptors from exposure to contaminants in the shallow groundwater. Prevent migration of the contaminants in the shallow groundwater at unacceptable concentrations (above SRGs) from Site 47 to uncontained media. Return the shallow groundwater to its beneficial use to the extent practicable.	ISCO using AAP in the source area where CT and PCE concentrations are ≥ 500 µg/L Monitored natural attenuation for the remaining dissolved plume and the source area following the active treatment with AAP. Short-term ISCO performance sampling at baseline and 2-, 6-, and 9-month post-ISCO. Long-term groundwater monitoring for 52 years or until SRGs are met. 5-year reviews until SRGs are met. ICs in the form of land and groundwater use restrictions within the area of attainment. Also, any future building construction would require an evaluation of potential human health risks from vapor intrusion. The site will be designated as "restricted use" area in the NSF-IH system, which would remain in place until groundwater monitoring indicates that the SRGs have been met. This designation would place restrictions on intrusive activities such as excavation, and prohibit residential development and any use of the shallow groundwater.	Human health risk-based PRGs, EPA MCLs, or facility-wide background concentrations (refer to Table 2-2)	Return the shallow groundwater to its beneficial use to the extent practicable and maintain current land use (industrial).

Notes:

RAO - remedial action objective
CT - carbon tetrachloride
CF - chloroform
MCL - maximum contaminant level
1,2-DCA - 1,2-dichloroethane
µg/L - microgram(s) per liter
AAP - alkaline-activated sodium persulfate
ISCO - *in situ* chemical oxidation
IC - institutional control
PCE - tetrachloroethene
PRG - preliminary remediation goal
EPA - Environmental Protection Agency

TABLE 2-9
Chemical-Specific ARARs and TBCs
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Media	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Chemical-Specific ARARs					
Safe Drinking Water Act					
Groundwater	Chemical concentrations SDWA MCL.	Assessment of drinking water standards.	40 CFR 141.61(a)(1), (3), (4), (5), and (15); 40 CFR 141.62(b)(15) and (16); 40 CFR 141.53 (as it applies to chloroform)	Relevant and Appropriate	SRGs for the following chemicals are based on SDWA MCLs: carbon tetrachloride - 5 µg/L chloroform - 80 µg/L 1,2-dichloroethane - 5 µg/L tetrachloroethylene - 5 µg/L trichloroethylene - 5 µg/L vinyl chloride - 2 µg/L arsenic - 10 µg/L thallium - 2 µg/L.
EPA's Risk Assessment Guidance for Superfund					
Groundwater	Chemical concentrations corresponding to fixed levels of risks to human receptors	Assessment of risk-based standards.	EPA Region III RSL Tables: Only as they apply to carbon disulfide, cis-1,2-dichloroethane, and 1,1,2,2-TCA. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm	TBC	SRGs for the following chemicals are based on RSLs: carbon disulfide - 1,324 µg/L cis-1,2-dichloroethane - 72 µg/L 1,1,2,2-TCA - 20 µg/L
Site Background Conditions					
Groundwater	Navy policy prohibits remediation to concentrations that are below established background values	Assessment of background values	Background values established for NSF-IH in "Background Soil Investigation report for Indian head Stump Neck Annex". Naval Surface Warfare Center. Indian Head, Maryland (Tetra Tech, 2002) only as they apply to iron and vanadium. Note that groundwater values are contained in an appendix	TBC	SRGs for the following chemicals are based on established base background criteria: iron - 49,869 µg/L vanadium - 20.9 µg/L

TABLE 2-9
Chemical-Specific ARARs and TBCs
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Media	Requirement	Prerequisite	Citation	Applicability Determination	Comments
No Maryland Chemical-Specific ARARs apply.					

Notes

ARAR - Applicable or relevant and appropriate requirement
SDWA - Safe Drinking Water Act
CFR - Code for Federal Regulations
EPA - U.S. Environmental Protection Agency
RSL - Regional Screening Level
SRG - Site Remediation Goal
MCLs - Maximum Contaminant Levels
TBC - To be considered

TABLE 2-10
Location-Specific ARARs
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Location-Specific ARARs					
Migratory Bird Treaty Act					
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*	Applicable	The site is located in the Atlantic Migratory Flyway. If migratory birds (e.g., bald eagle), or their nests or eggs, are identified at the site, operations will not destroy the birds, nests, or eggs.
No Maryland Location-Specific ARARs apply					

Notes
ARARs - Applicable or relevant and appropriate requirements.
USC - United States Code.

TABLE 2-11
Action-Specific ARARs
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Location-Specific ARARs					
Clean Water Act					
Oil storage during in situ treatment	This regulation establishes procedures, methods, equipment, and other requirements to prevent the discharge of oil from non-transportation-related onshore and offshore facilities into or upon the navigable waters of the United States.	Storage of petroleum and non-petroleum oil	40 CFR Part 112.1, 112.3, 112.7	Applicable	If the storage capacity for all oil onsite, in containers with a capacity of 55 gallons or greater, is equal to or exceeds 1,320 U.S. gallons a Spill Prevention, Control, and Countermeasure (SPCC) Plan must be prepared and implemented.
Maryland Action-Specific ARARs					
Waste Management					
Staging of Non-hazardous Waste in containers	Non-hazardous waste may not be stored in a manner that creates a nuisance or impairs the quality of the environment	Management of non-hazardous wastes in containers	COMAR 26.04.07.03A	Applicable	Non-hazardous wastes will be generated during well installation and managed onsite.
Well Construction and Abandonment					
The construction and maintenance of a groundwater well network	Establishes the standards and procedures applicable to construction of wells in the State.	Well Construction	COMAR 26.04.04.10 A, C, E	Applicable	These requirements are applicable to the installation and maintenance of a groundwater monitoring network that will be installed as part of the response action.
Underground Injection Control					
Injection of chemicals to the subsurface	For any underground injection subject to this subtitle, a person may not cause, maintain, or allow any underground injection except as provided in this subtitle.	Underground Injection Control	COMAR 26.08.07.01A only as it applies to incorporating 40 CFR 144.12(a), 144.82(a)(1) and (b), 144.83(a)(1)(i), 146.8(a)-(e), 146.10(c)	Applicable	These requirements are applicable to underground injections being performed at the site.

Notes
ARAR - Applicable or relevant and appropriate requirement
CFR - Code for Federal Regulations
COMAR - Code of Maryland Regulations

V:\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\314138_SITE47_ROD\FIGURE 2-1 - SITE 47 LAYOUT.MXD GPERDEW 6/23/2011 10:21:42 AM

Legend

- Approximate IR Site Boundary
- Approximate Mercuric Nitrate Disposal Pit Location
- Approx Loc Barium Disposal Pit
- NSF-IH Base Boundary

N
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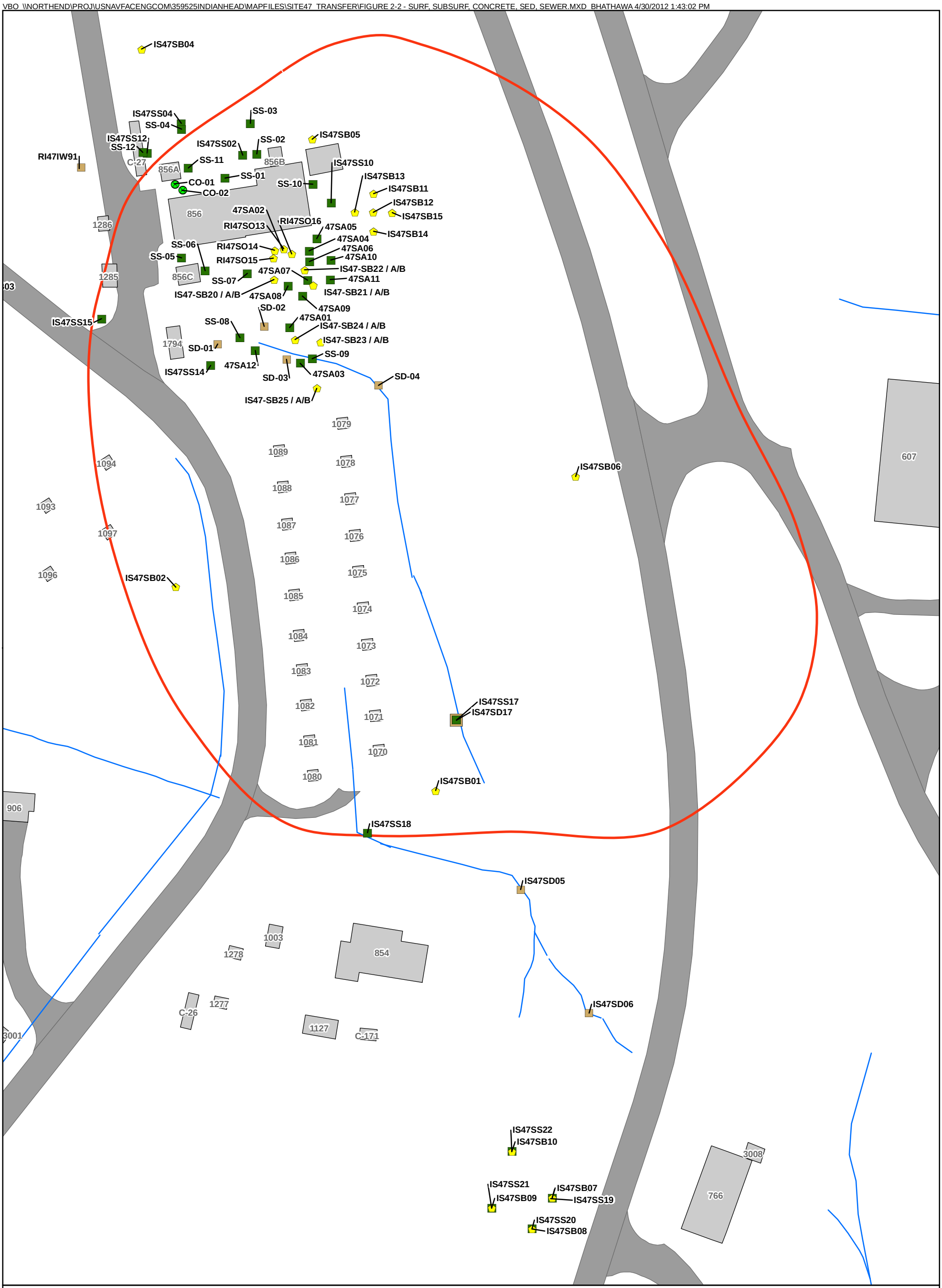
Feet

Figure 2-1
Site Layout
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\SITE47_TRANSFER\FIGURE 2-2 - SURF, SUBSURF, CONCRETE, SED, SEWER.MXD BHATHAWA 4/30/2012 1:43:02 PM



Legend

- Concrete Sample Location (Collected: RI)
- Surface Soil Sample Location (Collected: SI, RI, BERA)
- Subsurface Soil Sample Location (Collected: RI, Pilot Study)
- Sediment and Sewer Sediment Sample Location (Collected: RI, BERA)
- Surface Water
- Approximate IR Site Boundary
- Building
- Road

N
W E
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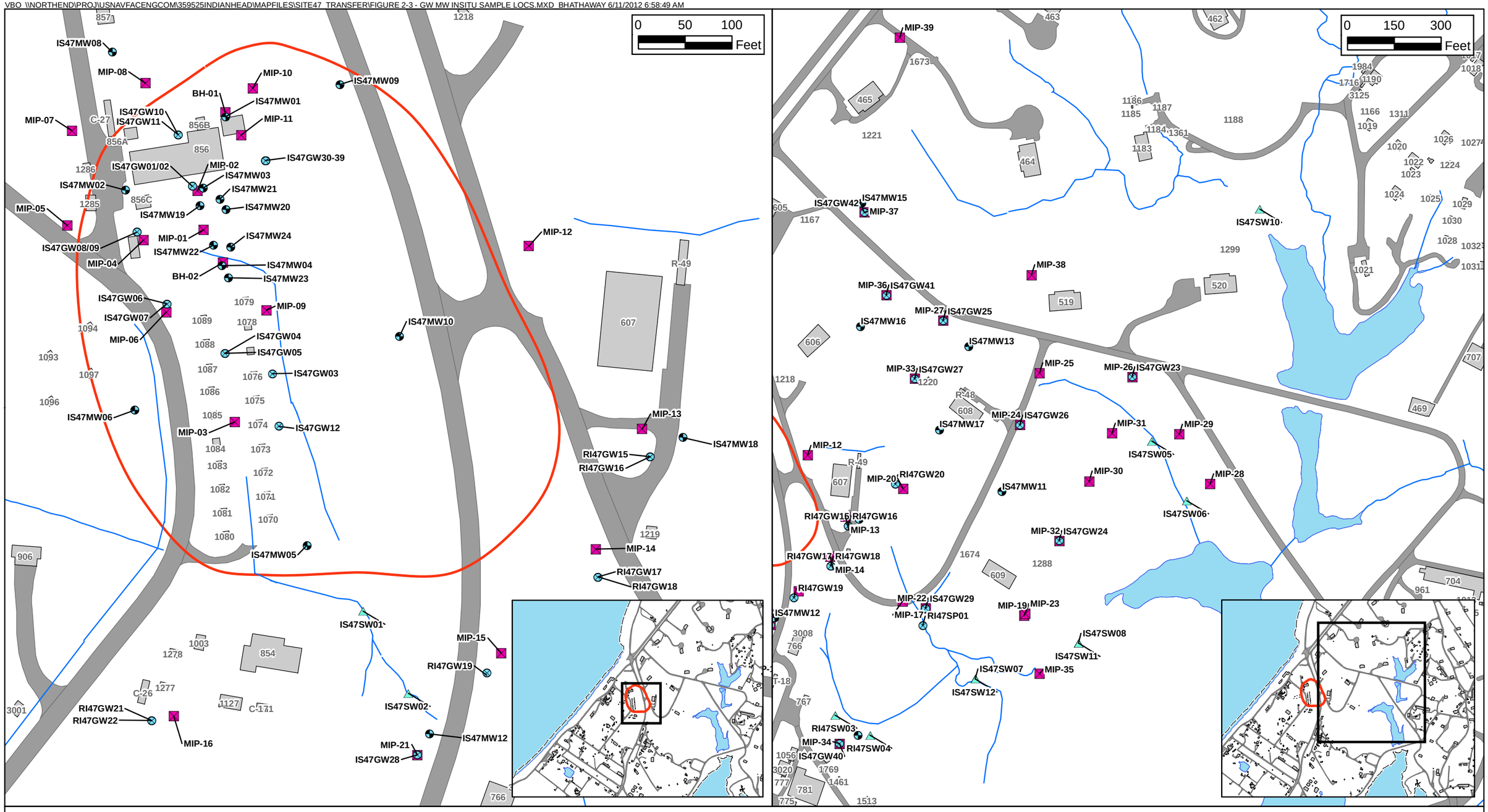
0 30 60
Feet

Figure 2-2
Surface Soil, Subsurface Soil, Concrete, and Sediment Sampling Locations
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\SITE47_TRANSFER\FIGURE 2-3 - GW MW INSITU SAMPLE LOCS.MXD BHATHAWAY 6/11/2012 6:58:49 AM



Legend

- Monitoring Well Location (Installed: RI, Pre-FS, Pilot Study)
- In Situ Direct Push Groundwater Samples (Collected: RI)
- Surface Water Sample (Collected: RI, BERA)
- MIP Location (Collected: RI)
- Surface Water
- Surface Waterbody
- Approximate IR Site Boundary
- Building
- Road
- NSF-IH Base Boundary

N W E S

Figure 2-3
Groundwater and Surface Water Sample Locations
Site 47 ROD
NSF-IH, Indian Head, Maryland

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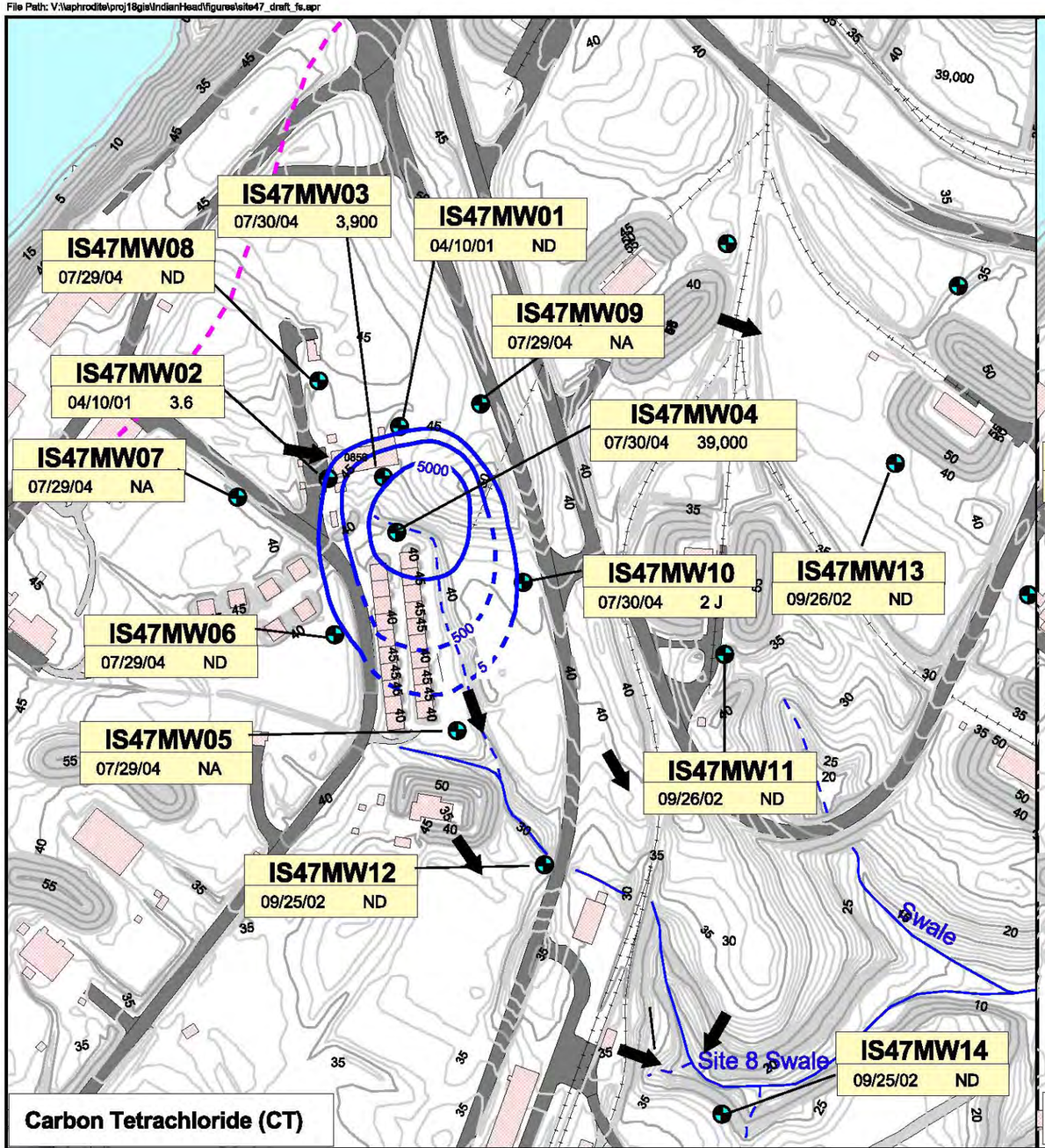

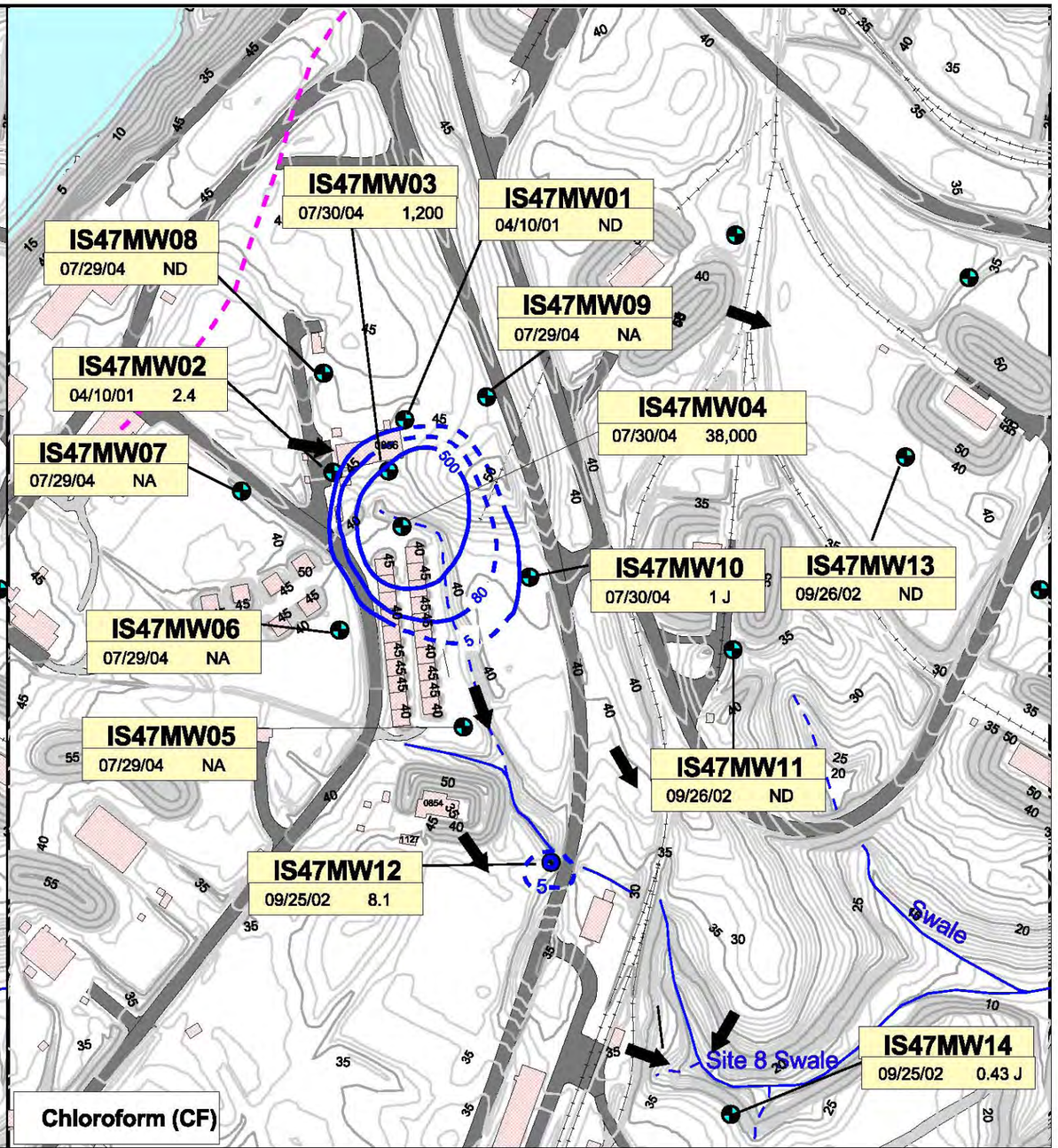

LEGEND

- Isoconcentration contour (dashed where inferred)
- Monitoring Well Location
- Perennial Swale
- Intermittent Swale
- Inferred Groundwater Divide
- Building
- Railroad
- Asphalt
- Dirt
- Gravel
- Groundwater Flow Direction

NA - Not Analyzed/Sampled
ND - Not Detected

Notes:
1. RI data were taken during multiple sampling events between 2001 and 2003.
2. Pre-FS investigation was perfomed in July 2004. VOC samples were obtained from 8 Wells.
3. Plume values are in ug/L.
4. Outer boundary of plumes are based on MCLs (CT = 5 ug/L and CF = 5 ug/L).
5. J labeled values are biased high.
6. Contours take into account direct push points IS47GW30 through IS47GW39, sampled in June 2002

N

0 100 200 Feet

Figure 2-4
Interpreted Carbon Tetrachloride and Chloroform Isoconcentration Contour Maps
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

CH2MHILL

V:\\northend\proj\USNavFacEngCom\359525IndianHead\Graphics\314138_Site47_ROD\Figure 2-4 - Interp CT_CF Iso Contours - Use CT only.ai

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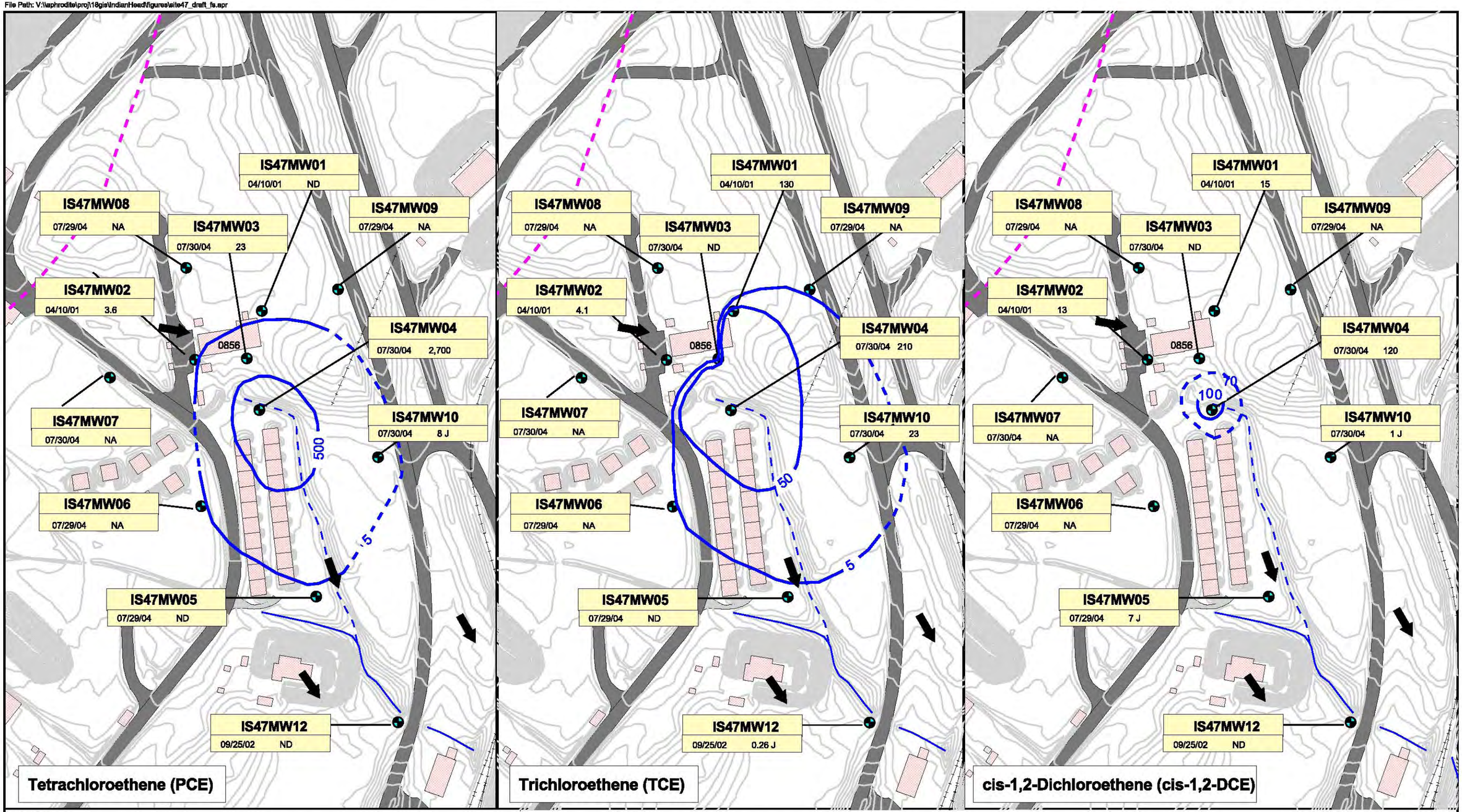

LEGEND

- Isoconcentration contour (dashed where inferred)
- Monitoring Well Location
- Perennial Swale
- Intermittent Swale
- Inferred Groundwater Divide
- Building
- Railroad
- Asphalt
- Dirt
- Gravel
- Groundwater Flow Direction

NA - Not Analyzed/Sampled

Notes:
1. RI data were taken during multiple sampling events between 2001 and 2003.
2. Pre-FS investigation was performed in July 2004.
3. Well IS47MW03 was formerly a location for direct push sample RI47GW03 taken in 7/13/99 CT=286,340; CF=57,570; CE=59,259;CM=ND
4. Wells outside of the plume were non detect.
5. Plume values are in ug/L.
6. Outer boundary of plumes are based on MCLs (PCE = 5 ug/L, TCE = 5 ug/L, cis-1,2-DCE = 7 ug/L).
7. J labeled values are biased high.
8. Contours take into account direct push points IS47GW30 through IS47GW39, sampled in June 2002

N

0 75 150 Feet

Figure 2-5
Interpreted PCE, TCE, and cis-1,2-DCE
Isoconcentration Contour Maps
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

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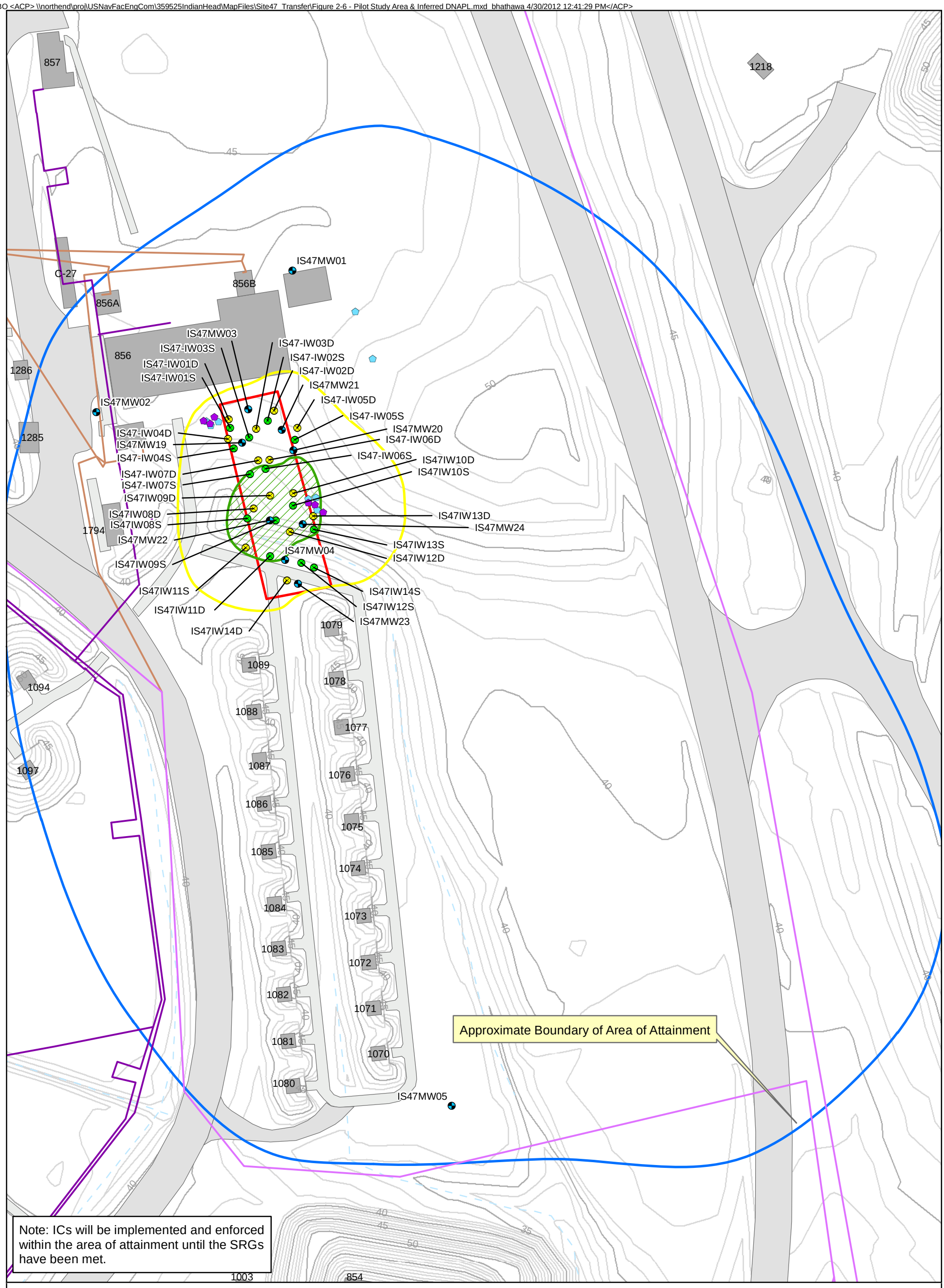
V:\\northend\proj\USNavFacEngCom\359525IndianHead\Graphics\314138_Site47_ROD\Figure 2-5 - Interp PCE, TCE, cisDCE Isocon - USE PCE_TCE only.ai

VBO <ACP> \\northend\proj\USNavFacEngCom\359525IndianHead\MapFiles\Site47_Transfer\Figure 2-6 - Pilot Study Area & Inferred DNAPL.mxd bhathawa 4/30/2012 12:41:29 PM</ACP>



Legend

- Existing Monitoring Well Location
- EC Probe Location (November 2009)
- EC Profiling Location (July 2010)
- Existing Shallow Permanent Injection Well (6-12' bgs)
- Existing Deep Permanent Injection Well (12-18' bgs)
- Intermittent Swale
- Heating and Cooling Line
- Industrial Waste Line
- Waste Water Line
- Elevation Contour Line (1 ft Interval)
- Elevation Contour Line (5 ft Interval)
- Approximate Boundary of Area of Attainment
- Pilot Study Area
- Inferred Residual DNAPL Area
- Source Area (CT and PCE >= 500 ppb)
- Building
- Road

Figure 2-6
Pilot Study Area, Area of Attainment, and Inferred Residual DNAPL Area
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

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Feet

CH2MHILL

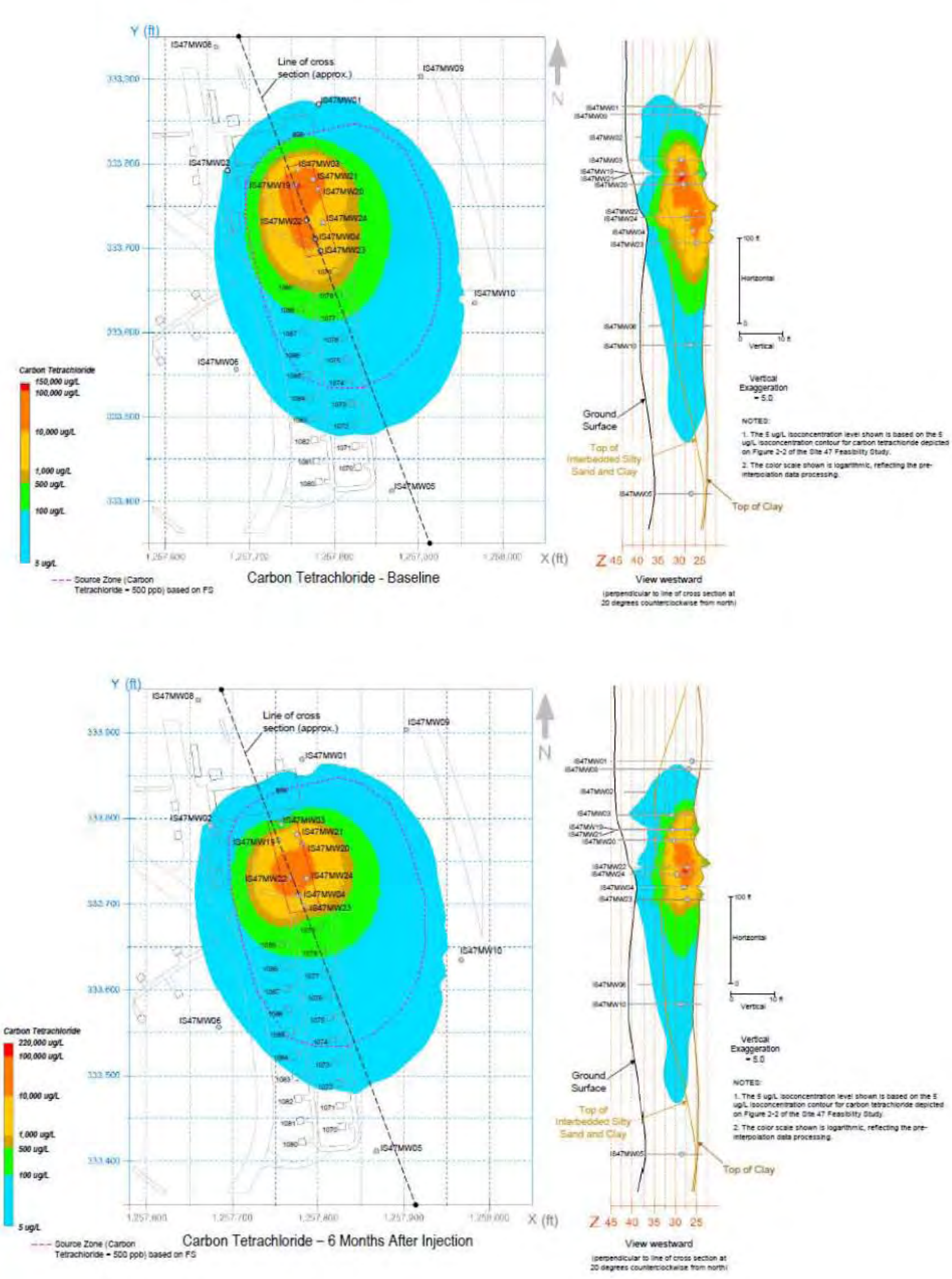


Figure 2-7
2-Dimensional CT Plumes – Baseline and 6-Month Post Injection
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

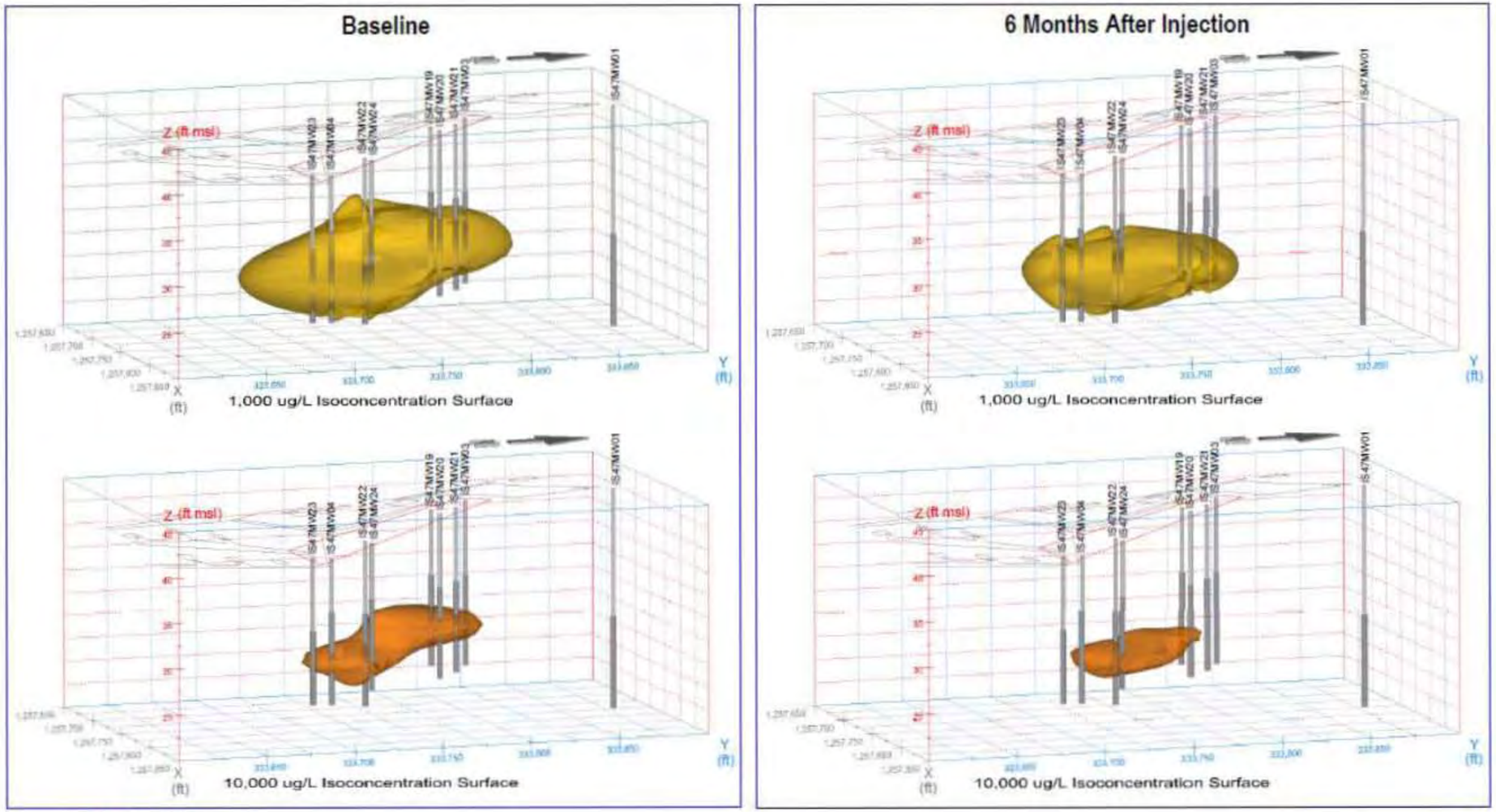


Figure 2-8
3-Dimensional CT Plumes – Baseline and 6-Month Post Injection
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

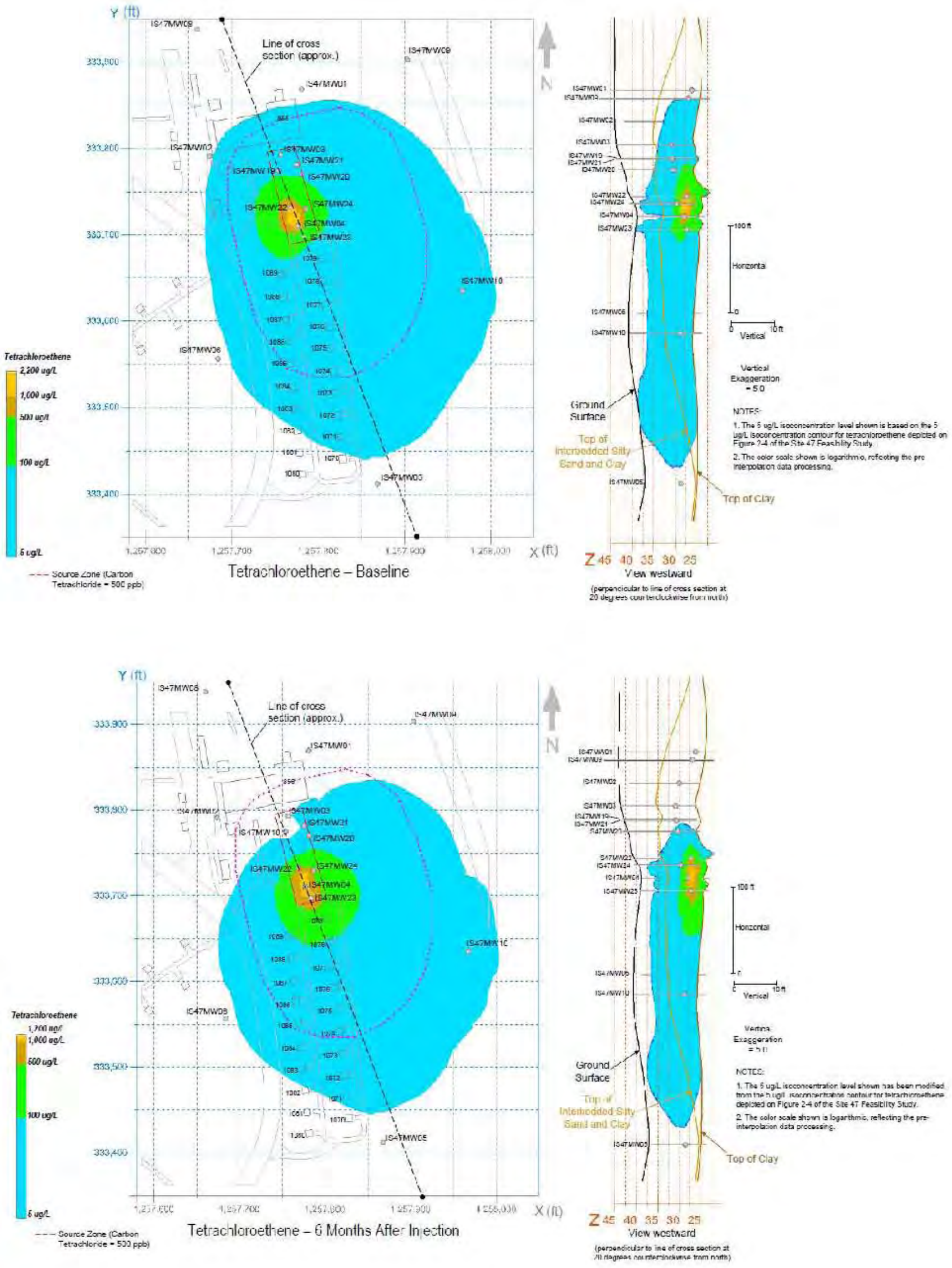


Figure 2-9
2-Dimensional PCE Plumes – Baseline and 6-Month Post Injection
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

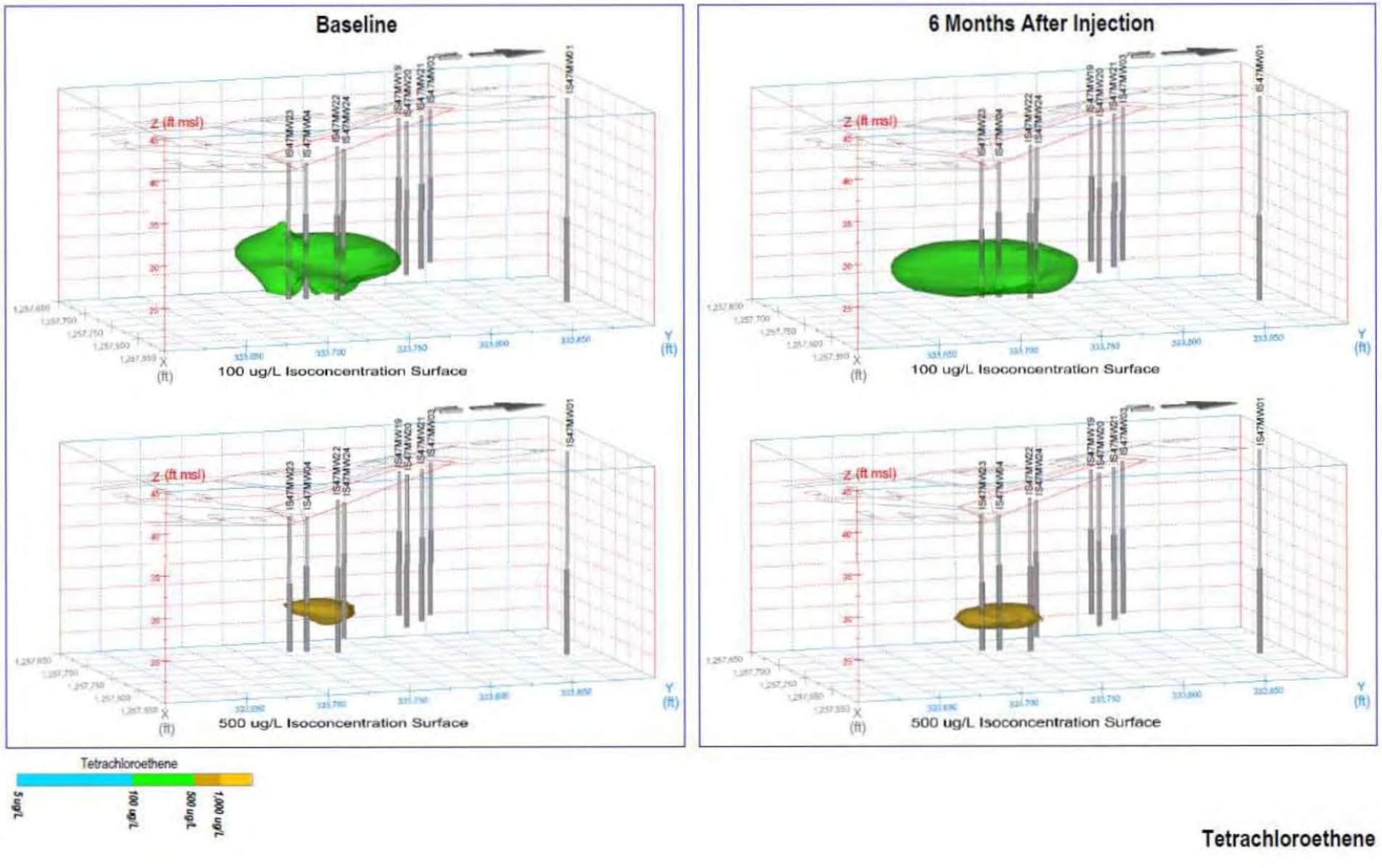
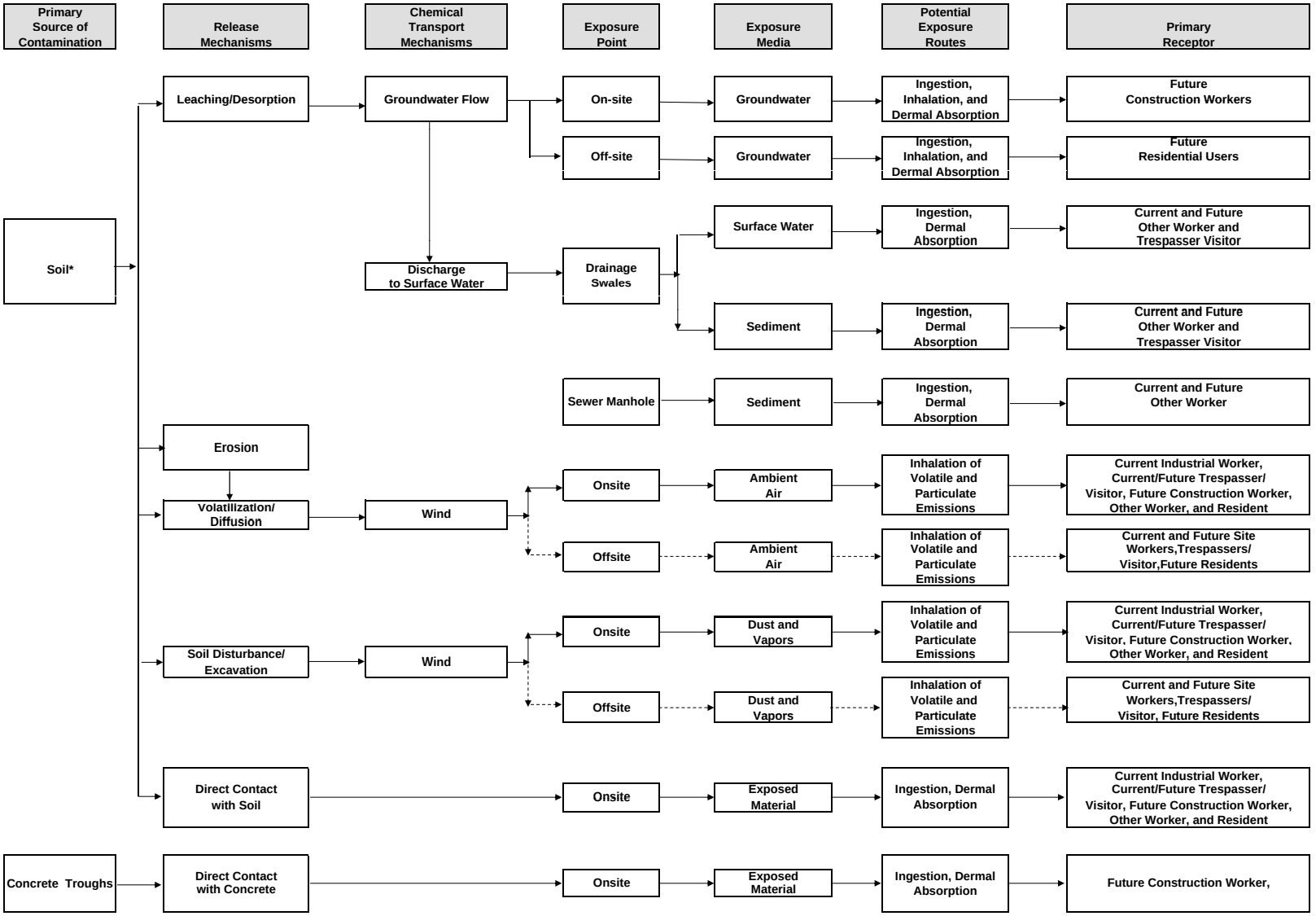


Figure 2-10
3-Dimensional PCE Plumes – Baseline and 6-Month Post Injection
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland



* Current scenario is for surface soil and future scenarios are for soil (surface and subsurface soil combined).

→ Complete Pathway

⇢ Incomplete Pathway

Figure 2-11
Conceptual Site Model for Human Receptors
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

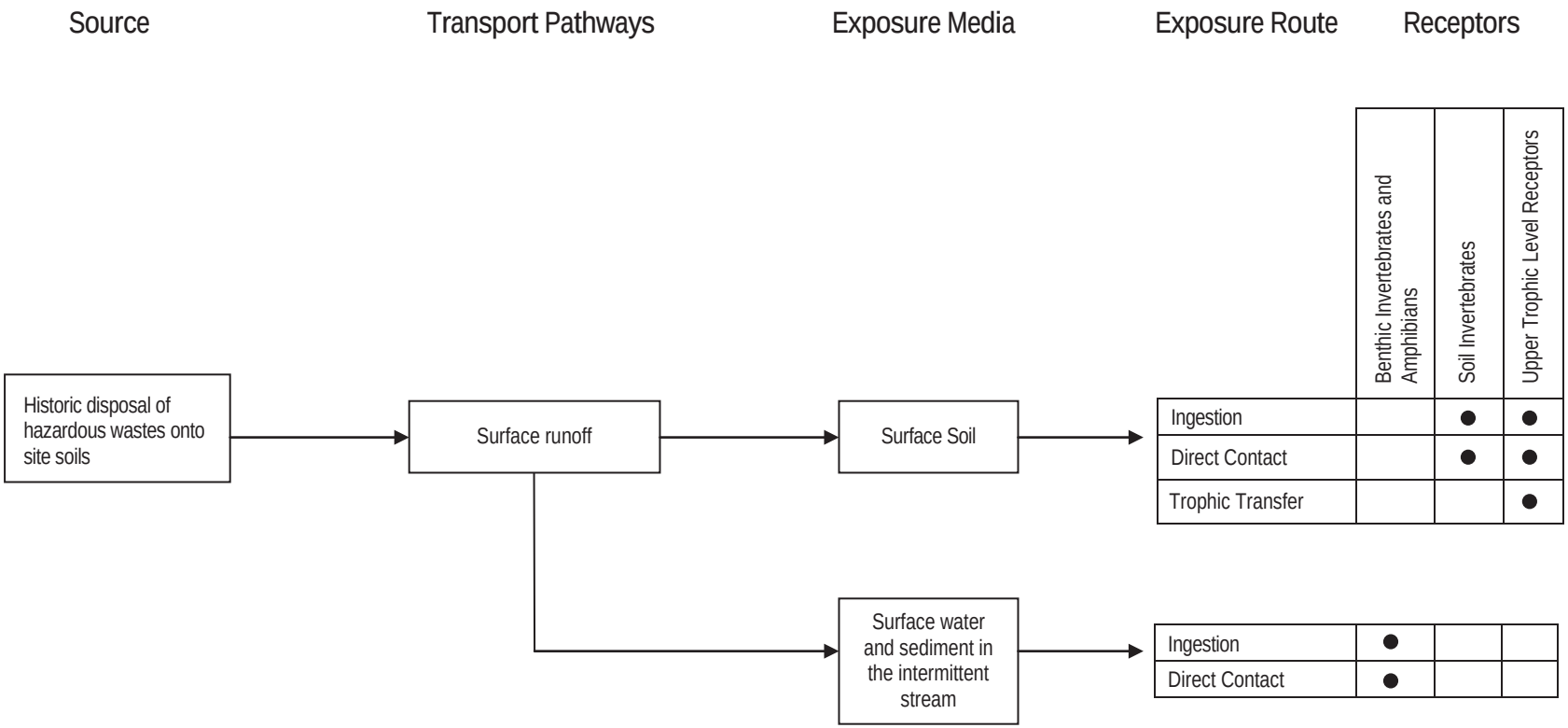


Figure 2-12
Conceptual Site Model for Ecological Receptors
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\359525INDIANHEAD\MAPFILES\SITE47_TRANSFER\FIGURE 2-13 - AOA AND CD.MXD BHATHAWA 4/30/2012 12:38:39 PM

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C-27
856B
856A
856
1286
1285
856C
1794
1094
1097
1003
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IS47MW01
IS47MW02
IS47MW03
IS47MW04
IS47MW05
IS47MW19
IS47MW20
IS47MW21
IS47MW22
IS47MW23
IS47MW24
IS47MW25
IS47MW26
IS47MW27
IS47MW28
IS47MW29
IS47MW30
IS47MW31
IS47MW32
Approximate Boundary of Area of Attainment
Note: ICs will be implemented and enforced within the area of attainment until the SRGs have been met.

Legend

- Proposed Monitoring Well Location
- Existing Monitoring Well Location
- EC Probe Location (November 2009)
- EC Profiling Location (July 2010)
- Existing Shallow Permanent Injection Well (6-12' bgs)
- Existing Deep Permanent Injection Well (12-18' bgs)
- Intermittent Swale
- Heating and Cooling Line
- Industrial Waste Line
- Waste Water Line
- Elevation Contour Line (1 ft Interval)
- Elevation Contour Line (5 ft Interval)
- Approximate Boundary of Area of Attainment
- Pilot Study Area
- Inferred Residual DNAPL Area
- Source Area (CT and PCE >= 500 ppb)
- Building
- Road

Figure 2-13
Area of Attainment and Conceptual Design
Site 47 Record of Decision
NSF-IH, Indian Head, Maryland

N
W E
S

0 25 50
Feet

CH2MHILL

SECTION 3

Responsiveness Summary

This Responsiveness Summary represents a concise and complete summary of significant comments received from the public on the Proposed Plan and includes responses to these comments. It was prepared after the public comment period ended on May 17, 2012, in accordance with guidance in *Community Relations in Superfund: A Handbook* (EPA, 1992). This Responsiveness Summary provides the decision maker with information about the views of the community. It also documents how the Navy, EPA, and MDE considered public comments during the decision making process and provides answers to major comments.

3.1 Stakeholder Comments and Lead Agency Responses

The 30-day public comment period for the Selected Remedy for Site 47 began on April 17, 2012 and ended on May 17, 2012. A public meeting was held on April 12, 2012 at the Indian Head Senior Center, 100 Cornwallis Square, Indian Head, Maryland, to accept oral and written comments on this decision. No oral or written comments were received during the public comment period.

3.2 Technical and Legal Issues

No technical or legal issues have been identified for Site 47 with respect to this ROD.

SECTION 4

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