4/1/08 – 01782

Final

Site 18 Action Memorandum

(Former Naval Magazine Waste Storage Area)

Naval Station Norfolk
Norfolk, Virginia

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

LANTDIV CLEAN Program
Contract No. N62470-02-D-3052
CTO-173

April 2008

Prepared by

CH2MHILL

Virginia Beach, Virginia

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DECLARATION

ACTION MEMORANDUM

Site 18
Former Naval Magazine Storage Area
Naval Station Norfolk, Norfolk, Virginia

DATE: March 21, 2008

SUBJECT: Enhanced Reductive Dechlorination, Former Naval Magazine Storage Area, Site 18, Naval Station Norfolk, Norfolk, Virginia

FROM: Commanding Officer, Naval Facilities Engineering Command, Mid-Atlantic

TO: CAPT S. J. DiNobile, USN
Commanding Officer
Naval Station Norfolk

This Action Memorandum documents approval for the removal action as described herein for Site 18, Former Naval Magazine Storage Area, at Naval Station Norfolk in Norfolk, Virginia. This Action Memorandum serves as the Decision Document for the Engineering Evaluation/Cost Analysis (EE/CA) for Site 18 prepared under separate cover.

This decision document represents the selected removal action for Site 18 and is developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended, and is consistent with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for the site.

Conditions at Site 18 meet the NCP Section 300.415(b)(2) criteria for removal. Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic recommends approval of the proposed removal action. The total project ceiling if approved is estimated to be $546,000. Response actions should commence as soon as practicable to expedite site cleanup.

Approved by:

8 APR 2008

CAPT S. J. DiNobile, USN
Commanding Officer
Naval Station Norfolk

Date

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Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
cis-1,1- DCE	cis-1,2-dichloroethene
CVOC	chlorinated volatile organic compounds
1,4-DCB	1,4-dichlorobenzene
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DoN	Department of the Navy
DPT	direct push technology
EE/CA	Engineering Evaluation/Cost Analysis
ERD	Enhanced Reductive Dechlorination
ERP	Environmental Restoration Program
ESI	Expanded Site Investigation
ft	foot/feet
ft^2	square feet
IRP	Installation Restoration Program
IAS	Initial Assessment Study
LUC	Land Use Control
NACIP	Navy Assessment and Control of Installation of Pollutants
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NM	Naval Magazine
NSN	Naval Station Norfolk
NTCRA	Non-Time Critical Removal Action
MCL	Maximum Contaminant Level
MIP	Membrane Interface Probe
MNA	Monitored Natural Attenuation
MRP	Munitions Response Program
MTBE	Methyl-t-butyl ether
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbons
PID	photoionization detector

RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
RRR	Relative Risk Ranking
SARA	Superfund Amendments and Reauthorization Act of 1986
SVOC	semi-volatile organic compounds
TCE	trichloroethene
USC	United States Code
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
VOCs	volatile organic compounds
µg/L	micrograms per liter

I. Purpose

This Action Memorandum documents approval for a non-time critical removal action (NTCRA) for the groundwater at Site 18, Former Naval Magazine (NM) Storage Area, Naval Station Norfolk (NSN), Norfolk, Virginia. The Engineering Evaluation/Cost Analysis (EE/CA) focused on contaminated groundwater resulting from historical releases from staged drums at Site 18 (CH2M HILL, 2008; Attachment A). The NTCRA will address contaminants identified in the groundwater at Site 18 which pose potential unacceptable human health risks. The contaminants of concern (COCs) consist of several chlorinated volatile organic compounds (CVOCs).

This Action Memorandum serves as the Decision Document for the EE/CA written for Site 18 and for the Navy to conduct the work proposed by the recommended alternative therein. The alternatives evaluated in the Site 18 EE/CA consist of the following:

- Alternative 1: No Action
- Alternative 2: Monitored Natural Attenuation (MNA)
- Alternative 3: Enhanced Reductive Dechlorination (ERD)

This Action Memorandum was completed in accordance with the removal program requirements defined by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the Superfund Amendments and Reauthorization Act of 1986 (SARA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and the United States Environmental Protection Agency's (USEPA) (1990) *Superfund Removal Procedures, Action Memorandum Guidance*.

The Department of the Navy (DoN) has broad authority under CERCLA Section 104 and Executive Order 12580 to carry out removal actions when the release is on, or the sole source of the release is from the DoN installation. The Navy/Marine Corps Environmental Installation Restoration Program (IRP), now subsumed with the Munitions Response Program (MRP) by the Environmental Restoration Program (ERP), was initiated to identify, assess, characterize, and clean up or control contamination from past hazardous waste disposal operations and hazardous material spills at Navy and Marine Corps activities. This Action Memorandum follows the guidelines published in the *Navy/Marine Corps ERP Manual* (Navy, 2006) and the *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (USEPA, 1993).

II. Site Conditions and Background

A. Site Description

This Action Memorandum addresses a NTCRA to mitigate potential human health risk in groundwater at Site 18. Detailed site characteristics are discussed in Section II(D).

This section describes Site 18, documented releases, and current National Priorities List (NPL) status. This section also reviews any previous and current actions conducted by the Navy in this area and discusses anticipated future actions at the state and local levels.

B. Removal Site Evaluation

In 1981, the Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) Program. The NACIP Program utilized a three-phase approach to a site study and cleanup. The program included an Initial Assessment Study (IAS) (ES&E, 1983) to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations. Site 18 was one area of concern identified during the IAS at NSN. A number of sampling events have been conducted at Site 18.

1. 1980-1985 Landfill Monitoring

An October 1980 temporary landfill permit required continuous monitoring of the shallow groundwater and nearby surface water to determine contaminant migration. Monthly monitoring indicated the presence of metals and semi-volatile organic compounds (SVOCs) (ES&E, 1983). In October 1985, following a review of the available analytical data, the Virginia Water Control Board eliminated the monthly monitoring requirement.

2. 1995 Resource Conservation and Recovery Act Inspection

In 1995, a Resource Conservation and Recovery Act (RCRA) inspection was conducted. No signs of adverse impacts or threats to human heath or the environment were identified; therefore, Site 18 was no longer subject to additional RCRA inspections.

3. 1995 Phase I Relative Risk Ranking Study

Site 18 was included in the Phase I Relative Risk Ranking (RRR) Study conducted at NSN in October 1995 (Baker, 1996). Surface soil samples were collected and the analytical data indicated the presence of several metals, SVOCs, and pesticides. Based on a visual evaluation of the site conditions, potential pathways for exposures (based on site conditions observed and the presence of metals and SVOCs in the surface soil), potential for migration, and the analytical data, the study assigned moderate rankings for migration of contaminants and exposure routes (human and/or ecological receptors) for groundwater, soil, sediment, and surface water. The site was not included in a follow-up Phase II RRR performed in 1996 for other sites.

4. 2001 Partnering Team Decision

During the October 2000 Partnering Team Meeting, the Tier I NSN Partnering Team agreed to re-evaluate the soil at Site 18 by comparing the Phase I RRR soil data to the most recent USEPA Region 3 risk based concentrations (RBCs) for residential soil. Based on the comparison, the Partnering Team agreed the soil at Site 18 was no longer a media of concern (January 2001 Team Consensus). The Partnering Team agreed to begin a groundwater investigation at the site.

5. June 2001 Supplemental Investigation

A groundwater investigation was conducted at Site 18 in June 2001 (CH2M HILL, 2001). Three new monitoring wells were installed within the estimated boundary of the site. Several volatile organic compounds (VOCs) and SVOCs exceeded the USEPA Region 3

RBCs for tap water and/or the federal maximum contaminant levels (MCLs); therefore additional groundwater investigative activities were recommended.

6. February 2002 Additional Field Investigation

Four additional monitoring wells were installed in the Columbia Aquifer to further characterize the extent of groundwater contamination detected during previous investigations (CH2M HILL, 2002). Groundwater analytical data were compared to the USEPA Region 3 tap water RBCs and MCLs. The February 2002 analytical data was similar to the June 2001 analytical data and suggested detected VOCs were localized at the site. In general, the same VOCs and metals detected during the June 2001 event exceeded screening values during the February 2002 event. However, no VOCs were detected in new monitoring wells installed on the outer boundaries of the site. Various metals were detected in these boundary wells; however the only exceedences (two metals) were detected in monitoring located north of the drainage channel. The presence of these metals north of the site (north of the drainage channel, flowing southwest toward the channel) indicated that they were not related to historical site operations and were attributed to background conditions.

Due to the elevated VOC concentrations, in one centrally located well, and elevated metal concentrations throughout the site, an Expanded Site Investigation (ESI) was recommended to further evaluate soil, sediment, surface water, and groundwater media.

7. December 2002 Expanded Site Investigation

The December 2002 ESI was conducted to further define the nature and extent and mobility of VOCs and metals in all media at the site (CH2M HILL, 2007). Soil borings were installed during which time soil cores were field-screened using a photoionization detector (PID). Screening results indicated only one response of the PID near the centrally located monitoring well MW03S.

Soil samples were collected for laboratory analysis throughout the site and along the bank of the drainage channel. The data were compared to residential soil RBCs and USEPA Region 3 Biological Technical Assistance Group (BTAG) screening benchmarks (and additional screening values available in the literature when there were no BTAG values). Several VOCs, SVOCs, and metals exceeded one or more screening value; however only two metals exceeded the established NSN soil background values (CH2M HILL, 2000).

Co-located surface water and sediment samples were collected from the drainage channel. Surface water data were compared to tap water RBCs and BTAG benchmarks. Two VOCs were detected above the tap water RBCs in all surface water sample; however, the detected concentrations were below site-specific background (i.e., upstream) concentrations. Therefore it was concluded that the VOCs may not be site-related. In addition, several metals exceeded the BTAG benchmarks for surface water; however when the samples were filtered, only one metal exceeded the BTAG benchmarks. Sediment data were compared to residential soil RBCs and BTAG benchmarks. All sediment results were below the residential soil RBCs; however, several metals were detected above the BTAG benchmarks. The exceedances were typically detected upstream of the site indicating that the metals were not site-related.

Two new monitoring wells were installed at varying depths in central location of the site where the highest VOC concentrations were previously detected. Following the installation of the new monitoring wells, all Site 18 monitoring wells were sampled. The groundwater data were compared to tap water RBCs and MCLs. Similar to the June 2001 and February 2002 results, the same VOCs and metals exceeded screening values in December 2002. The highest VOC concentrations were detected in two of the three centrally-located monitoring wells, both screened in the Columbia Aquifer. This indicated VOC contamination over the entire thickness of the Columbia Aquifer in this vicinity. With the exception of chloroform, VOCs and metals were not detected in the deep monitoring well installed in the Yorktown Aquifer. The chloroform detection was attributed to laboratory blank contamination. Generally, the highest concentrations of metals were detected in an upgradient monitoring well. A preliminary evaluation of natural attenuation of CVOCs at the site determined that natural attenuation was likely occurring.

Preliminary ecological and human health risk evaluations were completed based on a qualitative assessment using conservative screening values. No unacceptable risk was identified for ecological receptors. However, potential human health risk was identified for exposure to CVOCs in the groundwater (based on exceedances of MCLs and tap water RBCs). Therefore, it was recommended that an interim action be conducted to address the localized CVOCs detected in the Columbia Aquifer. To determine the existence of a CVOC plume versus an isolated hotspot, a membrane interface probe (MIP) survey and addition groundwater sampling were recommended.

8. December 2004 Additional Delineation

Additional delineation activities were conducted in December 2004 to determine the existence of a CVOC plume versus an isolated hotspot (CH2M HILL, 2007). Delineation was accomplished using a membrane interface probe (MIP) survey. Based on the results of the MIP survey, in situ grab groundwater samples were collected at select locations. In addition, groundwater samples were collected from monitoring wells MW03C and MW03S in the Columbia Aquifer. Groundwater data were compared to tap water RBCs and MCLs.

Concentrations of two CVOCs exceeded MCLs at the northern and eastern site boundaries, however there were no exceedences at the southern and western site boundaries. The MIP survey also confirmed that the CVOCs were indeed localized to a hot spot at the site. Temporal VOC groundwater data indicated similar or lower concentrations over time in this vicinity. The installation of additional monitoring wells was recommended to confirm the results of the MIP survey and in situ grab groundwater samples.

9. June 2006 Groundwater Sampling

Three additional monitoring wells were installed where previous in situ grab groundwater concentrations exceeded MCLs. Groundwater samples were collected from the three new wells and three existing wells. The groundwater data were compared to tap water RBCs and MCLs. Several CVOCs exceeded the screening criteria; however, a decrease in CVOC concentrations was observed. In addition, the potential for natural attenuation was evaluated by applying the USEPA (1997) screening procedure to the temporal data, which indicated there was evidence of the ongoing biodegradation of CVOCs at the site.

10. July 2007 Groundwater Sampling

In support of the EE/CA (Attachment A), groundwater samples were collected from all monitoring wells in July 2007 to provide information on the entire site from one event, as well as to ensure available data were current. The groundwater data were compared to tap water RBCs and MCLs. CVOCs were detected above screening values in a defined area of the site. The EE/CA was prepared to evaluate potential alternatives to mitigate potential unacceptable human health risk due to the presence of CVOCs in the Columbia Aquifer (CH2M HILL, 2007). Enhanced reductive dechlorination (ERD) was selected as the recommended alternative in the EE/CA.

C. Physical Location

NSN is the largest naval base in the U.S. and is situated on 4,631 acres of land in the northwestern portion of Norfolk, Virginia. NSN is bounded by Willoughby Bay to the north, the confluence of the Elizabeth and James Rivers to the west, and the City of Norfolk to the south and east (Figure 2-1). A portion of the eastern facility boundary is formed by Mason Creek.

NSN includes approximately 4,000 buildings, 20 piers, and an airfield. The western portion of the facility is a developed waterfront area containing the piers and facilities for loading, unloading, and servicing naval vessels. The remaining portions of the facility consist of a combination of industrial, commercial, and residential uses. Residential and recreational areas also border the facility to the south, east, and northeast.

NSN began operations in 1917, when the Navy acquired 474 acres of land to develop a naval base to support World War I activities. Bulkheads were built along the coast to extend available land and, after dredge and fill operations, the total land under Navy control was 792 acres. An additional 143 acres of land was acquired and officially commissioned for a Naval Air Station in 1918. From 1936 through 1941, improvements to the piers and an expansion of supply/material handling facilities were also completed. During World War II, a power plant, numerous runways and hangars, a tank farm, and several housing complexes were completed, with the total area of the facility expanding to more than 2,100 acres. After World War II, NSN continued to acquire land through various land transfers and significant dredge and fill operations conducted in the areas of Mason Creek, Bousch Creek, and Willoughby Bay.

NSN provides support to vessels, aircraft, and other activities. NSN also houses many tenants, each performing different operations involving the servicing and maintenance of vessels and aircraft. The service and maintenance of ships includes utilities hook-up, onboard maintenance, and coordination of ship movements in the harbor. Additional functions include loading, unloading, and handling of fuels and oils used aboard the vessels. Ship and aircraft repair operations consist of paint stripping, patching, cleaning, repainting, engine overhauls, and sandblasting. Repair operations are conducted under appropriate environmental regulations.

D. Site Characteristics

Site 18 consists of the Former NM Storage Area located in the southeastern corner of NSN (Figure 2-1). The site was used from 1975 to 1979 to store drums containing waste oil, metal plating solutions and sludges, chlorinated organic solvents (e.g., trichloroethene [TCE] and 1,1,1-trichloroethane), acids, and/or paint stripping solutions (CH2M HILL, 2007). The storage area was an open, unpaved yard east of the metal storage buildings in the NM Storage Area (Taussig Can Area). Accidental releases of drum contents occurred onsite, but an intentional spill occurred in July 1979 (ES&E, 1983). As a result of the July 1979 spill, a pit was excavated and an existing drainage ditch was widened and lengthened to channel the waste oil and contaminated runoff. The liquids were periodically pumped from the pit and transported to a wastewater treatment plant. Soil in the area of the spill was sampled and found to be contaminated primarily with chromium and cadmium. However, the soil was determined nonhazardous. A one-time landfill permit was obtained in October 1980 from the Virginia Department of Solid Waste to allow the contaminated soil at Site 18 to remain in place. The area was re-graded and seeded to establish a vegetative cover. Follow-on monitoring occurred at the site.

1. Site Surface Water Hydrology and Geology

Site 18 is currently vegetated. Overland flow is toward the small manmade ditch north of Site 18 (Figure 2-2). Sediments in this small drainage ditch consist of silty sands and fine to medium-grained clean sands.

Boring logs (CH2M HILL, 2007) collected during previous investigations at Site 18 show that the uppermost Sand Bridge Formation is approximately 30-foot (ft) thick site-wide as expected; however, the Norfolk Formation in this vicinity is not consistent across the entire site and is generally less than several feet thick.

A fill layer ranging from 1- to 3-ft thick comprised of sand with some debris (wood, glass, and coal fragments) was observed at the surface in the central and western portions of the site during the installation of wells MW01S, MW02S, and MW03S. Less fill material was observed at the eastern edge near well MW05S or in the upgradient and downgradient monitoring well locations (MW04S, MW06S, and MW07S) (CH2M HILL, 2002).

2. Hydrogeology

The Columbia Aquifer at Site 18 consists of fine to coarse-grained sands with minor amounts of silt, gravel layers, and shell hash. Depth to water typically ranges from 3.5 to 7 ft below ground surface (bgs). The Yorktown Confining Unit is located between 22 and 35 ft bgs throughout the site. The Yorktown Aquifer, below the confining unit, consists of fine to coarse-grained sands with some interbedded shell hash and thin clay layers.

Groundwater in the Columbia Aquifer flows north-northeast through the site toward the drainage channel located immediately north of the site boundary (Figure 2-2). The hydraulic gradient is low across the site at less than 0.005 ft/ft. There are local flow variations a groundwater flows past the monitoring well MW03S well cluster, past monitoring well MW08S towards the drainage channel. The drainage channel is the discharge point for the shallow groundwater flowing to the northeast from the site. North of the site, across the drainage channel, groundwater flows to the southwest towards the channel.

III. Release or Threatened Release into the Environment of a Hazardous Substance, Pollutant, or Contaminant

The site was used from 1975 to 1979 to store drums containing waste oil, metal plating solutions and sludges, chlorinated organic solvents, acids, and/or paint stripping solutions (CH2M HILL, 2007). Accidental releases of drum contents occurred onsite, but an intentional spill occurred in July 1979 (ES&E, 1983).

As part of the December 2002 Expanded Site Investigation, preliminary ecological and human health risk evaluations were completed based on a qualitative assessment using conservative screening values. No unacceptable risks were identified for ecological receptors. However, potential human health risk was identified for potential exposure to CVOCs in the groundwater. CVOCs are localized to the site and are not migrating offsite at levels that would cause an unacceptable risk. The Final Site Investigation Summary Report (CH2M HILL, 2007) recommended an EE/CA to evaluate removal alternatives to address the groundwater impacted by CVOCs at Site 18.

IV. National Priorities List Status

NSN was placed on the USEPA's NPL on April 1, 1997.

V. Maps, Pictures, and Other Graphic Representations

Several figures included in the EE/CA (Attachment A) provide graphical representation of Site 18 and its surroundings and the proposed removal action design. These include:

- Figure 2-1: Installation and Site Location
- Figure 2-2: Site Layout and Sample Locations
- Figure 4-2: Alternative #3—Enhanced Reductive Chlorination

VI. Summary of Actions to Date

A. Previous Actions

As a result of the July 1979 spill at Site 18, a pit was excavated and an existing drainage ditch was widened and lengthened to channel the waste oil and contaminated runoff. The liquids were periodically pumped from the pit and transported to a wastewater treatment plant. Soil in the area of the spill was sampled and found to be nonhazardous. A one-time landfill permit was obtained in October 1980 from the Virginia Department of Solid Waste to allow the contaminated soil at Site 18 to remain in place. The area was re-graded and seeded to establish a vegetative cover. Follow-on monitoring and additional investigations occurred at the site as detailed in Section B.

B. Current Actions

There are no current actions. The proposed near-future removal action is described herein and in the EE/CA (CH2M HILL, 2008).

VII. State and Local Authority's Role

A. State and Local Actions to Date

Under Executive Order 12580, the President delegates authority to undertake CERCLA response actions to the Department of Defense (DoD). Congress further outlined this authority in the Defense Environmental Restoration Program (DERP) Amendments, under 10 United States Code (USC) Sections 2701 through 2705. CERCLA Section 120 requires the Navy to apply state removal and remedial action law requirements at its facilities.

B. Potential for Continued State/Local Response

The Navy will continue to be the lead agency and the Navy's environmental restoration program will continue to be the exclusive source of funding for remedial actions on NSN property. As members of the NSN Tier I Partnering Team, the USEPA and Virginia Department of Environmental Quality (VDEQ) will continue to be consulted until actions addressing the contaminated area are complete.

VIII. Threats to Public Health, Welfare or the Environment, and Statutory and Regulatory Authorities

Section 300.415 of the NCP lists the factors to be considered in determining the appropriateness of a NTCRA. Paragraph (b)(2)(i) of Section 300.415 applies to the conditions as follows:

300.451(b)(2)(i) *Actual or potential exposures to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.*

Preliminary ecological and human health risk evaluations were completed based on a qualitative assessment using conservative screening values. No unacceptable risk was determined for ecological receptors for any media, but potential human health risk was identified for potential exposure to groundwater only.

IX. Endangerment Determination

Actual or threatened releases of pollutants and contaminants from Site 18, if not addressed by implementing the removal action discussed in this Action Memorandum, while not presenting an endangerment to ecological receptors, may present an endangerment to public health.

X. Proposed Actions and Estimated Costs

A. Proposed Actions

The scope of the removal action to be initiated at Site 18 consists of the injection of an electron donor substrate in order to enhance the natural biological degradation of CVOCs

(i.e., ERD) in groundwater. This removal action is anticipated to mitigate potential risks to human health.

1. Proposed Action Description

The preferred removal action alternative for Site 18 proposes implementation of ERD to mitigate the potential human health risk. The NCP recognizes the treatment of hazardous materials to reduce the likelihood of human exposures as an appropriate removal alternative for consideration under NTCRAs (Title 40 Code of Federal Regulations [CFR] 300.415[e][8]). Therefore, this Action Memorandum and the EE/CA refer to Alternative 3 (ERD) as a "removal action," which is consistent with the NCP.

An emulsified oil will serve as the electron donor to indigenous bacteria, thus enhancing the natural reductive dechlorination process in the aquifer. The food-grade oil will be injected in a grid pattern within the 10 micrograms per liter (µg/L) total CVOC isoconcentration contour line using approximately 27 temporary direct push technology (DPT) injection points (Figure 4-2). The total area to be treated within the 10 µg/L total CVOC isoconcentration contour will be approximately 11,000 square feet (ft^2). Based on the depths of CVOC detections, the treatment thickness will be approximately 10 ft.

Approximately 12,100 pounds (2,640 gallons) of emulsified oil (brand EOS®598 for these calculations) will be required for the entire injection area. Approximately 100 gallons of an EOS®/water mixture will be injected into each DPT injection point followed by 2,000 gallons of potable water for most effective and optimal radial distribution.

Following the injection, land use controls (LUCs) and associated activities will be implemented to ensure that there is no exposure to the groundwater until cleanup goals are met.

2. Contribution to Remedial Performance

The NTCRA for Site 18 will mitigate potential human health risks and satisfy project implementation and cost requirements. As discussed in Section II, results have identified potential risk and delineated the nature and extent of contamination.

3. Description of Alternatives Technologies

Three alternatives were evaluated and compared based on their effectiveness, implementability, and cost. The EE/CA (Attachment A) for Site 18 describes each of the alternatives considered in greater detail, and the process by which the alternatives were evaluated, compared, and selected. The preferred alternative for Site 18 is Alternative 3, ERD. The selection of this alternative balances the effectiveness of Alternatives 1 and 2 against their implementability and cost.

4. Applicable or Relevant and Appropriate Requirements

The NCP requires that removal actions attain Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) with limited exception to the extent practicable. Analysis of the removal action alternatives for Site 18 with the applicable ARARs is presented in the EE/CA The removal action set forth in this Action Memorandum will comply with ARARs to the extent practicable.

5. Project Schedule

The Draft Final Site 18 EE/CA was made available to the public for comment for 30 days beginning on January 25, 2008 (Attachment B). No comments were received from the public during the comment period.

The proposed estimated project schedule is as follows:

- EE/CA Public Comment Period 1 Month
- Preparation of Work Plan 4 Months
- Removal Action Implementation 1 Month
- Report Writing 3 Months

B. Estimated Costs

The NCP 40 CFR Part 300.415 dictates statutory limits of $2 million and 12 months of USEPA fund-financed removal actions, with statutory exemption for emergencies and actions consistent with the removal action to be taken. This removal action will not be USEPA fund-financed. The Navy ERP does not limit the cost or duration of the removal action (Navy, 2006).

1. Response Action Contract

The Navy will contract with an environmental remediation contractor to perform the required work associated with the removal action at Site 18. The estimated costs are itemized in Table 10-1.

TABLE 10-1
Alternative 3 – Site 18 Enhanced Reductive Dechlorination
Estimated Cost of Removal Action

Implementation: Work Plan, LUC Survey/Design, Injection	
Work Plan (i.e., Injection and Performance Monitoring Plan)	$24,000
Land-Use Control Design	$9,600
Utility Mark out	$2,000
Substrate Material	$24,940
Substrate Material Delivery	$5,800
Mobilization	$9,450
Substrate Injection Activity	$94,500
Drum Disposal	$435
Subtotal	**$170,725**
Performance Bond multiplier (0.4%)	$683
Oversight and Project Management multiplier (20%)	$34,145
Subtotal	**$205,553**
Future Costs: LUCs and Performance Monitoring	
Present Value of Future Costs for Performance Monitoring and Managing LUCs for 5 years	$170,222
Subtotal Implementation + Future Costs (Present Value)	**$375,775**
Contingency multiplier (20%)	$75,155
Subtotal	**$450,930**

General Conditions multiplier (10%)	$45,093
Subtotal	**$496,023**
Contractor Overhead/Profit multiplier (15%)	$49,602
Total Current Cost of Alternative 3 (Implementation + Future Costs [Present Value])	**$546,000**

XI. Expected Change in the Situation Should Action Be Delayed or Not Taken

If no action is taken or the action is delayed, the potential for human health risk will remain.

XII. Outstanding Policy Issues

There are no outstanding policy issues regarding this action.

XIII. Enforcement

The Navy can and will perform the proposed response promptly and properly.

XIV. Recommendation

This Decision Document represents the selected removal action for Site 18 at NSN, Norfolk, Virginia, developed in accordance with CERCLA as amended, and is consistent with the NCP. This decision is based on the Administrative Record file for NSN.

Conditions at the site meet the NCP Section 300.415(b)(2) criteria for removal action. NAVFAC Mid-Atlantic in cooperation with the USEPA and VDEQ recommends approval of the proposed removal action. If approved, the total project ceiling for Site 18 is estimated to be $546,000. Response actions should commence as soon as practicable to expedite site cleanup.

XV. References

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Figure 2-1
Installation and Site Location
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

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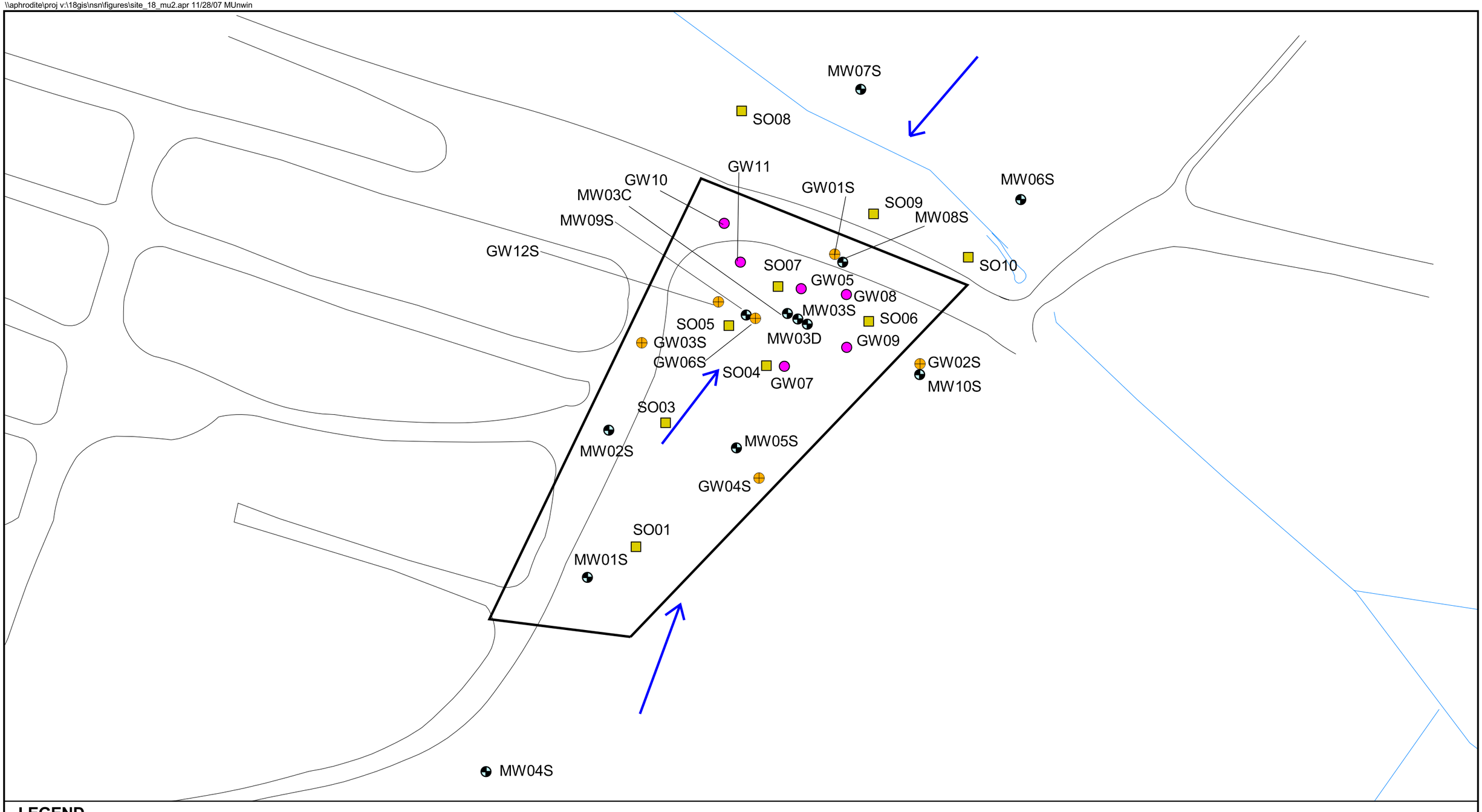

LEGEND

- Monitoring Well
- In-Situ Groundwater During MIP Investigation
- Soil Sampling Location
- MIP Locations
- Estimated Site Boundary
- Groundwater Flow Direction

N

0 60 120 Feet

Figure 2-2
Site Layout and Sample Locations
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

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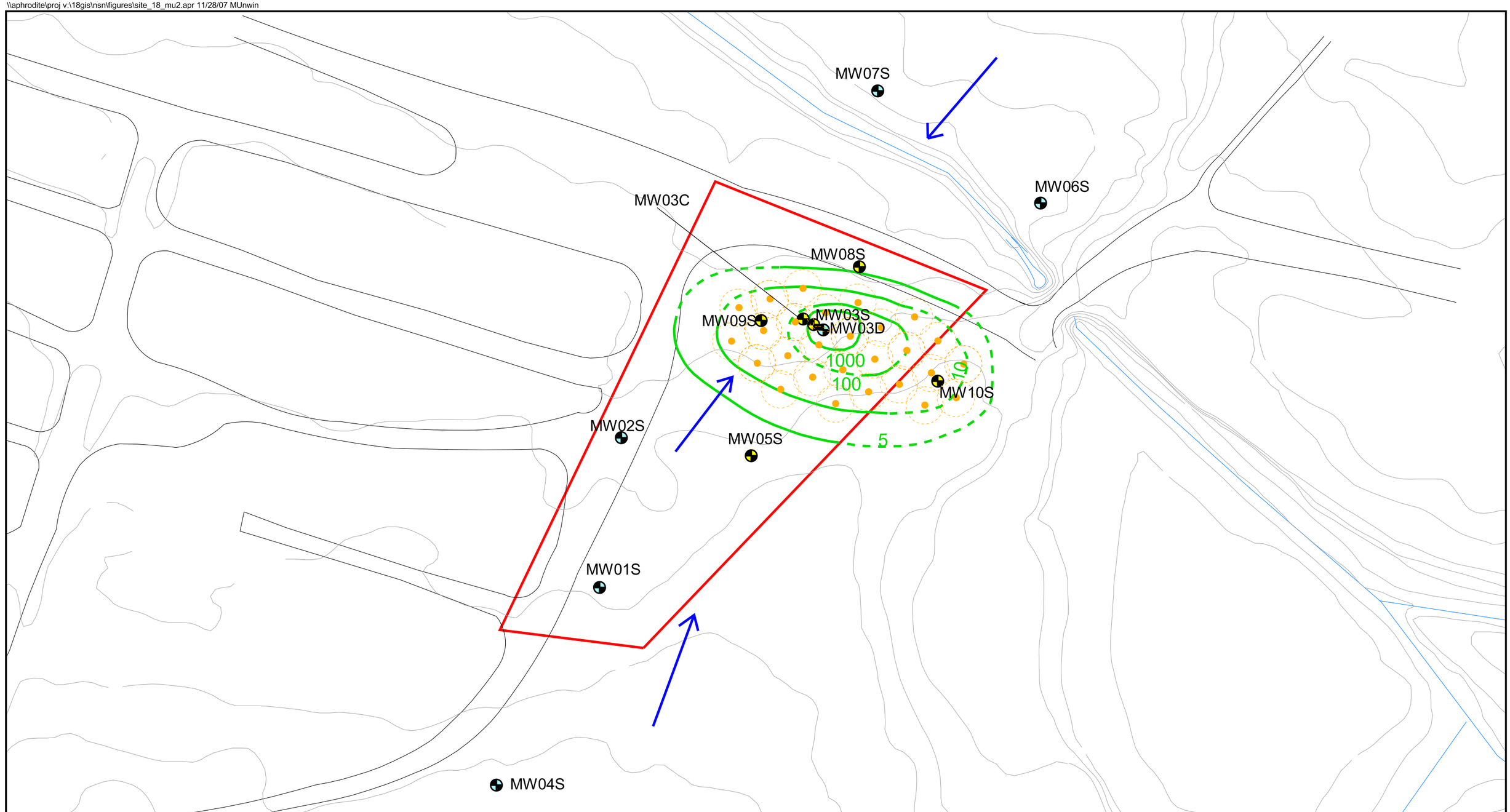

LEGEND

- Existing Monitoring Wells
- Estimated Site Boundary
- Estimated Groundwater Flow Direction
- Topographic Contours
- Total CVOCs Isoconcentration Contours (µg/L) (Dashed where inferred)
- Drainage Channel
- Proposed DPT Injection Point (12 ft ROI typical)
- Performance Monitoring Wells

N

0 60 120 Feet

Figure 4-2
Alternative 3 - Enhanced Reductive Dechlorination
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

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Attachment A
Final EE/CA for Site 18

Attachment A, the Final Engineering Evaluation/Cost Analysis (EE/CA) for Site 18 Former Naval Magazine Waste Storage Area is also located in the Administrative Record File as document number 01765.

Attachment B, the Public Notice inviting the Public to comment on the EE/CA for Site 18 is also in the Administrative Record File as document number 01731.

Final

Engineering Evaluation/Cost Analysis
Site 18, Former Naval Magazine Waste Storage Area

Naval Station Norfolk
Norfolk, Virginia

Contract Task Order 173

March 2008

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

LANTDIV CLEAN III Program
Contract N62470-02-D-3052

Prepared by

CH2MHILL

Virginia Beach, Virginia

Executive Summary

This report presents an Engineering Evaluation/Cost Analysis (EE/CA) for a Non-Time-Critical Removal Action (NTCRA) at Site 18—Former Naval Magazine Waste Storage Area, Naval Station Norfolk (NSN), Norfolk, Virginia. Site 18 is located in the southeast corner of NSN and consists of an open, grassy field east of Patrol Road. Previous site investigations detected chlorinated volatile organic compounds (CVOCs) in groundwater above maximum contaminant levels (MCLs) and risk-based screening levels. CVOCs are localized in the northern portion of the site and are not migrating offsite at levels causing unacceptable risk (i.e., presumably unacceptable risk exists only onsite due to potential exposure to groundwater).

This EE/CA has been prepared in accordance with current United States Environmental Protection Agency (USEPA) and Navy guidance documents for a NTCRA under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and provides an evaluation and comparison of alternatives to achieve the Removal Action Objective (RAO) for this NTCRA, which is to implement measures at Site 18 to mitigate potential unacceptable human health risk associated with exposure to CVOCs in groundwater.

Three removal action alternatives were evaluated and compared herein:

- **Alternative 1—No Action**. The no action alternative implies that no removal work would be done at this site.
- **Alternative 2—Monitored Natural Attenuation (MNA).** Reliance on the natural biodegradation of CVOCs in groundwater, as evaluated by groundwater monitoring, to achieve RAO.
- **Alternative 3—Enhanced Reductive Dechlorination (ERD).** Application of an electron donor to enhance the natural biological degradation of CVOCs in groundwater.

Alternative Evaluation

Alternative 1—No Action

The no action alternative implies that no removal work would be conducted at this site and the site would be left as it currently exists. The impacted groundwater would be left onsite for potential future exposure and contaminants might migrate further to the surrounding media. Selection of this alternative does not satisfy the RAO. There is no cost associated with this no action alternative.

Alternative 2—MNA

This alternative would rely on the one or more natural attenuation mechanisms to decrease and eliminate CVOCs. Land use controls (LUCs) to restrict the use of groundwater would be implemented until the RAO is achieved. Therefore this alternative is protective of human

health and the environment and expected to comply with applicable or relevant and appropriate requirements (ARARs).

Preliminary CVOC degradation modeling suggests that CVOC concentrations would decrease below MCLs (selected herein as cleanup levels for Site 18) in approximately 13 years. Groundwater monitoring would be required until the groundwater concentrations have reduced to or below the MCLs.

This alternative is considered easy to implement because it only involves sampling existing monitoring wells and implementing LUCs. The estimated total current cost for Alternative 2 is $493,000 (assuming the RAO would be achieved in 13 years). Implementation costs ($46,000) for this alternative include preparation of a groundwater monitoring plan and implementation of LUCs. Long-term costs (present value $447,000 over 13 years) include groundwater monitoring, quarterly site inspections, 5-year reviews, and associated data management and reporting.

Alternative 3—ERD

This alternative is a proven technology that involves introduction of substrate to the aquifer via injection in order to enhance the reductive dechlorination of CVOCs. In addition, this alternative includes post-injection groundwater monitoring and LUCs. This alternative would actively treat the chemicals of potential concern (COPCs) and prevent human exposure through the use of LUCs until the RAO is met. Therefore this alternative is protective of human health and the environment and is expected to comply with ARARs.

The electron donor substrate would be injected into the aquifer via temporary DPT injection points to stimulate indigenous dehalogenating (i.e., dechlorinating) microbes, accelerating the reduction of CVOCs (the COPCs at the site consist of CVOCs only). Following the injection, favorable conditions for continued ERD would be established in the aquifer. ERD is expected to reduce or eliminate concentrations of the COPCs to levels below the MCLs within approximately five years. As part of this alternative, performance monitoring will be required and will be conducted utilizing the existing monitoring wells. Alternative 3 will require additional health and safety precautions as compared to Alternative 2 to protect workers during the intrusive mechanical injection activities. However, the material to be injected is a nontoxic food-grade mixture of soybean oil, lactate, and vitamins, which has no negative impacts on the community or the environment.

The estimated total current cost for Alternative 3 is $546,000 (assuming the use of EOS® substrate and the RAO would be achieved in 5 years). Implementation costs ($299,000) for this alternative include preparation of the injection work plan and groundwater performance monitoring plan, the injection activity, and implementation of LUCs. Long-term costs (present value $247,000 - over 5 years) include groundwater monitoring, quarterly site inspections, 5-year reviews, and associated data management and reporting.

Alternative Comparison

Alternative 1—No Action

The No Action alternative is not considered to be effective. However, it is easy to implement and does not require funding as no action would be taken.

Alternative 2—MNA

MNA is effective, but is estimated to take 13 years to achieve the RAO, whereas Alternative 3 would show immediate results within the first year and can be completed in an estimated 5 years. Alternative 2 requires sampling the existing monitoring wells. Both Alternatives 2 and 3 offer the same protectiveness and compliance with ARARs. Their estimated costs are comparable at $493,000 (Alternative 2) and $546,000 (Alternative 3) (within 11 percent); however, Alternative 3 requires significantly more funding (over $250,000) during the first year.

Alternative 3—ERD

Enhanced Reductive Dechlorination is effective and can be completed in less than half the timeframe of Alternative 2 with considerable improvement of the aquifer conditions during the first year. Both Alternatives 2 and 3 offer the same protectiveness and compliance with ARARs. Their costs are comparable (within 11 percent); however, Alternative 3 would meet the RAO in less than half the time of Alternative 2.

Recommended Alternative

The comparative analysis included evaluating the effectiveness, implementability, and cost of each alternative. The evaluation of effectiveness included reviewing the protectiveness of the alternative; compliance with ARARs to the extent practical; long-term effectiveness and permanence; reduction in toxicity, mobility, or volume; short-term effectiveness; and its ability to meet the RAO. The evaluation of implementability included looking at the technical feasibility, availability, and administrative feasibility of the alternatives. The evaluation of cost included a review of capital cost and future cost (present value) for each alternative.

Based on the comparative analysis of the alternatives, **the recommended removal action is Alternative 3, Enhanced Reductive Dechlorination.** This alternative would satisfy project implementation and cost requirements, achieve the RAO of the NTCRA, and lead to site closure in the most expeditious, cost-effective manner.

In accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), this EE/CA will be placed in the Administrative Record, and notice of its availability for public review, along with a brief summary, will be published in the local newspaper. The EE/CA will then be subjected to a 30-day public comment period. The public comment period will be held from January 25, 2008, through February 25, 2008. A public information session will also be held during or immediately following the public comment period, if requested. Following the public comment period, if comments are received, a Responsiveness Summary summarizing responses to significant comments will be prepared and included Action Memorandum describing the proposed removal action and placed in the Administrative Record.

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Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action—Navy
COPC	chemical of potential concern
CTO	Contract Task Order
CVOC	chlorinated volatile organic compound
DCB	dichlorobenzene
DCE	dichloroethene
DO	dissolved oxygen
DPT	Direct Push Technology
EE/CA	Engineering Evaluation/Cost Analysis
ERD	enhanced reductive dechlorination
ESI	Expanded Site Investigation
ESS	Explosive Safety Submission
ft	foot, feet
ft^2	square feet
HI	hazard index
ILCR	incremental lifetime cancer risk
IRP	Installation Restoration Program
LUC	land use control
µg/L	microgram per liter
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MIP	membrane interface probe
MNA	monitored natural attenuation
MTBE	methyl-tert-butyl-ether
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NFA	No Further Action
NM	Naval Magazine

NSN	Naval Station Norfolk
NTCRA	Non-Time-Critical Removal Action
ORP	oxidation-reduction potential
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
RAO	Removal Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RRR	Relative Risk Ranking
SARA	Superfund Amendments and Reauthorization Act
SVOC	semivolatile organic compound
TCE	trichloroethene
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound

SECTION 1

Introduction

This report presents an Engineering Evaluation/Cost Analysis (EE/CA) for a Non-Time-Critical Removal Action (NTCRA) for Installation Restoration Program (IRP) Site 18, Former Naval Magazine (NM) Waste Storage Area, at Naval Station Norfolk (NSN) in Norfolk, Virginia.

A removal action is being considered for Site 18 to mitigate potential unacceptable human health risk due to the presence of chlorinated volatile organic compounds (CVOCs) in groundwater (CH2M HILL, 2007).

1.1 Regulatory Background

This document is issued by the United States (U.S.) Department of the Navy (Navy), lead agency responsible for the NTCRA at Site 18, in partnership with the United States Environmental Protection Agency (USEPA) Region 3 and the Virginia Department of Environmental Quality (VDEQ)[1], under Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Section 104 of CERCLA and SARA allows an authorized agency to provide for remedial action and to remove, or arrange for removal of, hazardous substances, pollutants, or contaminants at any time, or to take any other response measures consistent with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) as deemed necessary to protect public health or welfare and the environment.

The NCP, Title 40 of the Code of Federal Regulations (CFR), Section 300, provides regulations for implementing CERCLA and SARA and regulations specific to removal actions. The NCP defines a removal action as:

> [The] cleanup or removal of released hazardous substances from the environment, such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

A removal action is being considered for Site 18 to mitigate potential unacceptable human health risk from exposure to groundwater. This removal action is not time-critical. NTCRAs are defined in 40CFR 300.415(b)(4) as "actions pertaining to an imminent threat to human health and the environment… that have planning periods of 6 months or more."

[1] The entity of the partnership between the Navy, USEPA Region 3, and VDEQ is called the NSN Tier I Partnering Team.

For time-critical removal actions, activities shall begin as soon as possible to "abate, prevent, minimize, stabilize, mitigate, or eliminate the threat to public health or welfare of the United States or the environment"(40 CFR 300.415[b][3]).

40 CFR 300.415 requires the lead agency to conduct an EE/CA when a NTCRA is planned for a site. The goals of an EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. An EE/CA documents the removal action alternatives and selection process. Where the extent of the contamination is well defined and limited in extent, NTCRAs also allow for the expedited cleanup of sites in comparison to the remedial action process under CERCLA.

Community involvement requirements for NTCRAs include preparing an EE/CA and making it available for public review and comment for a period of 30 days. An announcement of the 30-day public comment period on the EE/CA is required in a local newspaper. Written responses to significant comments will be provided in a responsiveness summary to be attached to the Navy's Action Memorandum and will be included in the NSN Administrative Record. Information on the NSN Administrative Record can be found on the NSN Public Installation Restoration Program Web Site at http://public.lantops-ir.org/sites/public/nsn/Site%20Files/AdminRecords.aspx. The Administrative Record is available for public review at the Naval Facilities Engineering Command (NAVFAC) Atlantic Public Affairs Office.[2]

1.2 Purpose and Objectives

Submittal of this document fulfills the requirements for NTCRAs defined by CERCLA, SARA, and the NCP. This EE/CA has been prepared in accordance with USEPA (1993) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*.

This EE/CA compares three removal alternatives based on their technical feasibility, ability to protect human health and the environment, ability to prevent the potential release of hazardous chemicals or substances, and cost. Individual goals of this EE/CA are to:

- Satisfy environmental review and public information requirements for removal actions.
- Satisfy administrative record requirements for documenting the removal action selection.
- Provide a framework for evaluating and selecting alternative technologies.

The objective of this NTCRA is to mitigate potential unacceptable human health risk from exposure to CVOCs in groundwater at Site 18.

This EE/CA will provide and reference key site background information that lead to the decisions to perform a NTCRA. The specific alternatives evaluated to meet the removal objective are as follows:

- **Alternative 1:** No Action
- **Alternative 2:** Monitored Natural Attenuation (MNA)
- **Alternative 3:** Enhanced Reductive Dechlorination (ERD)

[2] Public Affairs Office, NAVFAC Atlantic, 6506 Hampton Blvd, Norfolk, VA 23508-1278; 757-322-8005; NFECL_PAO@navy.mil.

SECTION 2

Site Characterization

This section provides a brief summary of the facility background and environmental history, a description of Site 18, and a summary of previous investigations completed at Site 18. For additional background and historical information, please refer to the *Final Site Investigation Summary Report, Site 18, Former Naval Magazine Waste Storage Area, Naval Station Norfolk, Norfolk, Virginia* (CH2M HILL, 2007)

2.1 Facility History

NSN is the largest naval base in the U.S. and is situated on 4,631 acres of land in the northwestern portion of Norfolk, Virginia. NSN is bounded by Willoughby Bay to the north, the confluence of the Elizabeth and James Rivers to the west, and the City of Norfolk to the south and east (Figure 2-1). A portion of the eastern facility boundary is formed by Mason Creek.

NSN includes approximately 4,000 buildings, 20 piers, and an airfield. The western portion of the facility is a developed waterfront area containing the piers and facilities for loading, unloading, and servicing naval vessels. The remaining portions of the facility consist of a combination of industrial, commercial, and residential uses. Residential and recreational areas also border the facility to the south, east, and northeast.

NSN began operations in 1917, when the Navy acquired 474 acres of land to develop a naval base to support World War I activities. Bulkheads were built along the coast to extend available land and, after dredge and fill operations, the total land under Navy control was 792 acres. An additional 143 acres of land was acquired and officially commissioned for a Naval Air Station in 1918. From 1936 through 1941, improvements to the piers and an expansion of supply/material handling facilities were also completed. During World War II, a power plant, numerous runways and hangars, a tank farm, and several housing complexes were completed, with the total area of the facility expanding to more than 2,100 acres. After World War II, NSN continued to acquire land through various land transfers and significant dredge and fill operations conducted in the areas of Mason Creek, Bousch Creek, and Willoughby Bay.

NSN provides support to vessels, aircraft, and other activities. NSN also houses many tenants, each performing different operations involving the servicing and maintenance of vessels and aircraft. The service and maintenance of ships includes utilities hook-up, onboard maintenance, and coordination of ship movements in the harbor. Additional functions include loading, unloading, and handling of fuels and oils used aboard the vessels. Ship and aircraft repair operations consist of paint stripping, patching, cleaning, repainting, engine overhauls, and sandblasting. Repair operations are conducted under appropriate environmental regulations.

2.2 Site 18 Description and Background

Site 18 consists of the Former NM Storage Area located in the southeastern corner of NSN (Figure 2-1). The site was used from 1975 to 1979 to store drums containing waste oil, metal plating solutions and sludges, chlorinated organic solvents (e.g., trichloroethene [TCE], 1,1,1-trichloroethane), acids, and/or paint stripping solutions (CH2M HILL, 2007). The storage area was an open, unpaved yard east of the metal storage buildings in the NM Storage Area (Taussig Can Area). Accidental releases of drum contents occurred onsite, but an intentional spill occurred in July 1979 (ES&E, 1983). As a result of the July 1979 spill, a pit was excavated and an existing drainage ditch was widened and lengthened to channel the waste oil and contaminated runoff. The liquids were periodically pumped from the pit and transported to a wastewater treatment plant. Soil in the area of the spill was sampled and found to be contaminated primarily with chromium and cadmium. However, the soil was determined nonhazardous. A one-time landfill permit was obtained in October 1980 from the Virginia Department of Solid Waste to allow the contaminated soil at Site 18 to remain in place. The area was re-graded and seeded to establish a vegetative cover. Follow-on monitoring occurred at the site (refer to Section 2.3.1).

2.2.1 Site Surface Water Hydrology and Geology

Site 18 is currently vegetated. Overland flow is toward the small manmade ditch north of Site 18 (Figure 2-2). Sediments in this small drainage ditch consist of silty sands and fine to medium-grained clean sands.

Boring logs (CH2M HILL, 2007) collected during previous investigations at Site 18 show that the uppermost Sand Bridge Formation is approximately 30-foot (ft) thick site-wide as expected; however, the Norfolk Formation in this vicinity is not consistent across the entire site and is generally less than several feet thick.

A fill layer ranging from 1- to 3-ft thick comprised of sand with some debris (wood, glass, and coal fragments) was observed at the surface in the central and western portions of the site during the installation of wells MW01S, MW02S, and MW03S. Less fill material was observed at the eastern edge near well MW05S or in the upgradient and downgradient monitoring well locations (MW04S, MW06S, and MW07S) (CH2M HILL, 2002).

2.2.2 Hydrogeology

Monitoring well construction details are provided in Table 2-1. The Columbia Aquifer at Site 18 consists of fine to coarse-grained sands with minor amounts of silt, gravel layers, and shell hash. Depth to water is typically 3.5 to 7 ft below ground surface (bgs). The Yorktown Confining Unit is at 22 to 35 ft bgs throughout the site. The Yorktown Aquifer below the confining unit consists of fine to coarse-grained sands with some interbedded shell hash and thin clay layers.

Groundwater in the Columbia Aquifer flows north-northeast through the site toward the drainage channel located immediately north of the site boundary (Figure 2-3). The hydraulic gradient is low across the site at less than 0.005 ft/ft. There are local flow variations as groundwater flows past the MW03S well cluster past MW08S to the drainage channel. The drainage channel is the discharge point for the shallow groundwater flowing to the

northeast from the site. North of the site, across the drainage channel, groundwater flows to the southwest toward the channel.

2.3 Summary of Previous Investigations

In 1981, the Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) Program. The NACIP Program utilized a three-phase approach to a site study and cleanup. The program included an Initial Assessment Study (IAS) (ES&E, 1983) to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations. Site 18 was one area of concern identified during the IAS at NSN.

Brief summaries of previous investigations are provided below. Refer to Figure 2-2 for sample and monitoring well locations.

2.3.1 1980-1985 Landfill Monitoring

The temporary landfill permit obtained in October 1980 required continuous monitoring of the shallow groundwater (Columbia Aquifer) and nearby surface water to determine if contaminant migration was occurring. In addition, monthly monitoring of the standing water from the pit and the nearby creek from February 1980 to April 1982 indicated the presence of cadmium, chromium, cyanide, and phenol (ES&E, 1983). In October 1985, the Virginia Water Control Board eliminated monitoring requirements after a review of the data.

2.3.2 1995 Resource Conservation and Recovery Act Inspection

In 1995, a Resource Conservation and Recovery Act (RCRA) inspection was conducted. The inspection found no signs of adverse impacts or threats to human health or the environment, accordingly, the site was no longer subject to RCRA inspections.

2.3.3 1995 Phase I Relative Risk Ranking Study

Site 18 was included in the Phase I Relative Risk Ranking (RRR) Study conducted at NSN in October 1995 (Baker, 1996). Two surface soil samples were collected and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), inorganics, and pesticides/polychlorinated biphenyls (PCBs). The soil data indicated the presence of several metals and SVOCs as well as two pesticides. Based on an evaluation of the site conditions (visual), potential pathways for exposures, potential for migration, and the analytical data, the study assigned moderate rankings for migration of contaminants and exposure routes (human and/or ecological receptors) for groundwater, soil, sediment, and surface water. Potential pathways were based on site conditions observed and the presence of SVOCs and metals in surface soil.

2.3.4 2001 Partnering Team Decision

The Tier I NSN Partnering Team agreed during the October 2000 Partnering Team Meeting to re-evaluate Site 18 soil by comparing the Phase I RRR soil data to most recent USEPA Region 3 residential soil risk based concentrations (RBCs). Based on the comparison, the Team agreed soil was no longer a media of concern at Site 18 (January 2001 Team Consensus). The Team agreed to begin a groundwater investigation at the site.

2.3.5 June 2001 Supplemental Investigation

A groundwater investigation was conducted at Site 18 in June 2001 (CH2M HILL, 2001). Three monitoring wells (MW01S, MW02S, and MW03S) were installed within the estimated boundary of the site and sampled for VOCs, SVOCs, inorganics, and pesticides/PCBs. The data were compared to the USEPA Region 3 tap water RBCs and federal MCLs. Several metals (arsenic, iron, manganese, antimony, and thallium), VOCs (cis-1,2-dichloroethene [cis-1,2-DCE], TCE, vinyl chloride [VC], and 1,4–dichlorobenzene [1,4-DCB]), and one SVOC (naphthalene) exceeded screening values. Further groundwater investigation was warranted.

2.3.6 February 2002 Additional Field Investigation

The objective of the February 2002 investigation was to further characterize the extent of groundwater contamination detected during previous investigations. Four additional monitoring wells (MW04S, MW05S, MW06S, and MW07S) were installed in the Columbia Aquifer. Groundwater samples were collected from all monitoring wells and analyzed for VOCs and inorganics (CH2MHILL, 2002).

The groundwater data were compared to USEPA Region 3 tap water RBCs and MCLs. The February 2002 data was similar to the June 2001 data in wells MW01S, MW02S, and MW03S, suggesting that VOCs were localized at the site. In general, the same VOCs and metals (inorganics) that were detected during the June 2001 event exceeded screening values during the February 2002 event. However, no VOCs were detected in the new wells MW04S through MW07S to the south, east, and north of the site. Various metals were detected in these new wells, but the only exceedances (total antimony and thallium) occurred in MW06S to the north of the drainage channel. The presence of these metals north of the site (north of the drainage channel, flowing southwest toward the channel) indicated that they were not related to historical site operations and were attributed to background conditions.

Due to the elevated concentrations of VOCs in well MW03S and metals throughout the site, an Expanded Site Investigation (ESI) was recommended to further evaluate soil, sediment, surface water, and groundwater media.

2.3.7 December 2002 Expanded Site Investigation

The ESI, completed in December 2002, was performed to further define the nature and extent and mobility of VOCs and metals in all media at the site (CH2M HILL, 2007).

Thirteen soil borings were installed via hollow-stem auger drilling and screened with a photoionization detector (PID). Screening results showed only one location, in the vicinity of monitoring well MW03S, with a definite PID response.

Soil samples were collected at 0 to 2 ft bgs throughout the site and along the bank of the drainage channel. All soil samples were analyzed for VOCs, SVOCs, inorganics, pH, and total organic carbon (TOC). The soil data were compared to USEPA Region 3 residential soil RBCs and USEPA Region 3 Biological Technical Assistance Group (BTAG) screening benchmarks (and additional screening values available in the literature when there was no BTAG value). Polynuclear aromatic hydrocarbons (PAHs), VOCs, and metals exceeded one

or more screening value. However, only chromium and lead exceeded the established NSN soil background values (CH2M HILL, 2000).

Five collocated surface water and sediment samples were collected in the drainage channel. The surface water samples were analyzed for VOCs, SVOCs, inorganics, and hardness. Surface water data were compared to USEPA Region 3 tap water RBCs and BTAG benchmarks. The comparison showed RBC exceedances for methyl-tert-butyl-ether (MTBE) and TCE at all surface water locations. However, the concentrations were below site-specific background (i.e., upstream) concentrations. Because the MTBE and TCE concentrations were relatively consistent in the drainage channel both up- and downstream of the site, it was concluded that the chemicals were not site-related. Several metals exceeded the BTAG benchmarks for surface water in the total metals samples; however, in filtered samples, only iron exceeded the BTAG benchmark. Sediment data were compared to USEPA Region 3 residential soil RBCs and BTAG benchmarks. There were no exceedances of RBCs; however, several metals were detected in exceedance of the BTAG benchmarks. Exceedances were most frequent upstream of the site indicating that these metals were not site related.

Two new monitoring wells (MW03C and MW03D) were installed in the vicinity of well MW03S, where the highest concentrations of VOCs were previously detected. Well MW03C was screened just above the Yorktown Confining Unit and well MW03D was screened in the Yorktown Aquifer. All monitoring wells were sampled and analyzed for VOCs and inorganics. Natural attenuation indicator analyses (TOC, alkalinity, chloride, ferrous iron, methane, ethane, ethene, nitrate, nitrite, sulfate, sulfide, and carbon dioxide) were also performed.

Groundwater data were compared to USEPA Region 3 tap water RBCs and MCLs. Similar to the June 2001 and February 2002 data, the same VOCs and metals exceeded screening values in December 2002. The highest concentrations of VOCs occurred at wells MW03S and MW03C, indicating VOC contamination over the entire thickness of the surficial aquifer (i.e., Columbia Aquifer) in this vicinity. In general, the highest concentrations of metals were found in upgradient well MW01S. The data from the sample collected from the monitoring well screened in the Yorktown aquifer showed no detections of site-related contaminants. A preliminary evaluation of natural attenuation of chlorinated solvents at the site determined that natural attenuation was likely occurring.

Preliminary ecological and human health risk evaluations were completed based on a qualitative assessment using conservative screening values. No unacceptable risk was determined for ecological receptors due to site-related contaminants above background levels. Potential human health risk was identified for potential exposure to groundwater only. Therefore, it was recommended that an interim action be conducted to address the VOCs detected in groundwater at MW03S and MW03C. To further delineate the extent of VOCs detected in the MW03 well cluster and determine the existence of a plume or isolated hotspot, a membrane interface probe (MIP) survey and additional groundwater sampling was recommended.

2.3.8 December 2004 Additional Delineation

The objectives of the December 2004 investigation were to further define the extent of VOCs detected in wells MW03S and MW03C and determine if there was an isolated hotspot of

VOCs. Delineation was accomplished using a MIP survey. *In situ* grab samples of groundwater were collected at select locations based on the MIP survey results and analyzed for VOCs. Groundwater samples were also collected from monitoring wells MW03S and MW03C and analyzed for VOCs. Data were screened against USEPA Region 3 RBCs and MCLs.

Concentrations of TCE and cis-1,2-DCE exceeded MCLs at the northern and eastern site boundaries, but there were no exceedances at the southern and western boundaries. The maximum VOC concentrations were observed in wells MW03S, MW03C, the *in situ* grab sample located just east of the MW03 well cluster, and one *in situ* grab sample located west of the MW03 well cluster. The data showed that the VOC contamination in the surficial aquifer was isolated to the vicinity of the MW03 well cluster. Temporal VOC groundwater data showed similar or lower concentrations over time in the MW03 well cluster vicinity. Installation of additional monitoring wells was recommended to confirm the results of the MIP and *in situ* grab groundwater samples.

2.3.9 June 2006 Groundwater Sampling

The purpose of the June 2006 investigation was to confirm the results of the previous MIP investigation completed at the site in December 2004 and better define MW03 vicinity VOC hotspot. Three new monitoring wells (MW08S, MW09S, and MW10S) were installed where the December 2004 *in situ* grab samples (GW01S, GW02S, and GW06S) indicated constituent concentrations exceeded MCLs. The new monitoring wells and three existing monitoring wells (MW03S, MW03C, and MW05S) were sampled and analyzed for VOCs and natural attenuation indicators. Groundwater data were compared to USEPA Region 3 RBCs and MCLs.

The potential for natural attenuation based on site conditions was evaluated by applying the USEPA screening procedure to the temporal data (USEPA, 1997; Wiedemeier et al., 1998; Appendix C). The evaluation determined "limited evidence for biodegradation" in monitoring wells MW03C and MW10S and "adequate evidence for biodegradation" in monitoring wells MW03S and MW09S. Evidence for biodegradation of TCE was provided by the presence of cis-1,2-DCE and VC, which are breakdown products formed during reductive dechlorination of TCE (parent compound) by dehalogenating bacteria indigenous to the aquifer. A subsequent breakdown product in the sequence, ethene, was also detected at a very low concentration. The relatively high concentrations of cis-1,2-DCE compared to TCE and the presence of VC suggested that anaerobic biodegradation (reductive dechlorination) was occurring at the site. This process is typically limited by low availability of readily degradable organic substrates (electron donors), indicated by the generally low TOC concentrations.

2.3.10 July 2007 Groundwater Sampling

Groundwater samples were collected from all site monitoring wells in July 2007 to provide a complete and current data set of VOC concentrations in groundwater in support of the EE/CA. The results of this groundwater sampling event are summarized in this EE/CA report.

Groundwater sampling was performed in accordance with NSN Master Project Plans (CH2M HILL, 2006) and Tier I Partnering Team direction. All groundwater samples were analyzed for VOCs as detailed. In addition, select groundwater samples were analyzed for dechlorinating bacteria and natural attenuation indicators. Sample analyses, field data, raw analytical data, and results of the microbial analyses are provided in Appendix A.

Groundwater data from July 2007 were compared to MCLs to identify constituents that may have an adverse effect on human health (Table 2-2). Only CVOCs were detected at or above the screening criteria. These chemicals of potential concern (COPCs) consist of TCE; cis-1,2-DCE; 1,1-DCE; and VC (all CVOCs). Detections of these COPCs for all sampling events are summarized on Figure 2-4. VOC detections and exceedances of MCLs were limited to wells MW03C, MW03S, MW09S, and MW10S. There were no VOCs detected in any other monitoring wells at the site.

In the monitoring wells with the greatest VOC concentrations, dissolved oxygen (DO) concentrations were less than 0.5 milligram per liter (mg/L), ferrous iron concentrations were greater than 1 mg/L, and nitrate concentrations were less than 1 mg/L. These concentrations are indicative of anaerobic conditions. Methane was detected in samples collected from monitoring wells MW02S, MW03S, and MW09S at concentrations of more than 1 mg/L. Ethene was detected at low concentrations in samples collected from monitoring wells MW03S and MW09S. The presence of methane and ethene suggest degradation of parent VOCs. In addition, the microorganisms capable of degrading chlorinated ethenes were detected in the samples collected for microbial analysis (Appendix A). Limited anaerobic biodegradation is evident by the data described above and the presence of organic carbon (source of electrons) in wells MW02S, MW03S, and MW09S. The data suggest no anaerobic degradation in MW10S. Additional discussion of the data and anaerobic biodegradation is provided in Section 4.

Table 2-1
Site 18 Monitoring Well Construction Details
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

Well Number	Date Installed	TPVC Elevation (ft msl)	Total Well Depth (ft bgs)	Well Diameter (inches)	Screen Interval (ft bgs - ft bgs)	Aquifer
NBS18-MW01S	6/6/2001	8.96	14	2	3.5 - 13.5	Columbia
NBS18-MW02S	6/6/2001	8.01	13	2	2.5 - 12.5	Columbia
NBS18-MW03S	6/6/2001	7.22	13	2	2.5 - 12.5	Columbia
NBS18-MW03C	12/1/2002	6.86	21	2	16 - 21	Columbia
NBS18-MW03D	12/10/2002	7.03	60	2	50 - 60	Yorktown
NBS18-MW04S	2/21/2002	11.2	13.5	2	3.5 - 13.5	Columbia
NBS18-MW05S	2/21/2002	8.31	15	2	3.5 - 13.5	Columbia
NBS18-MW06S	2/21/2002	5.9	13	2	3.5 - 13	Columbia
NBS18-MW07S	2/22/2002	6.08	12.5	2	2 - 12.5	Columbia
NBS18-MW08S	6/19/2006	4.52	17.5	2	12.5 - 17.5	Columbia
NBS18-MW09S	6/20/2006	5.89	12.5	2	7.5 - 12.5	Columbia
NBS18-MW10S	6/20/2006	6.26	22	2	17 - 22	Columbia

Notes and Abbreviations

TPVC - Top of PVC well casing
ft bgs - feet below ground surface
Elevations are in feet above mean sea level (North American Vertical Datum of 1988)

Table 2-2
Detections in Groundwater - July 2007
Site 18 EE/CA
Naval Station Norfolk, Norfolk, Virginia

Sample ID	Maximum Contaminant Level (MCL)	NBS18-MW01S-07C	NBS18-MW01SP-07C (Duplicate)	NBS18-MW02S-07C	NBS18-MW02SP-07C (Duplicate)	NBS18-MW03C-07C	NBS18-MW03D-07C	NBS18-MW03S-07C	NBS18-MW04S-07C
Sample Date		7/17/07	7/17/07	7/16/07	7/16/07	7/17/07	7/18/07	7/18/07	7/17/07
Volatile Organic Compounds (µg/L)									
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	none	10 U	10 U	10 U	10 U	10 U	10 U	140	10 U
1,1-Dichloroethane	none	10 U	10 U	10 U	10 U	10 U	10 U	22	10 U
1,1-Dichloroethene (1,1-DCE)	**7**	10 U	10 U	10 U	10 U	10 U	10 U	7 J	10 U
1,2-Dichlorobenzene	600	10 U	10 U	10 U	10 U	10 U	10 U	8 J	10 U
1,4-Dichlorobenzene (1,4-DCB)	75	10 U	10 U	10 U	10 U	10 U	10 U	1 J	10 U
cis-1,2-Dichloroethene (cis-1,2-DCE)	**70**	10 U	10 U	10 U	10 U	57	10 U	1,900	10 U
Total 1,2-Dichloroethene (Total 1,2-DCE)	**70**	10 U	10 U	10 U	10 U	57	10 U	1,900	10 U
Isopropylbenzene (cumene)	none	10 U	10 U	10 U	10 U	10 U	10 U	3 J	10 U
Methylcyclohexane	none	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
trans-1,2-Dichloroethene	100	10 U	10 U	10 U	10 U	10 U	10 U	11	10 U
Trichloroethene (TCE)	**5**	10 U	10 U	10 U	10 U	14	10 U	46	10 U
Vinyl Chloride (VC)	**2**	10 U	10 U	10 U	10 U	4 J	10 U	680	10 U
Xylene, total	10,000	10 U	10 U	10 U	10 U	10 U	10 U	2 J	10 U
Dissolved (Filtered) Metals (µg/L)									
Methane	none	2.7 B	2.7 B	2,800	3,200	NA	NA	1,400 J	1.4 B
Ethane (no detections)	none	10 U	10 U	50 U	50 U	NA	NA	20 U	10 U
Ethene	none	10 U	10 U	50 U	50 U	NA	NA	170 J	10 U
Dissolved (Filtered) Metals (µg/L)									
Iron	none	209	136 K	24,200	24,000	NA	NA	7,770	65.7 B
Manganese	none	163	152	184	182	NA	NA	300	44.4
Wet Chemistry (mg/L)									
Alkalinity	none	4.4 B	5.5 B	140	140	NA	NA	110	14 B
Nitrate	10	0.063 L	0.06 L	0.05 UL	0.05 UL	NA	NA	0.05 UL	0.28 L
Sulfate	none	91 L	92 L	1 UL	1 UL	NA	NA	68 L	44 L
Sulfide	none	7.8 B	1 UL	1 UL	1 UL	NA	NA	1 UL	3 B
Total organic carbon (TOC)	none	2.3 B	2.1 B	8.2	8.4	NA	NA	7.3	2.1 B

Notes and Abbreviations

Shading indicates exceedance of MCL.

exceedances of MCLs 1,1-DCE, cis-1,2-DCE, TCE, and VC,

● Total 1,2-DCE is the sum of detected values of cis-1,2-DCE and trans-1,2-DCE

NA - Not analyzed

U - The material was analyed for, but not detected

J - Analyte present. Value may or may not be accurate or precise

B - Analyte not detected above the level reported in blanks

R - Unreliable Result

K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/L - milligrams per liter µg/L - micrograms per liter

Table 2-2
Detections in Groundwater - July 2007
Site 18 EE/CA
Naval Station Norfolk, Norfolk, Virginia

Sample ID / Sample Date	Maximum Contaminant Level (MCL)	NBS18-MW05S-07C 7/16/07	NBS18-MW06S-07C 7/18/07	NBS18-MW07S-07C 7/19/07	NBS18-MW08S-07C 7/18/07	NBS18-MW09S-07C 7/18/07	NBS18-MW10S-07C 7/17/07
Volatile Organic Compounds (µg/L)							
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	none	10 U	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	none	10 U	10 U	10 U	10 U	7 J	10 U
1,1-Dichloroethene (1,1-DCE)	**7**	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	600	10 U	10 U	10 U	10 U	10	10 U
1,4-Dichlorobenzene (1,4-DCB)	75	10 U	10 U	10 U	10 U	2 J	10 U
cis-1,2-Dichloroethene (cis-1,2-DCE)	**70**	10 U	10 U	10 U	10 U	9 J	62
Total 1,2-Dichloroethene (Total 1,2-DCE)	**70**	10 U	10 U	10 U	10 U	9 J	62
Isopropylbenzene (cumene)	none	10 U	10 U	10 U	10 U	10 U	10 U
Methylcyclohexane	none	10 U	10 U	10 U	10 U	2 J	10 U
trans-1,2-Dichloroethene	100	10 U	10 U	10 U	10 U	10 U	10 U
Trichloroethene (TCE)	**5**	10 U	10 U	10 U	10 U	10 U	7 J
Vinyl Chloride (VC)	**2**	10 U	10 U	10 U	10 U	14	10 U
Xylene, total	10,000	10 U	10 U	10 U	10 U	1 J	10 U
Dissolved (Filtered) Metals (µg/L)							
Methane	none	10 U	1.9 B	10 UJ	3.4 B	4,100 J	9.5 B
Ethane (no detections)	none	10 U	10 U	10 U	10 U	50 U	10 U
Ethene	none	10 U	10 U	10 UJ	10 U	28 J	10 U
Dissolved (Filtered) Metals (µg/L)							
Iron	none	12.1 B	6.4 B	15.5 B	11.1 B	20,600	4,550
Manganese	none	1.8 K	30.4	64	118	374	197
Wet Chemistry (mg/L)							
Alkalinity	none	200	7 B	7.8 B	16 B	280	29
Nitrate	10	0.25 L	0.96 L	1.1 L	0.74 L	0.05 UL	0.053 L
Sulfate	none	33 L	18 L	16 L	17 L	4.2 L	17 L
Sulfide	none	1 UL	1 UL	1 UL	1 UL	16 L	1 UL
Total organic carbon (TOC)	none	3.7	0.69 B	0.67 B	0.58 B	11	0.74 B

Notes and Abbreviations

Shading indicates exceedance of MCL.

exceedances of MCLs 1,1-DCE, cis-1,2-DCE, TCE, and VC,

● Total 1,2-DCE is the sum of detected values of cis-1,2-DCE and trans-1,2-DCE

NA - Not analyzed

U - The material was analyed for, but not detected

J - Analyte present. Value may or may not be accurate or precise

B - Analyte not detected above the level reported in blanks

R - Unreliable Result

K - Analyte present. Value may be biased high. Value may be lower

L - Analyte present. Value may be biased low. Value may be higher

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/L - milligrams per liter µg/L - micrograms per liter

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N

0 1500 3000 Feet

Figure 2-1
Installation and Site Location
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

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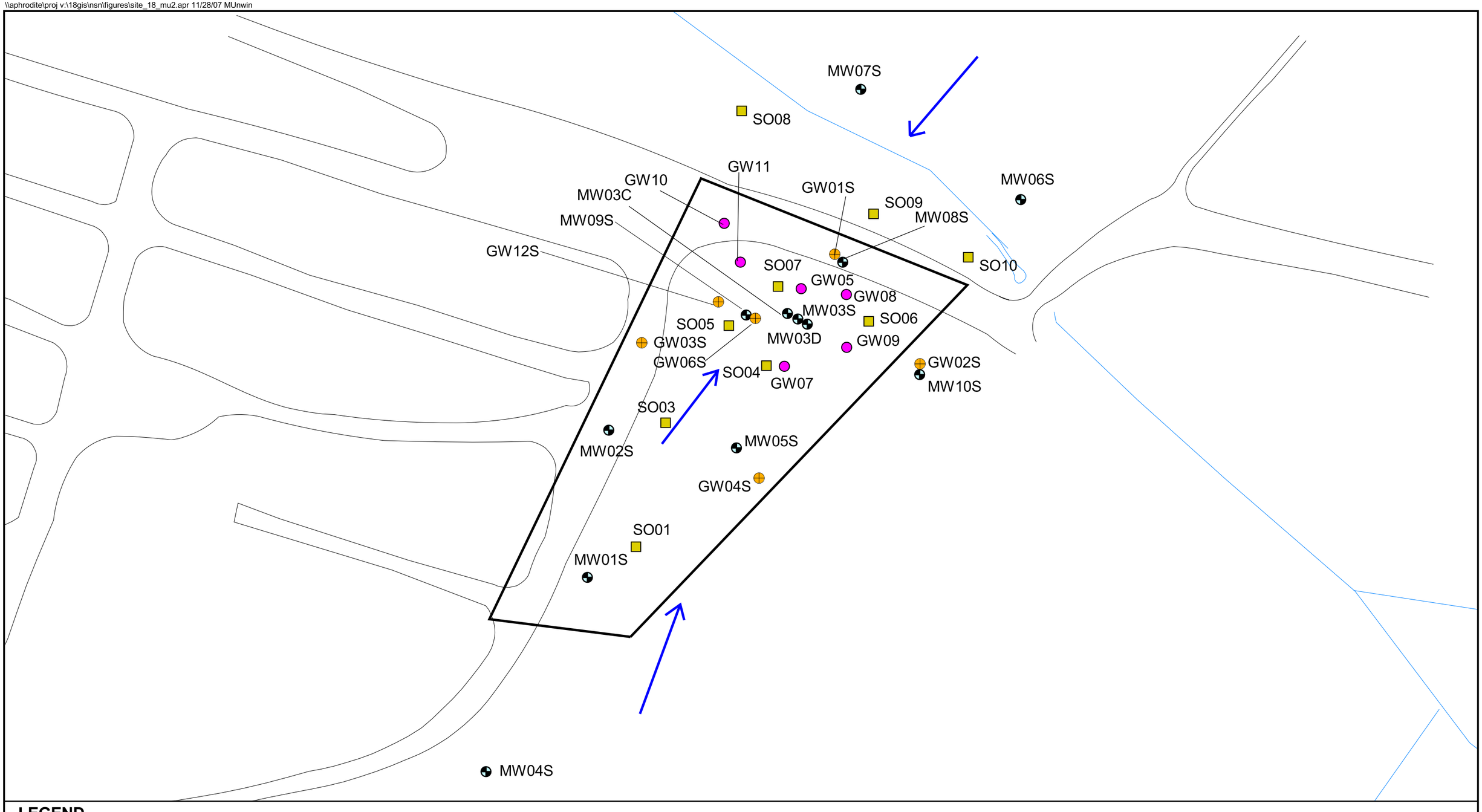

LEGEND

- Monitoring Well
- In-Situ Groundwater During MIP Investigation
- Soil Sampling Location
- MIP Locations
- Estimated Site Boundary
- Groundwater Flow Direction

N

0 60 120 Feet

Figure 2-2
Site Layout and Sample Locations
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

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NBS18-MW07S
2.53

NBS18-MW06S
2.60

NBS18-MW08S
0.43

NBS18-MW03C
2.36

NBS18-MW09S
2.15

NBS18-MW03S
2.33

NBS18-MW03D
2.48*

NBS18-MW10S
0.97

NBS18-MW02S
2.40

NBS18-MW05S
2.42

NBS18-MW01S
2.80

NBS18-MW04S
4.71

1 2 3 4

LEGEND

- Monitoring Well
- Estimated Site Boundary
- Groundwater Contour (dashed where inferred)
- Groundwater Flow Direction

N

0 30 60 90 120 Feet

* Note - Measured groundwater elevation in NBS18-MW03D (Yorktown Aquifer) not used to evaluate groundwater flow.

Figure 2-3
Estimated Columbia Aquifer Groundwater Flow (October 2006)
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

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MW07S (µg/L)	Feb-02	Dec-02	Jul-07
No detections			

GW01S (µg/L)	Dec-04
1,1-DCE	0.9
cis-1,2-DCE	21
Total 1,2-DCE	21
TCE	**132**

MW03C (µg/L)	Dec-02	Dec-04	Jun-06	Jul-07
cis-1,2-DCE	**1,500**	**84**	56 L	57
Total 1,2-DCE	**1,500**	**86.4**	56 L	57
TCE	84 U	3.5	**8 L**	**14**
VC	84 U	**40**	**10 L**	**4 J**

MW08S (µg/L)	Jun-06	Jul-07
No detections		

MW06S (µg/L)	Feb-02	Dec-02	Jul-07
No detections			

GW10

GW11

GW05

GW08

GW09

GW07

GW012S (µg/L)	Dec-04
cis-1,2-DCE	18
Total 1,2-DCE	18
TCE	**5.4**

MW03D (µg/L)	Dec-02	Jul-07
cis-1,2-DCE	0.26 J	10 U
Total 1,2-DCE	0.26 J	10 U

GW06S (µg/L)	Dec-04
1,1-DCE	2.1
cis-1,2-DCE	**278**
Total 1,2-DCE	**278**
TCE	**5**
VC	**208**

MW10S (µg/L)	Jun-06	Jul-07
cis-1,2-DCE	31 L	62
Total 1,2-DCE	31 L	62
TCE	**12 L**	**7 J**

GW03S (µg/L)	Dec-04
cis-1,2-DCE	2
Total 1,2-DCE	2

GW02S (µg/L)	Dec-04
1,1-DCE	0.8
cis-1,2-DCE	**182**
Total 1,2-DCE	**186.3**
TCE	**128**

MW09S (µg/L)	Jun-06	Jul-07
cis-1,2-DCE	6 L	9 J
Total 1,2-DCE	6 L	9 J
TCE	1 L	10 U
VC	**8 L**	**14**

GW04S (µg/L)	Dec-04
No Detections	

MW05S (µg/L)	Feb-02	Dec-02	Jun-06	Jul-07
TCE	10 U	0.15 J	10 UL	10 U

MW03S (µg/L)	Jun-01	Feb-02	Dec-02	Dec-04	Jun-06	Jul-07
1,1-DCE	33 U	20 U	0.96 U	1 U	10 UL	**7 J**
cis-1,2-DCE	**450**	**340**	24	22	**95 L**	**1,900**
Total 1,2-DCE	**450**	**340**	24	22	**97 L**	**1,900**
TCE	**9.8 J**	4.9 J	3.9	**8.8**	**6 L**	**46**
VC	**130**	**68**	**6.4**	1 U	**19 L**	**680**

MW02S (µg/L)	Jun-01	Feb-02	Dec-02	Jul-07
cis-1,2-DCE	10 U	10 U	1	10 U
Total 1,2-DCE	10 U	10 U	1	10 U
TCE	10 U	10 U	0.7	10 U
VC	10 U	10 U	0.36 J	10 U

MW01S (µg/L)	Jun-01	Feb-02	Dec-02	Jul-07
cis-1,2-DCE	10 U	10 U	0.24 J	10 U
Total 1,2-DCE	10 U	10 U	0.24 J	10 U

MW04S (µg/L)	Feb-02	Dec-02	Jul-07
No detections			

Site 18 - Chemicals of Potential Concern	
Chlorinated VOCs (µg/L)	**MCL**
1,1-Dichloroethene (1,1-DCE)	7
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
Total 1,2-Dichloroethene (Total 1,2-DCE)	70
Trichloroethene (TCE)	5
Vinyl Chloride (VC)	2

LEGEND

- Monitoring Well
- MIP Location / Grab Groundwater Sample
- MIP Locations
- Estimated Site Boundary
- Groundwater Flow Direction

Notes:

ND - Not detected
J - Reported value is estimated
L - Reported value may be biased low
U - Not detected above value
Bold text indicates exceedance of MCLs
Total 1,2-DCE is the sum of detected values of cis-1,2-DCE and trans-1,2-DCE

N

0 60 120 Feet

Figure 2-4
Detected COPCs at Site 18
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 3

Identification of Removal Action Objectives

3.1 Statutory Limits on Removal Action

The NCP 40 CFR Part 300.415 dictates statutory limits of $2 million and 12 months of USEPA fund-financed removal actions, with statutory exemptions for emergencies and actions consistent with the remedial action to be taken. However, this removal action will not be USEPA fund-financed. The Navy IRP does not limit the cost or duration of the removal action; nonetheless, cost-effectiveness is a recommended criterion for the evaluation of removal action alternatives.

3.2 Removal Action Objective and Scope

The Removal Action Objective (RAO) for this NTCRA is to implement measures at Site 18 to mitigate potential unacceptable human health risk associated with exposure to CVOCs in groundwater.

In the preparation of this EE/CA, three removal action alternatives were developed to meet the RAO:

- **Alternative 1—No Action**. The no action alternative implies that no removal work would be done at this site.
- **Alternative 2—MNA.** Reliance on the natural biodegradation of CVOCs in groundwater, as evaluated by groundwater monitoring, to achieve RAO.
- **Alternative 3—ERD.** Application of an electron donor to enhance the natural biological degradation of CVOCs in groundwater.

With the exception of Alternative 1 (no action), each of the removal alternatives evaluated would require the implementation of LUCs to prevent unacceptable risk exposure until site cleanup levels are achieved. Site cleanup levels would be federal MCLs. The removal action would be considered complete when the concentrations in groundwater are below the MCL for two consecutive groundwater sampling events. This exit strategy is further defined in Section 4.

3.3 Determination of Removal Schedule

The EE/CA will be placed in the Administrative Record, and notice of its availability for public review along with a brief summary will be published in the local newspaper. The EE/CA will then be subjected to a 30-day public comment period. The public comment period will be held from January 25, 2008, to February 25, 2008. A public information session will also be held during or immediately following the public comment period if requested. Following the public comment period, if comments are received, a Responsiveness Summary summarizing responses to significant comments will be prepared

and included in the Administrative Record. Since this removal action has been designated non-time-critical, the start date will be determined by factors other than the urgency of the potential risk. A possible factor may include weather conditions. The total project period for implementation of the removal action is predicted to last 7 months, from the end of the of the public comment period to completion of this removal action. Critical milestone periods are summarized below:

- EE/CA Public Comment Period 1 month
- Work Plan and Preparation 4 months
- Removal Action Implementation 1 months
- Construction Completion Report 3 months

The removal action timeframe includes the time required for mobilization and setup of equipment and performing the selected removal action. Both Alternatives 2 and 3 would require monitoring of groundwater to determine when cleanup levels are met. These estimated timeframes are described in detail in Section 4.

3.4 Applicable or Relevant and Appropriate Requirements

The removal action will, to the extent practicable, comply with applicable or relevant and appropriate requirements (ARARs) under federal and state environmental laws, as described in 40 CFR 300.415. Appendix B contains the ARAR tables and provides a summary of each potentially related environmental law. Other federal and state advisories, criteria, and/or guidance will be considered as appropriate in formulating the removal action. Applicable requirements are those requirements specific to the conditions at Site 18 that satisfy all jurisdiction prerequisites of the law or requirements. Relevant and appropriate requirements are those that do not have jurisdiction authority over the particular circumstances at Site 18, but are meant to address similar situations, and therefore are suitable for use at Site 18. Federal ARARs are determined by the lead agency (Navy). As outlined by 40 CFR 300.415(j), the lead agency may consider the urgency of the situation and the scope of the removal action to be conducted in determining whether compliance with ARARs is practicable. The NCP, 40 CFR 300.400(g)(2), specifies factors to consider in determining which requirements of other environmental laws are relevant and appropriate:

- The purpose of the requirement in relation to the purpose of CERCLA
- The media regulated by the requirement
- The substance(s) regulated by the requirement
- The actions or activities regulated by the requirement
- Variations, waivers, or exemptions of the requirement
- The type of place regulated and the type of place affected by the release or CERCLA action
- The type and size of the facility or structure regulated by the requirement or affected by the release
- The use or potential use of affected resources in the requirement

In some circumstances, a requirement may be relevant to the particular site-specific situation but may not be appropriate because of differences in the purpose of the requirement, the duration of the regulated activity, or the physical size or characteristic of the situation it is intended to address. There is more discretion in the judgment of relevant and appropriate requirements than in the determination of applicable requirements.

Three classifications of requirements are defined by USEPA in the ARAR determination process: chemical-specific, location-specific, and action-specific.

Chemical-specific ARARs are health or risk management-based numbers or methodologies that result in the establishment of numerical values for a given media that would meet the NCP "threshold criterion" of overall protection of human health and the environment. These requirements generally set protective cleanup concentrations for the chemicals of concern in the designated media. Federal and Virginia chemical-specific regulations that have been reviewed ARARs are summarized in Appendix B.

Location-specific ARARs restrict remedial activities and media concentrations based on the characteristics of the surrounding environments. Location-specific ARARs may include restrictions on removal actions within wetlands or coastal areas, near locations of known endangered species, or on protected waterways. The federal and Virginia location-specific regulations have been reviewed; however there are no federal or Virginia location-specific ARARs for the alternatives proposed for this site.

Action-specific ARARs are requirements that define acceptable treatment and disposal procedures for hazardous substances. Federal and Virginia Action-specific ARARs are summarized in Appendix B.

SECTION 4

Description and Evaluation of Removal Action Alternatives

Three removal alternatives were developed for Site 18, consisting of a no action alternative, MNA alternative, and one remedial technology alternative (ERD). This section provides a description of each alternative and the initial evaluation of each alternative. Section 5.0 continues the alternative evaluation and recommendation with a comparison of each alternative.

4.1 Identification of Removal Action Alternatives

The three removal action alternatives developed for Site 18 are as follows:

- **Alternative 1—**No Action
- **Alternative 2—**MNA
- **Alternative 3—**ERD

The remedial technology alternatives initially screened for Alternative 3 were considered using professional judgment and information from previous investigations. Treatment technologies requiring costly applications (e.g., thermal treatment or zero valent iron application) were eliminated as options because CVOC concentrations at Site 18 are relatively low. In addition, aerobic bioremediation and in situ chemical oxidation technologies were eliminated as options because the aquifer is already poised for anaerobic treatment (evidenced by natural attenuation indicator and geochemical data; see below).

With the exception of Alternative 1 (no action), each of the removal alternatives evaluated requires groundwater monitoring and the implementation of LUCs (aquifer restrictions) to prevent exposure to groundwater until cleanup levels are achieved. Groundwater monitoring and LUCs would be maintained until the RAO is achieved.

4.1.1 Alternative 1- No Action

The no action alternative implies that no removal work would be completed at this site. The site will be left as it currently exists, leaving the impacted groundwater contamination at levels posing potential risk to human health at Site 18.

4.1.2 Alternative 2 - MNA

Natural attenuation includes biodegradation, dilution, dispersion, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants (USEPA, 1997). The primary pathway for biodegradation of CVOCs occurs under anaerobic conditions via reductive dechlorination. In general, the more highly chlorinated the compound, the more oxidized the compound is and the more susceptible it is to anaerobic or reductive degradation mechanisms (Solutions, 2007). This occurs naturally under generally ideal conditions.

During this biotic process, the CVOCs are used as an electron acceptor by dechlorinating bacteria in the presence of a carbon source (electron donor), and a chlorine atom is removed and replaced with a hydrogen atom (USEPA, 1998). If the bacteria are able to obtain metabolically useful energy from reductive dechlorination, the process is also referred to as *halorespiration* (ESTCP, 2006). Given the appropriate conditions, native organic matter in adequate quantity can serve as sufficient electron donor to indigenous microorganisms to reduce CVOCs to innocuous products.

The COPCs at Site 18 based on the July 2007 groundwater data consist of the following (Section 2.3.10): TCE; 1,1-DCE; 1,2-DCE; cis-1,2-DCE; and VC.

The sequential degradation pathway for TCE begins with TCE degrading to 1,2-DCE (cis- and trans-1,2-DCE, and to a much lesser extent 1,1-DCE), VC, and finally to the innocuous end products ethene, ethane, and carbon dioxide. The transformation rate for each step varies but tends to become slower with progress along the breakdown sequence, often resulting in accumulation of DCE and VC. Further breakdown from DCE and VC to ethene varies and is contingent on site-specific conditions.

Based on the MNA evaluation completed using the data from the June 2006 groundwater sampling event (Section 2.3.9 and Appendix C), biodegradation of CVOCs is evident at Site 18. This conclusion is also supported by the similar July 2007 analytical and field data, including the confirmed low DO, negative oxidation-reduction potential (ORP), and presence of dechlorinating bacteria in the surficial aquifer.

The timeframe to reach the cleanup goals (MCLs) is estimated to be 13 years. This timeframe was determined using the groundwater modeling program SourceDK Version 1.0 (AFCEE, 2004). A description of the modeling effort and presentation of the results are in Appendix C. SourceDK is a planning-level screening model for estimating groundwater remediation timeframes with associated uncertainties. According to the SourceDK model, "remediation timeframe" is the time required for the high-concentration source zones at a site to reach a certain target concentration (i.e., cleanup goal). The 13-year timeframe is considered conservative.

Performance of the MNA alternative can be measured by observing decreasing CVOC concentrations (regardless of the method of natural attenuation [i.e., biodegradation versus dilution and adsorption mechanisms]). A groundwater monitoring plan would be developed to provide additional details for the implementation of the alternative and an exit strategy for the site. The proposed performance monitoring wells would consist of MW03C, MW03S, MW05S, MW08S, MW09S, and MW10S (Figure 4-1). A performance monitoring schedule may be as follows (but may vary based upon evaluation of data over time):

- **Year 1—**Quarterly Sampling
- **Years 2 and 3—**Semiannual Sampling
- **Years 4 through 13—**Annual Sampling

Groundwater samples would be collected from the six existing monitoring wells listed above and analyzed for VOCs and natural attenuation/biodegradation indicators (Appendix D details proposed analyses per event for all 13 years). If groundwater data consistently indicates groundwater has stabilized or that individual wells have met cleanup goals over time, the list of constituents monitored and number of wells sampled may be

recommended for reduction to minimize cost. In addition, if conditions become unfavorable for the degradation of chlorinated solvents, action may be needed to improve the conditions of the shallow aquifer in order to ultimately meet the cleanup goals.

This removal alternative would also require the implementation of LUCs to prevent exposure to the groundwater until site cleanup levels are achieved (i.e., site closeout). LUCs would consist of an LUC remedial design and implementation and quarterly inspections to verify the efficacy of the LUCs. Additionally, Site 18 will be evaluated as part of the NSN 5-Year Reviews until site closeout has been achieved.

For cost estimating purposes, it was assumed that an Explosive Safety Submission (ESS) would not be required to perform groundwater sampling throughout the MNA performance monitoring.

Decision Points for MNA Evaluation and Site Closure

Decision rules may be generated during preparation of the MNA performance monitoring plan. Using data collected during monitoring, these decision points would be used to make decisions regarding the effectiveness of MNA, potential revision of the monitoring plan, and the point at which the site can be closed. The following are decision points that may be considered in developing the exit strategy:

- Determine effectiveness of natural attenuation (i.e., biodegradation component).
- Determine whether adjustments (additions or deletions) should be made to the monitoring strategy to improve data quality and confidence or reduce monitoring costs by eliminating the collection of unnecessary data.
- Determine whether RAO has been met at Site 18 such that monitoring and LUC aspects can cease and the site can be closed.

4.1.3 Alternative 3—ERD

Alternative 3 is based on the same principal as Alternative 2; however, this alternative includes the introduction of a substrate to the surficial aquifer to increase electron donor availability to facilitate and expedite reductive dechlorination of CVOCs. Electron donor substrate is typically added to the subsurface when the quantity of electron donor is insufficient for reductive dechlorination to occur, or to occur in the desired timeframe. The introduced substrate depletes competing electron acceptors, creates strongly reducing conditions, and provides an electron donor source for reductive dechlorination.

A variety of different organic substrates have been used to generate hydrogen and stimulate reductive dechlorination. The substrates can be broadly categorized into four types (Solutions, 2007): soluble substrates (e.g., sodium lactate and molasses), slow-release substrates (e.g., hydrogen release compound [HRC®] and edible oil), solid substrates (e.g., mulch and chitin) and miscellaneous experimental substrates (e.g., hydrogen gas). All of these substrates are biodegraded and ultimately yield (or "release") hydrogen.

Soluble substrates degrade rapidly and are transported with groundwater flow. Since these substrates degrade rapidly, they typically require more frequent injections than insoluble substrates and therefore are generally dispensed via permanent injection wells. The most

commonly used insoluble substrates are HRC® and vegetable oil. Vegetable oil is injected as an emulsified liquid. Linoleic and other long chain fatty acids in the vegetable oil slowly solubilize in water over time and are broken down by native microorganisms to lower molecular weight fatty acids such as pyruvate and propionate. Ultimately, the oil degrades to form acetic acid and hydrogen. The hydrogen and dissolved organic carbon from the acetic acid are then available to support reductive dechlorination of chlorinated solvents. Substrate vendors typically estimate that vegetable oil may serve as an electron donor for at least a year and as much as three years depending on site-specific conditions. Insoluble substrates can be applied via permanent injection wells or direct push technology (DPT).

The addition of pure liquid edible oil and edible oil emulsions has been used to stimulate the in situ anaerobic biodegradation of CVOCs and related contaminants at commercial, industrial, and military sites throughout the United States to minimize the frequency of injections (Solutions, 2007). For the purpose of this EE/CA conceptual design and cost estimate, an emulsified substrate consisting of soybean oil, lactate, and micronutrients (amino acids and vitamins) called EOS® was selected as the injectate for this site. Other products (e.g., HRC®, SRS®, or Newman Zone®) could provide similar results. However, the EOS® product was selected for this evaluation based on the success rates of its ability to enhance degradation of CVOCs in both bench test studies and field applications. Further, it was chosen for this evaluation based on its high oil content (60 percent) and superior emulsion quality (EOS® oil droplet size is approximately 1 micron, versus the 5 micron size of SRS®'s oil; Newman Zone has a 0.7 micron size, but the oil concentration in the emulsion [50 percent] is less than EOS® [60 percent]). This food-grade mixture was selected because the lactate portion would result in a brief period of relatively high levels of hydrogen, while the soybean oil would not be degraded as fast (providing a source of electron donor for an extended period of time).

The substrate would be applied in a grid pattern within the 10 µg/L total CVOC isoconcentration contour line (Figure 4-2) using approximately 27 temporary DPT injection points. The total area to be treated within the 10 µg/L total CVOC isoconcentration contour would be approximately 11,000 square ft (ft^2). Based on the depths of CVOC detections, the treatment thickness would be 10 ft. Using this treatment volume and other input parameters (e.g., porosity of the aquifer), a dosage of EOS® can be calculated based on empirical data provided by the vendor and gained through professional experience (e.g., substrate-aquifer saturation at 0.001 pounds of EOS® per pound of soil in the aquifer to be treated) (Appendix D). The cost estimate was prepared assuming one injection event would be sufficient to provide the conditions necessary to achieve the RAO. Approximately 12,100 pounds (2,640 gallons) of EOS® would be required for the entire injection area. In addition, a source of potable water would be available to use for mixing and chase water during the injection process. Approximately 100 gallons of EOS mixture would be injected per DPT injection point with approximately 2,000 gallons of potable water for most effective saturation and distribution.

The effectiveness of the removal action would be evaluated by monitoring the COPC concentrations and biodegradation and geochemical indicators. It is anticipated that the CVOC concentrations would decrease below cleanup levels within an estimated 5 years. Favorable conditions for continued reduction of CVOC concentrations could be established by ERD even after the substrate is completely utilized by indigenous dehalogenating

microbes. For example, once CVOC concentrations are significantly reduced, dilution and dispersion mechanisms can further decrease the CVOC concentrations.

The proposed performance monitoring associated with Alternative 3 includes quarterly monitoring for 1 year following the injection. After completion of the first year of performance monitoring, the monitoring data will be evaluated to determine the appropriate actions to ensure the RAO could be achieved. Additional microbial analysis could be performed to evaluate the efficacy of the ERD in the treatment area (i.e., to monitor the anticipated increase in dehalogenating microbial population). The determination of an appropriate monitoring program will be made following evaluation of the initial year of groundwater data collection.

If groundwater data consistently indicates groundwater has stabilized or that individual wells have met cleanup goals over time, the list of constituents monitored and number of wells sampled may be recommended for reduction to minimize cost.

If ERD does not proceed as anticipated, the sampling parameters may be increased to re-evaluate site conditions, additional monitoring wells may be needed, or additional injection(s) with either temporary injection points or permanent injection wells may be required to accelerate the degradation process. The cost estimate was prepared based on the preference for temporary injection points rather than permanent injection wells due to the time period required for site approval for permanent well installation at this site.

This removal alternative would also require the implementation of the same LUCs and associated activities to ensure that there is no exposure to the groundwater until cleanup goals are met. For cost estimating purposes, it was assumed that an ESS would not be required prior to the injection via temporary DPT injection points and/or during the performance groundwater monitoring.

Decision Points for ERD Evaluation and Site Closure

This section proposes how the data collected during performance monitoring may be used to make decisions regarding the effectiveness of the removal action, potential revision of the monitoring plan, and the point at which the site can be closed. The first decision point occurs after the first year of performance monitoring. This decision point will include an evaluation of the monitoring data to determine any adjustments to the injection and monitoring program and the ultimate exit strategy.

The following are decision points that may be considered in development of the exit strategy:

- Determine whether ERD has met the site cleanup goals or whether additional electron donor needs to be injected.
- Determine whether adjustments (additions or deletions) should be made to the monitoring program to improve data quality and confidence or reduce monitoring costs by eliminating the collection of unnecessary data.
- Determine whether the RAO has been met such that monitoring and LUCs can cease and the site can be closed.

4.2 Evaluation of Alternatives

Table 4-1 presents the summary of the evaluation of Alternatives 1, 2, and 3.

The *effectiveness* of a technology refers to its capability of removing the specific items in the volumes required, the degree to which the technology achieves the RAO, and the reliability and performance of the technology over time, including protection of human health and the environment, compliance with ARARs to the extent practical, long-term effectiveness and permanence, reduction in the toxicity, mobility or volume, and short-term effectiveness.

The *ease of implementation* of a technology refers to the availability of commercial services to support it, the constructability of the technology under specific site conditions, and the acceptability of the technology to all parties involved (e.g., regulators, public, owner), including technical feasibility, administrative feasibility, availability of services, support agency acceptance, and community acceptance.

For the *detailed cost analysis* of the alternatives, the expenditures required to complete each measure were estimated in terms of capital costs to complete initial construction activities. Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances.

Future post-construction costs would be required to ensure the continued effectiveness of the selected removal alternative. The future costs were calculated using assumed inflation rates depending on the estimated timeframe of the alternative:

- Alternative 2 – Inflation rate at 3.8 percent for its estimated 13 year timeframe
- Alternative 3 – Inflation rate at 3.5 percent for its estimated 5 year timeframe

After inflating the future costs, they were analyzed using present worth, which discounts all future costs to a common base year (2007). Present worth analyses allows the cost of the removal action to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the removal action. The present worth calculations included assumed discount rates for each alternative (OMB, 2007):

- Alternative 2 – Discount rate at 3 percent for its estimated 13 year timeframe
- Alternative 3 – Discount rate at 2.6 percent for its estimated 5 year timeframe

The costs estimated are provided to an accuracy of +50% and –30%. The alternative cost estimates are in 2007 dollars and based on quotations from potential vendors and subcontractors, engineering estimates, recent and continual project experience on similar Navy CLEAN and AGVIQ projects, and published values by R.S. Means. Refer to Appendix D for all cost estimate details pertaining to each alternative discussed in the following sections.

4.2.1 Alternative 1—No Action

The no action alternative implies that no removal work would be conducted at this site and the site would be left as it currently exists. The impacted groundwater would be left onsite for potential future exposure and contaminants might migrate further to the surrounding media.

Selection of this alternative does not satisfy the objective of this EE/CA. There is no cost associated with this no action alternative.

4.2.2 Alternative 2—MNA

This alternative relies on the natural degradation of site CVOCs. Since there is evidence natural attenuation is occurring at the site, the treatment area is expected to decrease in size without further migration of the COPCs. LUCs to restrict use of groundwater would be implemented until the RAO is achieved. Therefore this alternative is protective of human health and the environment. This alternative is expected to comply with ARARs.

Monitoring wells required for performance monitoring already exist at the site. The potential for worker exposure is limited to groundwater monitoring, management of associated IDW, and site inspections. IDW requiring disposal would be containerized and temporarily stored onsite prior to characterization and disposal (disposal assumed onbase at no cost). Health and safety precautions would be required to protect workers and the community during transport and storage of IDW.

This alternative is easily implemented because actions associated with this removal action are limited to the implementation and maintenance of LUCs and groundwater monitoring. However, if review of performance data suggests natural attenuation is not proceeding as anticipated, action may be needed to improve the condition of the shallow aquifer.

The estimated total current cost (implementation cost and future cost in present value) for Alternative 2 is $493,000 (assuming the RAO would be achieved in 13 years). Implementation costs ($46,000) for this alternative include preparation of a groundwater monitoring plan and implementation of LUCs. Long-term costs (present value $447,000 over 13 years) include groundwater monitoring, quarterly site inspections, 5-year reviews, and associated data management and reporting.

4.2.3 Alternative 3—ERD

This alternative involves introduction of substrate to the aquifer via injection in order to enhance reductive dechlorination of CVOCs. In addition, the alternative includes post-injection groundwater monitoring and LUCs in the form of groundwater use restrictions. This alternative would actively treat the COPCs and prevent human exposure through the use of LUCs until the RAO is met. Therefore this alternative is protective of human health and the environment. This alternative is expected to comply with ARARs.

The electron donor substrate introduced to the aquifer via temporary DPT injection points would stimulate indigenous dehalogenating (i.e., dechlorinating) microbes, accelerating the reduction of COPC concentrations. Following the injection, the aquifer would be conditioned for continued ERD. Consequently, once adequately treated, the COPCs would be eliminated from the aquifer.

This alternative involves handling food-grade injectate and site groundwater. Therefore, this alternative has the same IDW precautions as Alternative 2. Additional health and safety precautions would be required to protect workers during intrusive injection activities. Since ERD as applied under Alternative 3 consists of injecting nontoxic food-grade soybean oil,

lactate, and vitamins into the aquifer, there are no impacts to the community or the environment beyond those involved with Alternative 2.

ERD is a proven technology in which the addition of substrate to the subsurface provides the necessary conditions for dechlorinating bacteria to degrade VOCs. While the EOS® product does not need to be specified for the alternative (i.e., other electron donor substrates are available), it has a proven track record in field application. The substrate application is straightforward and can be accomplished by an experienced environmental DPT firm.

Monitoring wells required for performance monitoring already exist at the site. The effectiveness of ERD would be monitored by analyzing groundwater geochemistry, the decrease in parent CVOC concentrations, and presence (temporary increase) of daughter products caused by the dechlorination of the parent compound.

The estimated total current cost for Alternative 3 is $546,000 (assuming the use of EOS® substrate and the RAO would be achieved in 5 years). Implementation costs ($299,000) for this alternative include preparation of the injection work plan and groundwater performance monitoring plan, the injection activity, and implementation of LUCs. Long-term costs (present value $247,000 - over 5 years) include groundwater monitoring, quarterly site inspections, 5-year reviews, and associated data management and reporting.

Table 4-1
Evaluation of Remedial Alternatives
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

Alternative	Description	Effectiveness	Ease of Implementation	Implementation Cost	Future Cost (Present Value)	Total Cost
Alternative 1 No Action	No removal work will be performed. The site will be left as it currently exists.	**This alternative is not effective**. It is not protective of human health and the environment, does not comply with ARARs, and does not achieve the RAO.	**This alternative is easy to implement** since there is no action associated with this alternative.	$0	$0	**$0**
Alternative 2 Monitored Natural Attenuation (MNA)	Reliance on natural attenuation of COPCs	**This alternative is effective** since there is evidence of one or more mechanisms of natural attenuation occurring at the site. LUCs will be implemented and COPC concentrations in groundwater would be monitored until the RAO is achieved. This alternative is expected to comply with ARARs.	**This alternative is easy to implement**. Required monitoring wells already exist. Groundwater sampling is a routine activity that is easily completed by experienced field personnel.	$46,000	$447,000 (Estimated 13 Years)	**$493,000**
Alternative 3 Enhanced Reductive Dechlorination (ERD)	Introduction of substrate to aquifer to enhance degradation of COPCs via reductive dechlorination pathway.	**This alternative is effective** because the aquifer is conditioned for ERD. Application of substrate increases the efficacy of the reductive dechlorination pathway for degradation COPCs, reducing the timeframe required to achieve the RAO and close out the site. LUCs will be implemented until the RAO is achieved. This alternative is expected to comply with ARARs.	**This alternative is moderately easy to implement**. Required monitoring wells already exist. Substrate application via temporary injection points is a straightforward task performed relatively frequently throughout the country, and can be completed by an experienced environmental DPT operator. Groundwater sampling is a routine activity that is easily completed by experienced field personnel.	$299,000	$247,000 (Estimated 5 Years)	**$546,000**

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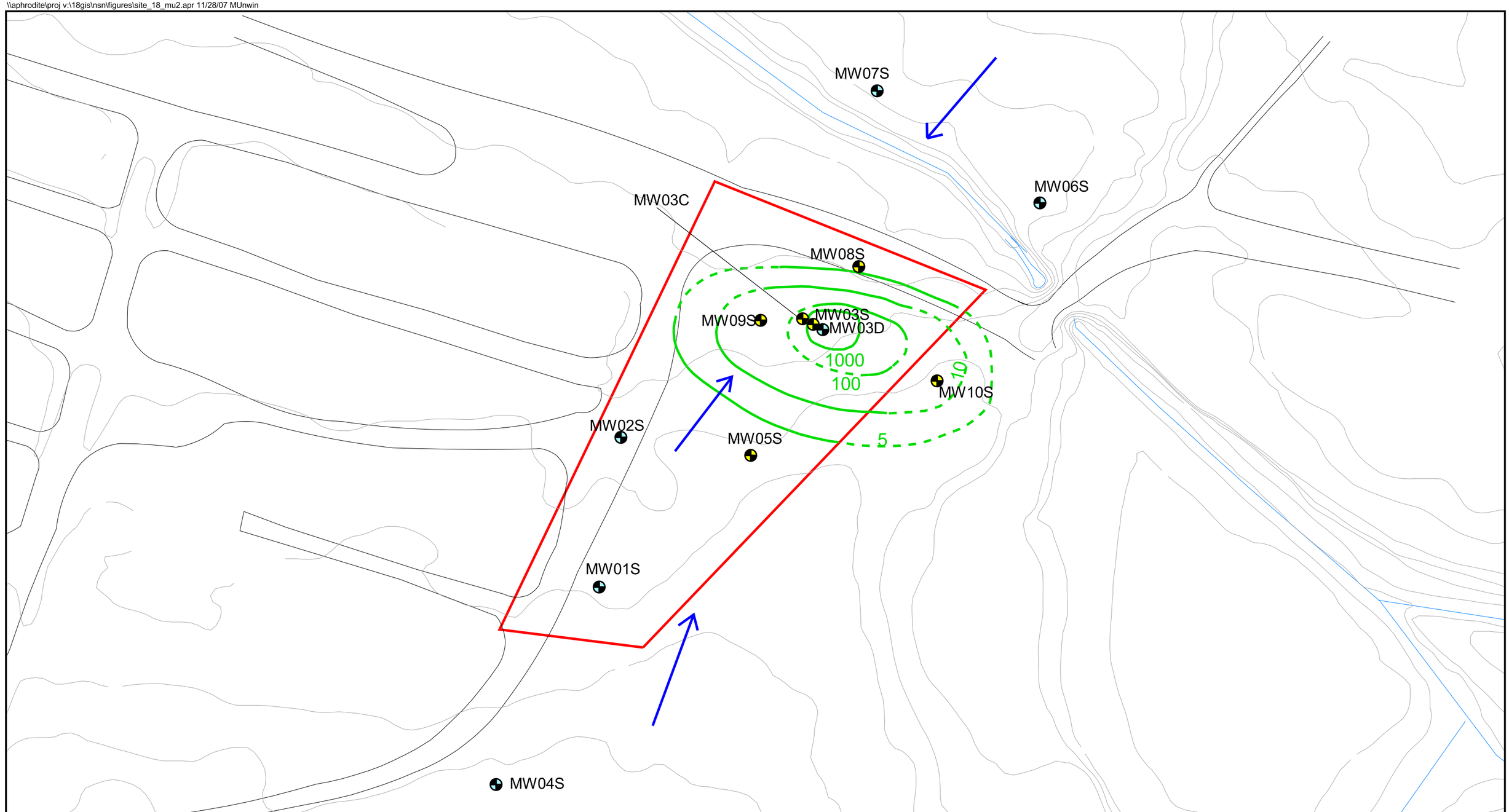

LEGEND

- Existing Monitoring Wells
- MNA Monitoring Wells
- Estimated Site Boundary
- Estimated Groundwater Flow Direction
- Topographic Contours
- Total CVOCs Isoconcentration Contours (µg/L) (Dashed where inferred)
- Drainage Channel

N

0 60 120 Feet

Figure 4-1
Alternative 2 - Monitored Natural Attenuation
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

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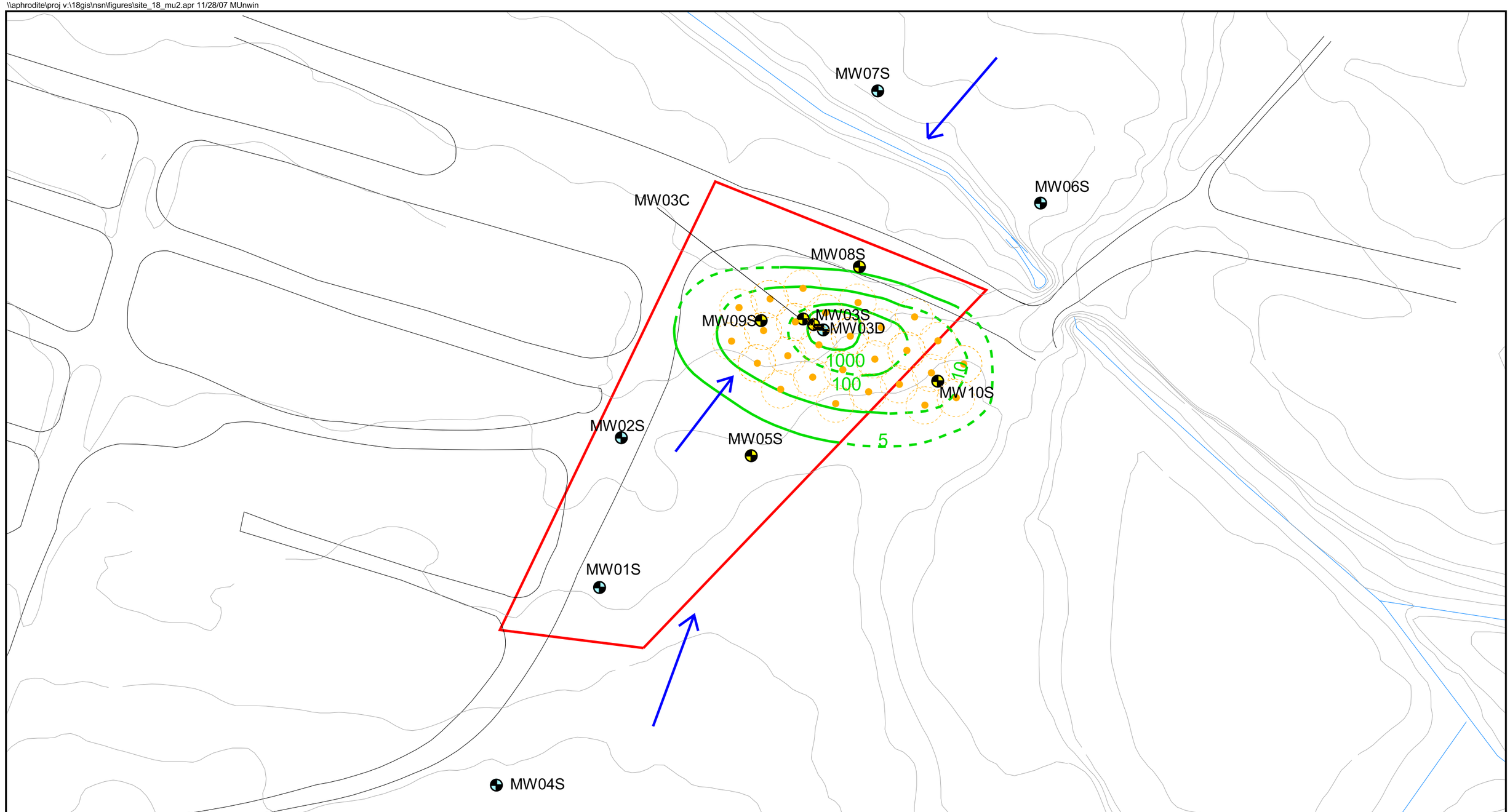

LEGEND

- Existing Monitoring Wells
- Estimated Site Boundary
- Estimated Groundwater Flow Direction
- Topographic Contours
- Total CVOCs Isoconcentration Contours (µg/L) (Dashed where inferred)
- Drainage Channel
- Proposed DPT Injection Point (12 ft ROI typical)
- Performance Monitoring Wells

N

0 60 120 Feet

Figure 4-2
Alternative 3 - Enhanced Reductive Dechlorination
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

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SECTION 5

Comparative Analysis

Section 5.0 provides a comparative analysis of the three removal alternatives presented in Section 4.0 to assist the decision-making process by which a removal action will be selected. In Section 4.0, these alternatives were evaluated according to their effectiveness (including protection of human health and the environment, compliance with ARARs to the extent practical, short- and long-term effectiveness, and reduction in toxicity, mobility, or volume), ease of implementation (including technical and administrative feasibility, availability of services, support agency acceptance, and community acceptance), and cost. In this section, the alternatives are directly compared for each of the three criteria.

Levels of effectiveness were assessed based upon the number of "effectiveness criteria" that would be satisfied by each alternative. The USEPA (1993) "effectiveness criteria" consist of the following:

- Protection of human health
- Protection of workers during implementation
- Protection of environment
- Compliance with ARARs
- Level of treatment and containment expected
- Residual effect concerns

Levels of implementability were assessed based upon the number of "implementability criteria" satisfied by each alternative. The USEPA (1993) "implementability criteria" consist two groups, technical implementability and administrative feasibility:

- Technical Implementability
  - Construction and operational considerations
  - Demonstrated performance/useful life
  - Adaptable to environment conditions
  - Contributes to remedial performance
  - Can be implemented in 1 year
  - Availability of equipment, personnel and services, outside laboratory testing capacity, and offsite treatment and disposal capacity
- Administrative Feasibility.
  - Permits required
  - Easements or rights-of-way required
  - Impact on adjoining property
  - Ability to impose institutional controls

5.1 Removal Action Comparison

Referring to Table 5-1:

- **Alternative 1—No Action** is not effective. However, it is easy to implement and does not require funding as no action would be taken.
- **Alternative 2—MNA** is effective, but is estimated to take 13 years to achieve the RAO. Alternative 2 only requires sampling the existing monitoring wells. Both Alternatives 2 and 3 offer the same protectiveness and compliance with ARARs. Their costs are comparable (within 11 percent); however, Alternative 3 requires significantly more funding during the first year.
- **Alternative 3—ERD** is effective and can be completed in less than half the timeframe of Alternative 2 with considerable improvement of aquifer conditions during the first year. Both Alternatives 2 and 3 offer the same level of protectiveness and compliance with ARARs. Their costs are comparable (within 11 percent total cost); however, Alternative 3 will meet the RAOs in less than half the time of Alternative 2.

Table 5-1
Comparison of Remedial Alternatives
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

Alternative	Effectiveness	Ease of Implementation	Cost
Alternative 1 No Action	**Not Effective** Not protective	**Easy** Nothing to implement.	**No Cost**
Alternative 2 Monitored Natural Attenuation (MNA)	**Moderately Effective** However, will take a longer timeframe. Low short-term effectiveness. Same compliance with ARARs and protectiveness as Alternative 3.	**Easy** Only sampling existing wells; however, this alternative will take estimated 13 years to complete. Minimal administration beyond normal project management and data tracking.	**Moderate Cost for Both** Total cost of Alternatives 2 and 3 are comparable ($493,000 versus $546,000, respectively), especially considering the preliminary aspects of the cost estimate. However, Alternative 3 requires over $250,000 in implementation cost during the first year, with the rest of the cost over only 5 years.
Alternative 3 Enhanced Reductive Dechlorination (ERD)	**Immediately effective** High confidence of short and long-term effectiveness. Same compliance with ARARs and protectiveness as Alternative 2.	**Moderately Easy** Only the injection activity makes Alternative 3 more technically complicated than Alternative 2. This alternative can be implemented in 1 year with follow-on monitoring for up an estimated 5 years. Slightly more administration required, but still within normal project management and data tracking.	

SECTION 6

Recommended Removal Alternative

This EE/CA is prepared in accordance with current USEPA and Navy guidance documents for a NTCRA under CERCLA. The purpose of this EE/CA is to identify and analyze alternatives to address the COPCs in groundwater at Site 18 to mitigate potential human health risk from potential exposure to groundwater in the future. Three alternatives were identified, evaluated, and ranked.

The comparative analysis included evaluating the effectiveness, implementability, and cost of each alternative. The evaluation of effectiveness included reviewing the protectiveness of the alternative; compliance with ARARs to the extent practical; long-term effectiveness and permanence; reduction in toxicity, mobility, or volume; short-term effectiveness; and its ability to meet the RAO. The evaluation of implementability included looking at the technical feasibility, availability, and administrative feasibility of the alternatives. The evaluation of cost included a review of capital cost and future cost (present value) for each alternative.

Based on the comparative analysis of the alternatives completed in Section 5.0, **the recommended removal action is Alternative 3—ERD.** This alternative satisfies implementation and cost requirements considering the comparison between the alternatives. The selection of this alternative meets the RAO of the NTCRA to implement measures at Site 18 to mitigate potential unacceptable human health risk associated with exposure to CVOCs in groundwater. Alternative 3 would lead to site closure in the most expeditious, cost-effective manner.

SECTION 7

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Appendix A
July 2007 Information and Data

Table A-1
Sample Parameters and Methods
July 2007 Groundwater Sampling Event at Site 18
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

				Contaminants of Concern	Natural Attenuation Indicators and Geochemical Indicators								
			Parameter	TCL VOC	Microbial [2] (qPCR)	Total Organic Carbon (quad)	Methane, Ethane, Ethene	Dissolved Metals [3] (Fe & Mn)	Sulfide	Nitrate, Nirtrite, Sulfate	Alkalinity	Iron II Hach field test kit and Chemetrics DO field test kit
			Method	OLM 4.3	qPCR	SW846 9060	RSK175	SW846 9060	EPA 376.1	EPA 300.0	EPA 310.1	
			Sample Container	3-40ml VOA	1L Poly	3-40ml VOA	3-40ml VOA	250 ml Plastic	500 ml Plastic	250 ml Plastic	100ml Poly	
			Preservative	HCl	4^oC	H_2S0_4	HCl	$HN0_3$	NaOH/Zinc Acetate	None	4^oC	
			Holding Times	14 Days	24-48	28 Days	14 Days	6 Months	7 Days	28 Days	14	
Monitoring Well	**Screened Interval (ft bgs)**	**Sample ID [1]**	**Sample Media**									
NBS18-MW01S	3.5-13.5	NBS18-MW01S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW01S	3.5-13.5	NBS18-MW01SP-07C (Duplicate)	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW02S	2.5-12.5	NBS18-MW02S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW02S	2.5-12.5	NBS18-MW02SP-07C (Duplicate)	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW03S	5.5-15.5	NBS18-MW03S-07C	Groundwater	X	X	X	X	X	X	X	X	X
NBS18-MW03C	16-21	NBS18-MW03C-07C	Groundwater	X	X							X
NBS18-MW03D	50-60	NBS18-MW03D-07C	Groundwater	X								X
NBS18-MW04S	3.5-13.5	NBS18-MW04S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW05S	3.5-13.5	NBS18-MW05S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW06S	3-13	NBS18-MW06S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW07S	2.5-12.5	NBS18-MW07S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW08S	12.5-17.5	NBS18-MW08S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW09S	7.5-12.5	NBS18-MW09S-07C	Groundwater	X		X	X	X	X	X	X	X
NBS18-MW10S	17-22	NBS18-MW10S-07C	Groundwater	X	X	X	X	X	X	X	X	X
QA/QC Samples												
MS/MSDs		No Designation Needed	QC	X		X	X	X	X	X	X	
Trip Blank		NBS18-TBMMDDYY	QC	X			X					
Field Blank		NBS18-FBMMDDYY	QC	X		X	X	X	X	X	X	
Equipment Blank		NBS18-EBMMDDYY	QC	X		X	X	X	X	X	X	

Notes and Abbreviations

[1] "07C" in sample nomenclature designates third quarter of 2007
[2] Microbial qPCR analysis included quantification of dehalococcoides (dechlorinating bacteria), including spp. tceA reductase, bvcA reductase, and vcrA reductase.
[3] Samples collected for analysis of dissolved iron and manganese were field-filtered using a 0.45 mm in line filter before placement into bottles with preservatives.
Note on COC that samples were filtered in the field

QA/QC - Quality Assurance and Quality Control
TCL - Target Contaminant List
VOCs - Volatile Organic Compounds
DO - Dissolved Oxygen
Fe and Mn - Iron and Manganese
H_2S0_4 - Sulfuric Acid preservative
HCl - Hydrochloric Acid preservative
$HN0_3$ - Nitric Acid preservative
NaOH/Zinc Acetate - Sodium Hydroxide and Zinc Acetate preservative
ft bgs - feet below ground surface

Table A-2
Stabilized Field Parameters and Field Test Kit Results
July 2007 Groundwater Sampling Event at Site 18
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

Monitoring Well	Date	Horiba U-22					CHEMetrics Test Kit	Hach Test Kit
		pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Temperature (°C)	ORP (mV)	DO (mg/L)	Iron II (mg/L)
NBS18-MW01S	07/17/07	4.45	3.59	73	20.3	320	0.6	0.4
NBS18-MW02S	07/16/07	6.46	0.838	160	22.0	-131	0.8	4.5
NBS18-MW03S	07/18/07	6.22	1.13	252	20.2	-9	0.4	4.2
NBS18-MW03C	07/17/07	6.59	0.737	209	17.8	-56	0.2	3.4
NBS18-MW03D	07/18/07	8.14	1.09	81	20.5	-181	0.8	0.6
NBS18-MW04S	07/17/07	5.2	66.1	63	23.7	262	> 1	0.2
NBS18-MW05S	07/16/07	6.89	1.52	41	20.7	129	> 1	0.9
NBS18-MW06S	07/18/07	4.95	1.09	56	18.4	349	0.8	0.4
NBS18-MW07S	07/19/07	4.99	0.522	13	17.5	314	0.4	0
NBS18-MW08S	07/18/07	5.46	1.5	101	17.5	281	0.6	0
NBS18-MW09S	07/18/07	6.87	0.899	115	18.4	-107	0.2	3.8
NBS18-MW10S	07/17/07	5.93	0.9	159	19.6	26	0.2	3.6

Notes and Abbreviations

Specific conductance is the electrical conductivity value standardized to 25°C (degrees Celsius)
mS/cm - millisiemens per centimeter; 1 siemen = 1/ohm = mho.
NTU - Nephelometric Turbidity Units
DO - Dissolved Oxygen
mg/L - milligrams per liter
°C - degrees Celsius
ORP - Oxidation-Reduction Potential
mV - millivolts

Table A-3
Raw Analytical Data
July 2007 Groundwater Sampling Event at Site 18
Naval Station Norfolk, Norfolk, Virginia

Sample ID	NBS18-MW01S-07C	NBS18-MW01SP-07C	NBS18-MW02S-07C	NBS18-MW02SP-07C	NBS18-MW03C-07C	NBS18-MW03D-07C	NBS18-MW03S-07C	NBS18-MW04S-07C
Sample Date	7/17/07	7/17/07	7/16/07	7/16/07	7/17/07	7/18/07	7/18/07	7/17/07
Volatile Organic Compounds (µg/L)								
1,1,1-Trichloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2,2-Tetrachloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	10 U	10 U	10 U	10 U	10 U	10 U	140	10 U
1,1,2-Trichloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	10 U	10 U	10 U	10 U	10 U	10 U	22	10 U
1,1-Dichloroethene	10 U	10 U	10 U	10 U	10 U	10 U	7 J	10 U
1,2,4-Trichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dibromo-3-chloropropane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dibromoethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	8 J	10 U
1,2-Dichloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene (total)	10 U	10 U	10 U	10 U	57	10 U	1,900	10 U
1,2-Dichloropropane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	1 J	10 U
2-Butanone	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Methyl-2-pentanone	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acetone	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Benzene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bromoform	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon disulfide	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chloroform	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chloromethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	10 U	10 U	10 U	10 U	57	10 U	1,900	10 U
cis-1,3-Dichloropropene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Cyclohexane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Dibromochloromethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Dichlorodifluoromethane (Freon-12)	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Ethylbenzene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Isopropylbenzene (cumene)	10 U	10 U	10 U	10 U	10 U	10 U	3 J	10 U
m- and p-Xylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Methyl acetate	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Methylcyclohexane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Methylene chloride	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Methyl-tert-butyl ether (MTBE)	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	10 U	10 U	10 U	10 U	10 U	10 U	2 J	10 U
Styrene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Toluene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
trans-1,2-Dichloroethene	10 U	10 U	10 U	10 U	10 U	10 U	11	10 U
trans-1,3-Dichloropropene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Trichloroethene	10 U	10 U	10 U	10 U	14	10 U	46	10 U

Table A-3
Raw Analytical Data
July 2007 Groundwater Sampling Event at Site 18
Naval Station Norfolk, Norfolk, Virginia

Sample ID	NBS18-MW01S-07C	NBS18-MW01SP-07C	NBS18-MW02S-07C	NBS18-MW02SP-07C	NBS18-MW03C-07C	NBS18-MW03D-07C	NBS18-MW03S-07C	NBS18-MW04S-07C
Sample Date	7/17/07	7/17/07	7/16/07	7/16/07	7/17/07	7/18/07	7/18/07	7/17/07
Trichlorofluoromethane(Freon-11)	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	10 U	10 U	10 U	10 U	4 J	10 U	680	10 U
Xylene, total	10 U	10 U	10 U	10 U	10 U	10 U	2 J	10 U
Dissolved Gases (µg/L)								
Ethane	10 U	10 U	50 U	50 U	NA	NA	20 U	10 U
Ethene	10 U	10 U	50 U	50 U	NA	NA	170 J	10 U
Methane	2.7 B	2.7 B	2,800	3,200	NA	NA	1,400 J	1.4 B
Dissolved (Filtered) Metals (µg/L)								
Iron	209	136 K	24,200	24,000	NA	NA	7,770	65.7 B
Manganese	163	152	184	182	NA	NA	300	44.4
Wet Chemistry (mg/L)								
Alkalinity	4.4 B	5.5 B	140	140	NA	NA	110	14 B
Nitrate	0.063 L	0.06 L	0.05 UL	0.05 UL	NA	NA	0.05 UL	0.28 L
Nitrite	0.05 U	0.05 U	0.016 B	0.016 B	NA	NA	0.05 U	0.05 U
Sulfate	91 L	92 L	1 UL	1 UL	NA	NA	68 L	44 L
Sulfide	7.8 B	1 UL	1 UL	1 UL	NA	NA	1 UL	3 B
Total organic carbon (TOC)	2.3 B	2.1 B	8.2	8.4	NA	NA	7.3	2.1 B

Notes:

NA - Not analyzed
U - The material was analyed for, but not detected
J - Analyte present. Value may or may not be accurate or precise
B - Analyte not detected above the level reported in blanks
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
R - Unreliable Result
mg/L - Milligrams per liter
µg/L - Micrograms per liter

Table A-3
Raw Analytical Data
July 2007 Groundwater Sampling Event at Site 18
Naval Station Norfolk, Norfolk, Virginia

Sample ID	NBS18-MW05S-07C	NBS18-MW06S-07C	NBS18-MW07S-07C	NBS18-MW08S-07C	NBS18-MW09S-07C	NBS18-MW10S-07C
Sample Date	7/16/07	7/18/07	7/19/07	7/18/07	7/18/07	7/17/07
Volatile Organic Compounds (µg/L)						
1,1,1-Trichloroethane	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2,2-Tetrachloroethane	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloroethane	10 U	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	10 U	10 U	10 U	10 U	7 J	10 U
1,1-Dichloroethene	10 U	10 U	10 U	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dibromo-3-chloropropane	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dibromoethane	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	10 U	10 U	10 U	10 U	10	10 U
1,2-Dichloroethane	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene (total)	10 U	10 U	10 U	10 U	9 J	62
1,2-Dichloropropane	10 U	10 U	10 U	10 U	10 U	10 U
1,3-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
1,4-Dichlorobenzene	10 U	10 U	10 U	10 U	2 J	10 U
2-Butanone	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U	10 U	10 U
4-Methyl-2-pentanone	10 U	10 U	10 U	10 U	10 U	10 U
Acetone	10 U	10 U	10 U	10 U	10 U	10 U
Benzene	10 U	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	10 U	10 U	10 U	10 U	10 U	10 U
Bromoform	10 U	10 U	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U	10 U	10 U
Carbon disulfide	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	10 U	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U
Chloroform	10 U	10 U	10 U	10 U	10 U	10 U
Chloromethane	10 U	10 U	10 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	10 U	10 U	10 U	10 U	9 J	62
cis-1,3-Dichloropropene	10 U	10 U	10 U	10 U	10 U	10 U
Cyclohexane	10 U	10 U	10 U	10 U	10 U	10 U
Dibromochloromethane	10 U	10 U	10 U	10 U	10 U	10 U
Dichlorodifluoromethane (Freon-12)	10 U	10 U	10 U	10 U	10 U	10 U
Ethylbenzene	10 U	10 U	10 U	10 U	10 U	10 U
Isopropylbenzene (cumene)	10 U	10 U	10 U	10 U	10 U	10 U
m- and p-Xylene	10 U	10 U	10 U	10 U	10 U	10 U
Methyl acetate	10 U	10 U	10 U	10 U	10 U	10 U
Methylcyclohexane	10 U	10 U	10 U	10 U	2 J	10 U
Methylene chloride	10 U	10 U	10 U	10 U	10 U	10 U
Methyl-tert-butyl ether (MTBE)	10 U	10 U	10 U	10 U	10 U	10 U
o-Xylene	10 U	10 U	10 U	10 U	1 J	10 U
Styrene	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	10 U	10 U	10 U	10 U	10 U	10 U
Toluene	10 U	10 U	10 U	10 U	10 U	10 U
trans-1,2-Dichloroethene	10 U	10 U	10 U	10 U	10 U	10 U
trans-1,3-Dichloropropene	10 U	10 U	10 U	10 U	10 U	10 U
Trichloroethene	10 U	10 U	10 U	10 U	10 U	7 J

Table A-3
Raw Analytical Data
July 2007 Groundwater Sampling Event at Site 18
Naval Station Norfolk, Norfolk, Virginia

Sample ID	NBS18-MW05S-07C	NBS18-MW06S-07C	NBS18-MW07S-07C	NBS18-MW08S-07C	NBS18-MW09S-07C	NBS18-MW10S-07C
Sample Date	7/16/07	7/18/07	7/19/07	7/18/07	7/18/07	7/17/07
Trichlorofluoromethane(Freon-11)	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	10 U	10 U	10 U	10 U	14	10 U
Xylene, total	10 U	10 U	10 U	10 U	1 J	10 U
Dissolved Gases (µg/L)						
Ethane	10 U	10 U	10 U	10 U	50 U	10 U
Ethene	10 U	10 U	10 UJ	10 U	28 J	10 U
Methane	10 U	1.9 B	10 UJ	3.4 B	4,100 J	9.5 B
Dissolved (Filtered) Metals (µg/L)						
Iron	12.1 B	6.4 B	15.5 B	11.1 B	20,600	4,550
Manganese	1.8 K	30.4	64	118	374	197
Wet Chemistry (mg/L)						
Alkalinity	200	7 B	7.8 B	16 B	280	29
Nitrate	0.25 L	0.96 L	1.1 L	0.74 L	0.05 UL	0.053 L
Nitrite	0.011 B	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Sulfate	33 L	18 L	16 L	17 L	4.2 L	17 L
Sulfide	1 UL	1 UL	1 UL	1 UL	16 L	1 UL
Total organic carbon (TOC)	3.7	0.69 B	0.67 B	0.58 B	11	0.74 B

Notes:

NA - Not analyzed
U - The material was analyed for, but not detected
J - Analyte present. Value may or may not be accurate or precise
B - Analyte not detected above the level reported in blanks
K - Analyte present. Value may be biased high. Value may be lower
L - Analyte present. Value may be biased low. Value may be higher
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
R - Unreliable Result
mg/L - Milligrams per liter
µg/L - Micrograms per liter

microbialinsights

2340 Stock Creek Blvd.
Rockford TN 37853-3044
Phone: (865) 573-8188
Fax: (865) 573-8133
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DNA Analysis Report

Client: Ryan VanOosten
CH2M HILL
5700 Cleveland Street
Suite 101
Virginia Beach, VA 23462

Phone: (757) 671-8311

Fax: (757) 497-6885

MI Identifier: 036EG **Date Rec:** 07/19/2007 **Report Date:** 07/23/2007

Client Project #: TO45 **Client Project Name:** NSN Site 18

Purchase Order #:

Analysis Requested: CENSUS

Comments:

All samples within this data package were analyzed under U.S. EPA Good Laboratory Practice Standards: Toxic Substances Control Act (40 CFR part 790). All samples were processed according to standard operating procedures. Test results submitted in this data package meet the quality assurance requirements established by Microbial Insights, Inc.

Reported By: Anita Biernacki

Reviewed By: Dora M Ogles

MICROBIAL INSIGHTS, INC.

2340 Stock Creek Blvd. Rockford, TN 37853-3044
Tel: (865) 573-8188; Fax: (865) 573-8133

Q Potential (DNA)

Client: **CH2M HILL**
Project: NSN Site 18

MI Project Number: **036EG**
Date Received: 07/19/2007

Sample Information

Client Sample ID:	**NB518-MW035-076**
Sample Date:	07/19/2007
Units:	cells/mL

Dechlorinating Bacteria

Dehalococcoides spp (1)	DHC	**2.96E+03**

Functional Genes

TCE R-Dase (1)	TCE	**3.09E-01 (J)**
BAV1 VC R-Dase (1)	BVC	**1.49E+00**
VC R-Dase	VCR	**2.07E+03**

Legend:
NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
< = Result not detected

Notes:
1 Bio-Dechlor Census technology was developed by Dr. Loeffler and colleagues at Georgia Institute of Technology and was licensed for use through Regenesis.

REPORT TO:

Reports will be provided to the contact(s) listed below. Parties other than the contact(s) listed below will require prior approval.

Name: Ryan Van Oosten
Company: CH2M Hill
Address: 5700 Cleveland St Ste 101
Virginia Beach VA 23462
email:
Phone: (757) 671-8311 x 465
Fax: ( )

Project Manager: Paul Landin
Project Name: NSN SITE 18
Project No.: TO 45

Report Type: ☐ Standard (default) Per Contract ☐ Comprehensive (15% surcharge) ☐ Historical (30% surcharge)

INVOICE TO: TO 45

For Invoices **paid by a third party** it is imperative that contact information & corresponding reference No. be provided.

Name:
Company:
Address:
email:
Phone: ( )
Fax: ( )

Purchase Order No.
Subcontract No.

Filter Samples in LAB

microbialinsights

2340 Stock Creek Blvd.
Rockford, TN 37853-3044
phone (865) 573-8188
fax: (865) 573-8133
email: info@microbe.com
www.microbe.com

Please Check One:
☐ More samples to follow
☑ No Additional Samples

Saturday Delivery
Please see sampling protocol for instructions

Please contact us prior to submitting samples regarding questions about the analyses you are requesting at (865) 573-8188 (8:00 am to 4:00 pm M-F). After these hours please call (865) 300-8053.

Sample Information

MI ID (Laboratory Use Only)	Sample Name	Date Sampled	Time Sampled	Matrix	PLFA	VFA	M/E/E	DGGE+3ID	DGGE+5ID	
036EG1	NBS18-MW03S-07C	7/18/07	0925	GW						

CENSUS: Please select the target organism/gene

MI ID	qDHC (Dehalococcoides)	DHC Functional genes	qDHB (Dehalobacter)	qDSM (Desulfuromonas)	qDSB (Desulfitobacterium)	qEBAC (Total)	qDSR (SRBs only)	qSRB/IRB	qMGN (methanogens)	qMOB (methanotrophs)	qDNF (Denitrifying)	qAOB (ammonia oxidizing)	qPM1 (MTBE aerobic)	qTOD (Initial PAHs aerobic)	qCAT (Intermediate PAHs aerobic)	qBSS (Toluen/Xylene Anaerobic)	qNAH (Napthalene aerobic)	~~add. qPCR:~~ TCE R DASE	~~add. qPCR:~~ QBAV1 VCR-DASE	add. qPCR	RNA (Expression Option)*	Other: SPP tce A reductase	Other: bvcA reductase	Other: vcrA Reductase	Other: Q Potential DNA
036EG1	X	–			–	–												X	X			X	X	X	X

Relinquished by: Brett Caron [signature] Date: 07-18-07 @ 1800

Received by: Tiffany Morgan Date: 7/19/7

In order for analysis to be completed correctly, it is vital that chain of custody is filled out correctly & that all relative information is provided. Failure to provide sufficient and/or correct information regarding reporting, invoicing & analyses requested information may result in delays for which MI will not be liable. * **additional cost and sample preservation are associated with RNA samples.**

2340 Stock Creek Blvd.
Rockford TN 37853-3044
Phone: (865) 573-8188
Fax: (865) 573-8133
Email: info@microbe.com

DNA Analysis Report

Client: Ryan VanOosten
CH2M HILL
5700 Cleveland Street
Suite 101
Virginia Beach, VA 23462

Phone: (757) 671-8311

Fax: (757) 497-6885

MI Identifier: 032EG **Date Rec:** 07/18/2007 **Report Date:** 07/20/2007

Client Project #: **Client Project Name:** TO43 NSN Site 18

Purchase Order #:

Analysis Requested: CENSUS

Comments:

All samples within this data package were analyzed under U.S. EPA Good Laboratory Practice Standards: Toxic Substances Control Act (40 CFR part 790). All samples were processed according to standard operating procedures. Test results submitted in this data package meet the quality assurance requirements established by Microbial Insights, Inc.

Reported By: Anita Biernacki

Reviewed By: Dora M Ogles

MICROBIAL INSIGHTS, INC.

2340 Stock Creek Blvd. Rockford, TN 37853-3044
Tel: (865) 573-8188; Fax: (865) 573-8133

Q Potential (DNA)

Client: **CH2M HILL**
Project: TO43 NSN Site 18

MI Project Number: **032EG**
Date Received: 07/18/2007

Sample Information

Client Sample ID:		**NBS18-MW10S-07C**	**NBS18-MW03C-07C**
Sample Date:		07/17/2007	07/17/2007
Units:		cells/mL	cells/mL

Dechlorinating Bacteria

Dehalococcoides spp (1)	DHC	**1.88E+01**	**7.13E+03**

Functional Genes

TCE R-Dase (1)	TCE	<4.82E-01	**3.47E-01 (J)**
BAV1 VC R-Dase (1)	BVC	<4.82E-01	**5.37E+00**
VC R-Dase	VCR	**1.56E+00**	**3.42E+02**

Legend:
NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
< = Result not detected

Notes:
1 Bio-Dechlor Census technology was developed by Dr. Loeffler and colleagues at Georgia Institute of Technology and was licensed for use through Regenesis.

To-45

REPORT TO:

Reports will be provided to the contact(s) listed below. Parties other than the contact(s) listed below will require prior approval.

Name: Ryan Van Oosten
Company: CH2M Hill
Address: 5700 Cleveland St Ste 101 Virginia Beach VA. 23462
email:
Phone: (757) 671-8311 x 463
Fax: ( )

Project Manager: Adina Carrera / Paul Landin
Project Name: TO 45 NSA Site 18
Project No.: Per Contract

INVOICE TO:

For Invoices **paid by a third party** it is imperative that contact information & corresponding reference No. be provided.

Name:
Company:
Address:
email:
Phone: ( )
Fax: ( )

Purchase Order No.
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microbialinsights

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Rockford, TN 37853-3044
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fax: (865) 573-8133
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www.microbe.com

Please Check One:
☑ More samples to follow
☐ No Additional Samples

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Filter Microbial Samples in LAB

Report Type: ☐ Standard (default) ☐ Comprehensive (15% surcharge) ☐ Historical (30% surcharge)

Please contact us prior to submitting samples regarding questions about the analyses you are requesting at (865) 573-8188 (8:00 am to 4:00 pm M-F). After these hours please call (865) 300-8053.

Sample Information

MI ID (Laboratory Use Only) 32EG	Sample Name	Date Sampled	Time Sampled	Matrix	PLFA	VFA	M/E/E	DGGE+SID	DGGE+SID	
1	NAS18-MW105-07C	7/17/07	1600	GW						
2	NBS18-MW03C-07C	7/17/07	1750	GW						

CENSUS: Please select the target organism/gene

Sample Name	qDHC (Dehalococcoides)	DHC Functional genes	qDHB (Dehalobacter)	qDSM (Desulfuromonas)	qDSB (Desulfitobacterium)	qEBAC (Total)	qDSR (SRBs only)	qSRB/IRB	qMGN (methanogens)	qMOB (methanotrophs)	qDNF (Denitrifying)	qAOB (ammonia oxidizing)	qPM1 (MTBE aerobic)	qTOD (Initial PAHs aerobic)	qCAT (Intermediate PAHs aerobic)	qBSS (Toluen/Xylene Anaerobic)	qNAH (Napthalene aerobic)	add. qPCR: TCE R-DASE	add. qPCR: BAV1 VC R DASE	add. qPCR:	RNA (Expression Option)*
NAS18-MW105-07C	X																	X	X		
NBS18-MW03C-07C	X																	X	X		

Sample Name	Other: Q Potential DNA	Other: SPP. TCEA reductase	Other: bvcA Reductase	Other: VCRA reductase
NAS18-MW105-07C	+	X	X	X
NBS18-MW03C-07C	X	X	X	X

Relinquished by: Mark L. [signature] Date: 7/17/07 Received by: Tiffany Morgan Date 7/18/07

In order for analysis to be completed correctly, it is vital that chain of custody is filled out correctly & that all relative information is provided. Failure to provide sufficient and/or correct information regarding reporting, invoicing & analyses requested information may result in delays for which MI will not be liable. * additional cost and sample preservation are associated with RNA samples.

Appendix B
Applicable or Relevant and Appropriate Requirements

Acronyms and Abbreviations

ARAR	Applicable or relevant and appropriate requirement
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
DCR	Virginia Department of Conservation and Recreation
DNH	Division of Natural Heritage
IDW	Investigation Derived Waste
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NAAQS	National Ambient Air Quality Standards
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSDWRs	National Secondary Drinking Water Regulations
NSPS	New Source Performance Standards
OSWER	Office of Solid Waste and Emergency Response
PCB	Polychlorinated biphenyls
PMCL	Primary Maximum Contaminant Level
POTW	Publicly Owned Treatment Works
ppm	Parts per Million
RAO	Remedial Action Objective
RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
UIC	Underground Injection Control
USACE	US Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
UU/UE	Unlimited Use/Unrestricted Exposure
VAC	Virginia Administrative Code
VMRC	Virginia Marine Resource Commission
VPA	Virginia Pollutant Abatement
VPDES	Virginia Pollutant Discharge Elimination System

References

Commonwealth of Virginia, 2004. Preliminary Identification, Applicable or Relevant and Appropriate Requirements.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Interim Final* . Office of Emergency and Remedial Response. EPA/540/G-89/006.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes.* Office of Emergency and Remedial Response.

USEPA, 1998. RCRA, Superfund & EPCRA Hotline Training Manual. Introduction to Applicable or Relevant and Appropriate Requirements. EPA540-R-98-020.

Table B-1
Federal Chemical-Specific ARARs
Site 18 EE/CA
Naval Station Norfolk, Norfolk, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Safe Drinking Water Act						
Groundwater	SDWA standards serve to protect public water systems. Primary drinking water standards consist of federally enforceable MCLs. MCLs are the highest level of a contaminant that is allowed in drinking water.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.	40 CFR 141.11 to 141.16 and 141.61 to 141.66	2 - MNA	Applicable	This removal action is being implemented with a target goal of achieving MCLs. However, the aquifer is not currently, nor reasonably anticipated in the future to be used as a potable water supply.
				3 - ERD	Applicable	This removal action is being implemented with a target goal of achieving MCLs. However, the aquifer is not currently, nor reasonably anticipated in the future to be used as a potable water supply.

Table B-2
Virginia Chemical-Specific ARARs
Site 18 EE/CA
Naval Station Norfolk, Norfolk, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
State Water Control Law [VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]						
Groundwater	Establishes groundwater quality standards to protect the public health or welfare and enhance the quality of water.	Standards are used when no MCL is available.	*Groundwater Quality Standards*, 9 VAC 25-280	2 - MNA	Relevant	This removal action is being completed to address concentrations in groundwater. MCLs are used as cleanup goals. There are no surrogates listed in 9VAC 25-280 for other VOCs detected in Site 18 groundwater
				3 - ERD	Relevant	
Virginia Waste Management Act [VA Code Ann. §§ 10.1-1400 to 1457 (2004)]						
Waste/Soil/Water	Wastes to be managed must be sampled for TCLP analyses to determine the appropriate waste characterization. TCLP regulatory levels and definition of RCRA hazardous waste.	Management of wastes.	H*azardous Waste Regulations*, 9 VAC 20-60-261	2 - MNA	Applicable	This remedy will generate water IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.
				3 - ERD	Applicable	This remedy will generate soil and water IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.
Waste/Soil/Water	Hazardous wastes shall not be disposed or managed in solid waste disposal facilities.	Management of solid waste.	Solid Waste Management Regulations, 9VAC20-80-240 (c)	2 - MNA	Relevant and Appropriate	This remedy will generate water IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.
				3 - ERD	Relevant and Appropriate	This remedy will generate soil and water IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.

Table B-3
Federal Action-Specific ARARs
Site 18 EE/CA
Naval Station Norfolk, Norfolk, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Safe Drinking Water Act						
Underground injection	Regulates the subsurface emplacement of liquids through the Underground Injection Control program, which governs the design and operation of five classes of injection wells in order to prevent contamination of underground sources of drinking water.	Any dug hole or well that is deeper than it's largest surface dimension, where the principal function of the hole is in placement of fluids.	40 CFR 144.1(g)(1),144.3, 144.6,144.11,144.12(a), 144.24(a),144.80(e), 144.82, 144.83, 146.8, 146.10(c)	2 - MNA	Not Applicable	Alternative 2 does not involve the injection of fluids into the subsurface.
				3 - ERD	Applicable	This removal action will include food-grade substrate injection. The remedy will comply with the substantive requirements of the regulation. This ARAR is applicable because the temporary injections wells (via direct push application) could be considered class V groundwater wells and fluids will be injected into the ground.
Resource Conservation and Recovery Act Subtitle C						
Off-site disposal of hazardous wastes	Administrative standards for hazardous wastes sent off-site for further management. Administrative RCRA standards include the obligation to obtain permits and keep various records at all hazardous waste treatment, storage, and disposal facilities; and the requirement to include a hazardous waste manifest when sending hazardous wastes off-site.	Off-site disposal of hazardous wastes.	40 CFR 240 to 282	2 - MNA	Relevant and Appropriate	This remedy will generate soil and aqueous IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.
				3 - ERD	Relevant and Appropriate	

Table B-4
Virginia Action-Specific ARARs
Site 18 EE/CA
Naval Station Norfolk, Norfolk, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Virginia Waste Management Act [VA Code Ann. §§ 10.1-1400 to 1457 (2004)]						
Handling, storage, treatment, disposal, and/or transportation of hazardous waste IDW	Provides for the control of all hazardous wastes that are generated within, or transported to, the Commonwealth for the purposes of storage, treatment, or disposal or for the purposes of resource conservation or recovery. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of hazardous waste.	*Hazardous Waste Regulations*, 9 VAC 20-60-261.3	2 - MNA	Applicable	This remedy will generate aqueous IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.
				3 - ERD	Applicable	This remedy will generate soil and aqueous IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste.
Handling, storage, treatment, disposal, and/or transportation of hazardous waste IDW	Provides for the control of all hazardous wastes that are generated within, or transported to, the Commonwealth for the purposes of storage, treatment, or disposal or for the purposes of resource conservation or recovery. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of hazardous waste.	*Hazardous Waste Regulations*, 9 VAC 20-60-12 to 1505; *Regulations Governing the Transportation of Hazardous Materials*, 9 VAC 20-110-10 to 130	2 - MNA	Relevant and Appropriate	This remedy will generate aqueous IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste. If characterization results indicate this material is hazardous, it will be disposed of accordingly.
				3 - ERD	Relevant and Appropriate	This remedy will generate soil and aqueous IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste. If characterization results indicate this material is hazardous, it will be disposed of accordingly.
Handling, storage, treatment, disposal, and/or transportation of solid waste IDW	Establishes standards and procedures pertaining to the management of solid wastes, and siting, design, construction, operation, maintenance, closure, and post-closure care of solid waste management facilities in this Commonwealth in order to protect the public health, public safety, the environment, and natural resources. Provides the means for identification of open dumping of solid waste and provides the means for prevention or elimination of open dumping of solid waste to protect the public health and safety and enhance the environment. Sets forth the requirements for undertaking corrective actions at solid waste management facilities. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of solid waste.	*Solid Waste Management Regulations*, 9 VAC 20-80-10 to 790	2 - MNA	Relevant and Appropriate	This remedy will generate aqueous IDW which will be characterized for off site disposal. If characterization results indicate this material is hazardous, it will be disposed of accordingly.
				3 - ERD	Relevant and Appropriate	This remedy will generate soil and aqueous IDW which will be characterized for off site disposal. If characterization results indicate this material is hazardous, it will be disposed of accordingly.

Appendix C
Natural Attenuation Evaluation and Modeling

Preliminary Evaluation of Natural Attenuation Potential at Naval Station Norfolk Site 18

PREPARED FOR: Dave Collins/ WDC

PREPARED BY: Joe Kenderdine/ WDC

DATE: November 27, 2006

1. Introduction

This technical memorandum presents a preliminary evaluation of natural attenuation of chlorinated solvents (more specifically, chlorinated aliphatic hydrocarbons or CAHs) in groundwater at Site 18 at Naval Station Norfolk. This evaluation is based primarily on groundwater data collected in June 2006.

2. Background

Natural attenuation is the result of naturally occurring processes that cause a reduction in the mass, concentration, volume, toxicity, or mobility of contaminants in soil or groundwater. These processes may include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants (EPA, 1997).

Biodegradation is the principal destructive process contributing to natural attenuation of CAHs. The most important biodegradation process for CAHs under typical groundwater conditions is biological reductive dechlorination (RD). RD is an anaerobic process in which chlorine is sequentially removed from a CAH molecule and replaced with hydrogen. Under suitable environmental conditions, the RD process occurs when a CAH molecule serves as an electron acceptor in conjunction with the microbial metabolism of a substrate or electron donor. Suitable electron donors include naturally occurring organic matter, anthropogenic organic carbon (such as fuel hydrocarbons or landfill leachate), and hydrogen. RD of most CAHs occurs primarily under the deeply anaerobic conditions associated with sulfate reduction and particularly methanogenesis, and is inhibited by the presence of energetically more-favorable competing electron acceptors such as dissolved oxygen, nitrate, manganese (IV), and iron (III). Figure 1 shows anaerobic transformation pathways for some CAHs commonly found as groundwater contaminants. These are primarily biotransformation (RD) reactions, but important abiotic reactions are also shown.

EPA's OSWER Directive 9200.4-17 (EPA, 1997) presents the Agency's policy regarding the use of monitored natural attenuation (MNA) for remediation of contaminated soil or groundwater, and lists three types of evidence that can be used to evaluate the efficacy of MNA as a remedial approach. The types of evidence are:

1. *Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.*

2. *Hydrogeologic and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.*

3. *Data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only). [Note: this third type of evidence is typically only necessary when the first two types are inadequate or inconclusive.]*

EPA states that MNA should be selected only when it meets all relevant remedy selection criteria, when it will be fully protective of human heath and the environment, and when it will achieve site remediation objectives within a time frame that is reasonable compared to that offered by other alternatives (EPA, 1997).

EPA's guidance document (Wiedemeier et al., 1998) describes a step-wise procedure for evaluating and demonstrating MNA of CAHs. Each step in the procedure is provided in Attachment 1. The first step in this nine-step procedure is to review available site data, develop a site conceptual model, and determine if receptor pathways have already been completed. The second step is a preliminary assessment of the potential for MNA to be a viable remedial alternative at the site, which is the intent of this Technical Memorandum. This involves preliminary screening to determine if biodegradation is occurring and preliminary modeling to determine whether MNA has the potential to be sufficiently protective (i.e., if predictions indicate that contaminant levels will attenuate to acceptably low levels before reaching a receptor or point of compliance).

Site history, site geology and hydrogeology, nature and extent of contamination, and site risk are described in previous reports for Site 18. The evaluation below focuses primarily on the evidence for CAH biodegradation at the site (Step 2 of the process outlined in EPA's guidance document [Wiedemeier et al., 1998]).

3. Preliminary MNA Evaluation

Geochemical data needed for MNA evaluation were collected in June 2006. The data from June 2006 sampling event are summarized in Table 1. The monitoring results show that the CAH compounds trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE) were detected at relatively low concentrations (maximum concentrations were 8 and 95 µg/L, respectively) in several wells at the site. Vinyl chloride (VC) was also detected at concentrations that exceeded the reporting limit (maximum concentration was 19 µg/L).

The principal anaerobic biotransformation pathway for TCE is:

$$\text{TCE} \rightarrow \text{cis-1,2-DCE} \rightarrow \text{VC} \rightarrow \text{ethene}$$

Thus, assuming that TCE is the parent CAH compound that was released to the environment at the site, it would be reasonable to assume that the cis-1,2-DCE and VC detected in Site 18 groundwater are daughter products formed by anaerobic biodegradation (reductive dechlorination) of TCE.

3.1 Biodegradation Screening

EPA (Wiedemeier et al., 1998) presented a set of parameters and weighting factors for preliminary screening of anaerobic biodegradation of CAHs. These screening criteria are presented in Table 2, along with guidelines for interpreting resulting scores. The screening process involves collection of field monitoring data and scoring the results for the most contaminated zone. Table 3 presents the scoring results for the June 2006 data from the four monitoring wells at Site 18 with the greatest CAH concentrations. The total scores were 13, 16, 18, and 12, for wells MW03C, MW03S, MW09S, and MW10S, respectively. These scores indicate "limited evidence for biodegradation" at two wells (MW03C and MW10S), and "adequate evidence for biodegradation" at two wells (MW03S and MW09S). The specific natural attenuation indicator data are discussed briefly below.

Parent/Daughter Products. Evidence for RD is provided by the presence of cis-1,2-DCE and VC, which are presumed to exist as degradation products of TCE. This evidence assumes that TCE was the parent compound released. Historical records of material released at the site support this assumption. Ethene, subsequent TCE breakdown products in the sequence, was detected at a very low concentration in one well (MW03S).

Redox Indicators. Geochemical parameter data indicate that site conditions are reasonable favorable for RD. Low dissolved oxygen concentrations (less than 1 mg/L) at all 4 locations and moderately low oxidation-reduction potential (ORP) levels (less than 50 mV) at three of the four locations indicate that anaerobic, moderately reducing conditions exist in the contaminated zone. Low nitrate levels indicate that this electron acceptor would not constitute competition for RD. Elevated ferrous iron concentrations imply that iron reduction has occurred and that conditions are reducing. Sulfate levels were elevated, which could present competition to RD, especially for the latter steps in the sequence (DCE $\rightarrow$ VC $\rightarrow$ ethene). Methane levels were low or non-detectable in the groundwater, indicating that the most deeply reducing conditions associated with methanogenesis were limited.

TOC. The relatively low total organic carbon (TOC) concentrations may be one of the primary factors limiting the extent of RD. TOC concentrations were less than 9 mg/L in all the wells, indicating low availability of electron donors needed for RD reactions. Enhancement of biodegradation via substrate addition is one way to overcome this limitation and accelerate RD.

4. Conclusions and Recommendations

Applying the EPA screening procedure to data for the four most contaminated wells at Site 18 yielded scores indicating:

- "limited evidence for biodegradation" at two wells (MW03C and MW10S); and
- "adequate evidence for biodegradation" at two well (MW03S and MW09S).

Evidence for biodegradation of TCE is provided by the presence of cis-1,2-DCE and VC, which are breakdown products formed by anaerobic biotransformation of TCE (assumed to be the parent CAH compound released at the site). A subsequent breakdown product in the sequence, ethene, was also detected at a very low concentration. The relatively high concentrations of cis-1,2-DCE compared to TCE levels and the presence of VC suggest that anaerobic biodegradation (reductive dechlorination) is occurring at the site. RD is probably limited by low availability of readily degradable organic substrates (electron donors). Low substrate availability is indicated by the generally low TOC concentrations.

These conclusions are based on the evaluation of data collected during the June 2006 sampling event. Additional groundwater sampling events are recommended to determine if biodegradation is occurring at a rate sufficient to meet remediation objectives for the site in a period that is reasonable compared with other alternatives. In addition, microbial analysis during one groundwater sampling event is recommended to determine if dechlorinating bacteria are present.

5. References

EPA. 1997. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Draft – Interim Final. OSWER Directive No. 9200.4-17. U.S. EPA, Washington D.C., December 1, 1977.

Wiedemeier, T. et al. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. EPA/600/R-98/128. U.S. EPA, Washington D.C., 1998.

Table 1
June 2006 Groundwater Monitoring Data
Site 18
Naval Station Norfolk

Station ID	MCL-Groundwater	RBC-Tap Water	NBS18-MW03C	NBS18-MW03S	NBS18-MW05S	NBS18-MW08S	NBS18-MW09S	NBS18-MW10S
Sample ID			NBS18-MW03C-R04	NBS18-MW03S-R04	NBS18-MW05S-R04[1]	NBS18-MW08S-R01	NBS18-MW09S-R01	NBS18-MW10S-R01
Sample Date			06/27/06	06/27/06	06/27/06	06/27/06	06/27/06	06/27/06
Chemical Name								
Volatile Organic Compounds (UG/L)								
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	--	59,000	1 L	5 L	10 UL	10 UL	10 L	10 UL
1,1-Dichloroethane	--	900	10 UL	2 L	10 UL	10 UL	6 L	10 UL
1,2-Dichlorobenzene	600	270	10 UL	10 UL	10 UL	10 UL	8 L	10 UL
1,2-Dichloroethene (total)	**70**	**55**	56 L	97 L	10 UL	10 UL	6 L	31 L
1,4-Dichlorobenzene	75	**0.47**	10 UL	10 UL	10 UL	10 UL	1 L	10 UL
Ethylbenzene	700	1,300	10 UL	10 UL	10 UL	10 UL	2 L	10 UL
Methylcyclohexane	--	6,300	10 UL	10 UL	10 UL	10 UL	1 L	10 UL
Trichloroethene	**5**	**0.026**	8 L	6 L	10 UL	10 UL	1 L	12 L
Vinyl chloride	**2**	**0.015**	10 L	19 L	10 UL	10 UL	8 L	10 UL
cis-1,2-Dichloroethene	**70**	**61**	56 L	95 L	10 UL	10 UL	6 L	31 L
trans-1,2-Dichloroethene	100	120	10 UL	2 L	10 UL	10 UL	10 UL	10 UL
Wet Chemistry (MG/L)								
Alkalinity	--	--	130	230	200	14	230	30
Chloride	--	--	4.1 B	4.9 B	6.5 K	4.1 B	6.7 K	5 B
Ethene	--	--	0.01 UL	0.0048 L	0.01 UL	0.01 UL	0.1 UL	0.01 UL
Ferrous iron	--	--	11	1.4	0.1 U	0.1 U	17	5.7
Methane	--	--	0.12 L	0.071 L	0.0023 B	0.0023 B	6.3 L	0.0058 B
Nitrate	10	10	0.05 UL	0.11 L	0.41 L	0.75 L	0.05 UL	0.1 L
Nitrite	1	1	0.05 UL	0.05 UL	0.05 UL	0.02 L	0.05 UL	0.05 UL
Sulfate	--	--	51 L	19 L	32 L	17 L	5 L	18 L
Total organic carbon (TOC)	--	--	3.1	4.9	2.8	0.62 B	8.3	0.64 B
Field Parameters								
Temperature (°C)			19.0	21.4	20.0	17.2	18.9	17.1
Dissolved Oxygen (MG/L)			0.0	0.6	1.0	0.5	0.0	0.0
pH			6.67	6.68	6.00	4.88	6.75	5.65
Oxidation-Reduction Potential (mV)			-53	12	206	259	-77	106

Notes:

Shaded values exceed screening criteria

U- Analyte not detected

UL- not detected, quantitation limit is probably higher

L- analyte present, biased low

B- Not detected substantially above the level reported in lab or field blanks

K- analyte present, biased high

[1] Duplicate sample taken at location, most conservative value between the two was kept.

TABLE 2
MNA Biodegradation Screening Criteria and Weighting
Site 18
Naval Station Norfolk

Analyte	Concentration in Most Contaminated Zone	Interpretation	Value
Dissolved Oxygen	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	3
(DO)	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically	-3
Nitrate (NO3-N)	<1 mg/L	At higher concentrations may compete with reductive pathway	2
Ferrous Iron (FeII)	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions	3
Sulfate	<20 mg/L	At higher concentrations may compete with reductive pathway	2
Sulfide	>1 mg/L	Reductive pathway possible	3
Methane	<0.5 mg/L	VC oxidizes	0
	>0.5 mg/L	Ultimate reductive daughter product, VC accumulates	3
Oxidation-Reduction Potential (ORP)	<50 mV	Reductive pathway possible	1
	<-100 mV	Reductive pathway likely	2
pH	5<pH<9	Optimal range for reductive pathway	0
	5>pH>9	Outside optimal range for reductive pathway	-2
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2
Temperature	>20°C	At T>20°C biochemical processes are accelerated	1
Carbon Dioxide (CO2)	>2x background	Ultimate oxidative daughter product	1
Alkalinity	>2x background	Results from interaction of CO_2 with aquifer minerals	1
Chloride	>2x background	Daughter product of reductive dechlorination of chlorinated organics	2
Hydrogen	>1 nM	Reductive pathway possible; VC may accumulate	3
Hydrogen	<1 nM	VC oxidized	0
Volatile Fatty Acids (VFAs)	>0.1 mg/L	Intermediates resulting from biodegradation of complex organics; carbon and energy source	2
BTEX	>0.1 mg/L	Carbon and energy source; drives dechlorination	2
PCE		Material released	0
TCE		Material released	0
		Daughter product of PCE	2
DCE		Material released	0
		Daughter product of TCE (If cis is greater than 80% of total DCE it is likely a daughter product of TCE)	2
		1,1-DCE can be chemical reaction product of TCA	
VC		Material released	0
		Daughter product of DCE	2
Ethene/Ethane	>0.01 mg/L	Daughter product of VC/Ethene	2
	>0.1 mg/L		3
TCA		Material released	0
DCA		Material released	0
		Daughter product of TCA	2
CA		Daughter product of DCA or VC under reducing conditions	2

Total Score	Interpretation
0 to 5	Inadequate evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics
6 to 14	Limited evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics
15 to 20	Adequate evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics
>20	Strong evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics

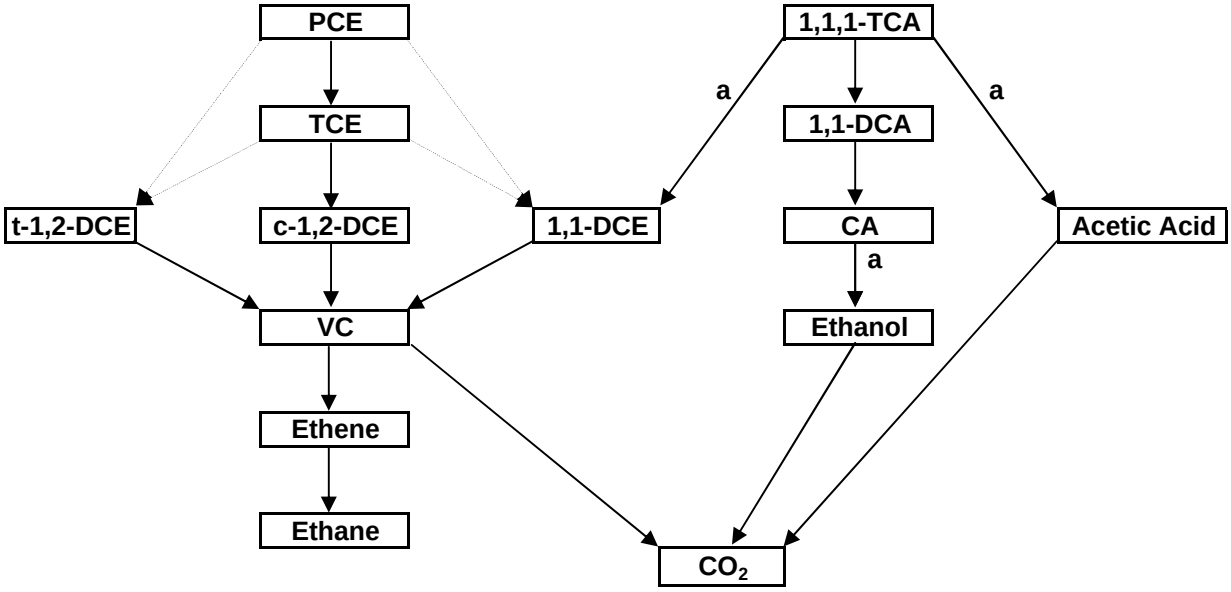
Source: Wiedemeier et al., 1998

TABLE 3
MNA Data and Scoring
Site 18
Naval Station Norfolk

												Background Monitoring Wells			
				MW03C		MW03S		MW09S		MW10S		MW05S		MW08S	
Parameter	**Units**	**Criteria**	**Potential Points**	**Value**	**Pts**	**Value**	**Pts**	**Value**	**Pts**	**Value**	**Pts**	**Value**	**Pts**	**Value**	**Pts**
DO	mg/L	<0.5	3	0.0	3	0.6	3	0.0	3	0.0	3	1.0	0	0.5	3
		>5	-3												
NO3-N	mg/L	<1	2	0.05 UL	2	0.11 L	2	0.05 UL	2	0.1 L	2	0.41 L	2	0.75 L	2
Fe(II)*	mg/L	>1	3	11	3	1.4	3	17	3	5.7	3	0.1 U	0	0.1 U	0
Sulfate	mg/L	<20	2	51 L	0	19 L	2	5 L	2	18 L	2	32 L	0	17 L	2
Methane	mg/L	<0.5	0	0.12 L	0	0.071 L	0			0.006 B	0	0.002 B	0	0.002 B	0
		>0.5	3					6.3 L	3						
ORP	mV	<50	1	-53	1	12	1	-77	1	106	0	206	0	259	0
		<-100	2												
pH	pH units	5<pH<9	0	6.67	0	6.68	0	6.75	0	5.65	0	6.00	0		
		5>pH>9	-2											4.88	-2
TOC	mg/L	>20	2	3.1	0	4.9	0	8.3	0	0.64 B	0	2.8	0	0.62 B	0
Temperature	°C	>20	1	19.0	0	21.4	1	18.88	0	17.12	0	20.0	0	17.23	0
Alkalinity	mg/L	>2X BG	1	130	0	230	0	230	0	30	0	200	0	14	0
Chloride	mg/L	>2X BG	2	4.1 B	0	4.9 B	0	6.7 K	0	5 B	0	6.5 K	0	4.1 B	0
VFAs	mg/L	>0.1	2	NM		NM		NM		NM		NM		NM	
TCE (released)	mg/L		0												
1,2-DCE (product)	mg/L		2	56 L	2	97 L	2	6 L	0	31 L	2	10 UL	0	10 UL	0
VC (product)	mg/L		2	10 L	2	19 L	2	8 L	2	10 UL	0	10 UL	0	10 UL	0
Ethene/Ethane	mg/L	>0.01	2	0.01 UL	0	0.005 L	0	0.1 UL	2	0.01 UL	0	0.01 UL	0	0.01 UL	0
		>0.1	3												
Total Points					**13**		**16**		**18**		**12**		**2**		**5**

Average background chloride concentration = 5.3 mg/L
Average background alkalinity concentration = 107 mg/L
Background monitoring wells: MW05S and MW08S
U = Not detected at specified reporting limit; UL- not detected, quantitation limit is probably higher; L- analyte present, biased low;
B- Not detected substantially above the level reported in lab or field blanks; K- analyte present, biased high
NM = Not Measured

FIGURE 1
Anaerobic Transformations of Selected CAHs
Site 18
Naval Station Norfolk



a = abiotic
minor pathway

Attachment 1

The nine key steps for evaluating natural attenuation (Wiedemeier et al., 1998) are:

1. Review available site data and develop a preliminary conceptual model. Determine if receptor pathways have already been completed. Respond as appropriate.
2. If sufficient existing data of appropriate quality exist, apply the screening process to assess the potential for natural attenuation.
3. If preliminary site data suggest natural attenuation is potentially appropriate, perform additional site characterization to further evaluate natural attenuation. If all the recommended screening parameters listed in Section 2.2 have been collected and the screening processes suggest that natural attenuation is not appropriate based on the potential for natural attenuation, evaluate whether other processes can meet the cleanup objectives for the site (e.g., abiotic degradation or transformation, volatilization, or sorption) or select a remedial option other than MNA.
4. Refine conceptual model based on site characterization data, complete pre-modeling calculations, and document indicators of natural attenuation.
5. Simulate, if necessary, natural attenuation using analytical or numerical solute fate and transport models that allow incorporation of a biodegradation term.
6. Identify potential receptors and exposure points and conduct an exposure pathways analysis.
7. Evaluate the need for supplemental source control measures. Additional source control may allow MNA to be a viable remedial option or decrease the time needed for natural processes to attain remedial objectives.
8. Prepare a long-term monitoring and verification plan for the selected alternative. In some cases, this includes monitored natural attenuation alone, or in other cases in concert with supplemental remediation systems.
9. Present findings of natural attenuation studies in an appropriate remedy selection document, such as a CERCLA Feasibility or RCRA Corrective Measures Study. The appropriate regulatory agencies should be consulted early in the remedy selection process to clarify the remedial objectives that are appropriate for the site and any other requirements that the remedy will be expected to meet. However, it should be noted that remedy requirements are not finalized until a decision is signed, such as a CERCLA Record of Decision or a RCRA Statement of Basis.

Preliminary Model: Projected Natural Attenuation Timeframes as a Sole Remedy at Site 18 Naval Station Norfolk, Norfolk, VA

TO: Adina Carver/VBO
Ed Corack/VBO

FROM: Gunarti Coghlan/WDC

DATE: October 25, 2007

PROJECT NUMBER: 358444.EC.DR.18

This memorandum presents the projected timeframes associated with a sole reliance on natural attenuation (NA) processes as a remedy for treating the shallow groundwater contamination at Site 18, Naval Station Norfolk (NSN) in Norfolk, Virginia. The calculation of these timeframes was conducted in support of the Engineering Evaluation and Cost Analysis (EE/CA) for the site.

Concentrations of trichloroethene (TCE); cis-1,2-dichloroethene (cis-1,2-DCE); and vinyl chloride (VC) in the shallow groundwater at Site 18 were detected exceeding the maximum contaminant levels (MCLs), which are determined in the EE/CA as the site cleanup levels. Historically, the maximum concentrations of TCE, cis-1,2-DCE, and VC were observed at 132 micrograms per liter (µg/L), 1,900 µg/L, and 680 µg/L, respectively. Several other volatile organic compounds (VOCs) were also detected at a concentrations much lower than those of TCE; cis-1,2-DCE; and VC. Therefore, the projected NA timeframes calculation focuses on these compounds.

To assess the viability, effectiveness, and implementability of NA processes for treating the contamination in the shallow groundwater of Site 18, a preliminary model called SourceDK (Version 1.0; AFCEE, 2004) was used to project the remediation timeframes associated with NA. SourceDK is a planning-level screening model for estimating groundwater remediation timeframes with associated uncertainties. According to the SourceDK model, "remediation timeframe" is the time required for the high-concentration source zones at a site to reach a certain target concentration. The model uses Microsoft Excel™ and provides three different approaches, or Tiers, from easiest to most complex conditions. Below is a summarized description of the tiers:

1. Tier 1 – Extrapolation: Source zones that have extended records of concentration versus time can be analyzed using the Tier 1 tool. With this tool, log concentration vs. time is plotted and then extrapolated to estimate the time needed to achieve a cleanup goal, assuming the current trend continues.

2. Tier 2 – Box Model: This tier consists of an enhanced BIOSCREEN model. The box model provides an estimate of the contaminant mass in the source zone and the mass flux of contaminants leaving the source zone as well as biodegradation processes possibly occurring within the source zones.
3. Tier 3 – Process Model: This tier employs more detailed fundamental process-based equations to determine the time and amount of naturally flowing groundwater required to flush out dissolved-phase and non aqueous phase liquid (NAPL) dominated constituents from the source zone.

At Site 18, the Tier 3 approach was used to determine the time required to flush out dissolved phases of TCE; cis-1,2-DCE; and VC from the interpreted MCL exceedance area to achieve the cleanup levels (MCLs). Input parameters, assumptions, and the results are provided in Table 1 and the attached model run reports. Table 1 summarizes the estimated timeframes for NA of TCE (13 years); cis-1,2-DCE (3.5 years); and VC (5 years) to below MCLs. These are conservative timeframes.

Reference:

Air Force Center for Engineering and the Environment (formerly the Air Force Center for Environmental Excellence) (AFCEE). 2004. *SourceDK Remediation Timeframe Decision Support System* Version 1.0. April.

Table 1

SourceDK Tier-3 Dissolved Phase Attenuation, Scenario and Results

Site 18 EE/CA

Naval Station Norfolk, Norfolk, Virginia

	Source Zone		
INPUT PARAMETERS			
	Cis-1,2-DCE (MW03S)	**TCE (GW01S)**	**VC (MW03S)**
Original Constituent Concentration (Co) – mg/L	1.9 mg/L	0.132 mg/L	0.68 mg/L
Desired Cleanup Level - MCL	0.07mg/L	0.005 mg/L	0.002 mg/L
Length of Source Zone Parallel to Groundwater Flow	100 **ft** (length of plume interpreted to exceed the MCL)		
Natural Groundwater Seepage Velocity	This unit is the average linear velocity of groundwater; Darcy velocity divided by the effective porosity. Involves several estimates including:		
	K (gpd/sf) =		100
	K (ft/day) =		1.34E+01
	h (hydraulic gradient) =		0.024
	effective porosity (n) =		0.2
	V (ft/year) = K.h/n.365		
	V (ft/year) =		**586**
Fraction of organic carbon (f_{oc}) - unitless	0.03 (average TOC data from December 02)		
Bulk density (p_d) g/ml	1.85 (assumed)		
Effective porosity (ne) – unitless	0.2		
	Cis-1,2-DCE	TCE	VC
Organic Carbon Partition Coefficient (Koc) - L/Kg	32.00	126	29
	https://www.denix.osd.mil/denix/Public/Library/Remedy/MCBC/mclebc02.html		http://www.dtsc.ca.gov/AssessingRisk/upload/vc.pdf
RESULTS			
Timeframe to reduce initial concentrations to MCL:	**cis-1,2-DCE** 3.5 years	**TCE** 13 years	**VC** 5 years

SourceDK

Remediation Timeframe Decision Support System

Air Force Center for Environmental Excellence — *Version 1.0*

TIER 3 Process Models

Data Input Instructions:

- 115 — *1. Enter value directly....or*
- ↑ or
- 115 — *2. Calculate by filling in blue cells. Press Enter, then hit "Calculate"*
- 115 — *3. Value calculated by model. (Don't enter any data.)*

Site Location: Site 18 NNS EE/CA

Constituent: Cis-1,2-DCE (MW03S)

METHOD 1: DISSOLVED PHASE CONSTITUENTS

Original Constituent Concentration	C_o	1.9	*(mg/L)*
Desired Cleanup Level	C_t	0.07	*(mg/L)*
Length of Source Zone Parallel to Groundwater Flow	L	100	*(ft)*
Groundwater Seepage Velocity	V_x	586	*(ft/yr)*
Retardation Factor	R	9.93	*(-)*
		↑ or	
Soil Bulk Density	Rho	1.86	*(kg/L)*
Partition Coefficient	K_{oc}	32.00	*(L/kg)*
Fraction Organic Carbon	f_{oc}	0.03	*(-)*
Effective Porosity	n_e	0.2	*(-)*

Calculate R

Create Graph | HELP

METHOD 2: NAPL ZONE CONSTITUENTS

Type of Media			
Initial Aqueous-Phase Concentration in Source Zone Under Natural Flow Conditions	C_s		*(mg/L)*
Desired Cleanup Concentration	C_t		*(mg/L)*
Density of NAPL Fluid	Rho		*(g/mL)*
Initial NAPL Saturation in Porous Media	S_o		*(%)*
Uncertainty in NAPL Saturation	± *Factor of*		
Natural Groundwater Seepage Velocity	V_s		*(ft/yr)*
Length of Source Zone Parallel to Groundwater Flow	L		*(ft)*

Is This a Pumping Scenario?

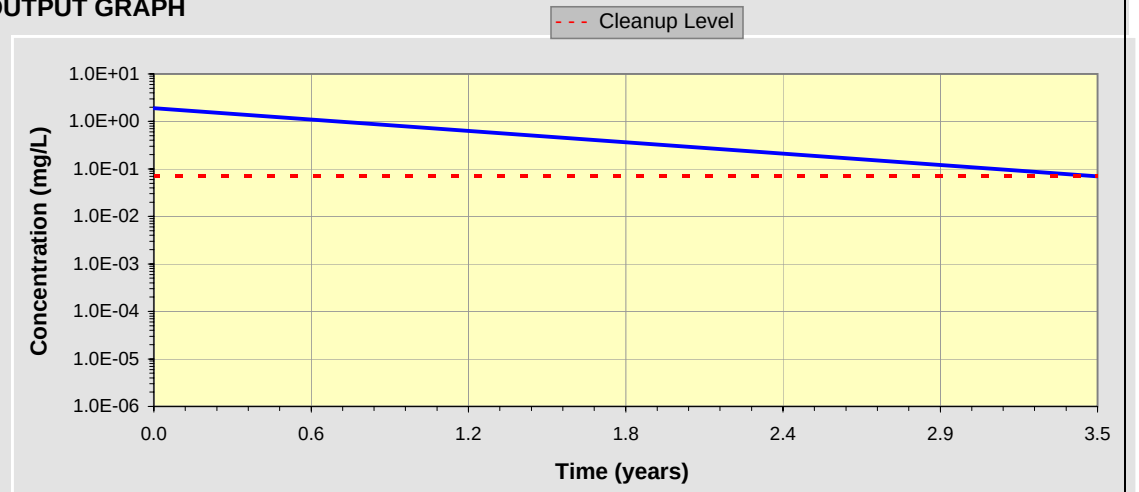
METHOD 2: Continued

What is the Typical Groundwater Seepage Velocity While Pumping? *(ft/yr)*

Concentration in Produced Groundwater as a Result of Mass Transfer Effects is *(mg/L)*

Create Graph | HELP

OUTPUT GRAPH



RESULTS

1) The Number of Pore Volumes Required to Reach Desired Cleanup Level — **2.07E+01** *(-)*

2) Time to Flush Out Constituents and Achieve Desired Cleanup Level — **3.53E+00** *(yrs)*

Return to Main Screen | *New Site/Clear Screen* | *Paste Example Data Set*

SourceDK

Remediation Timeframe Decision Support System

Air Force Center for Environmental Excellence — *Version 1.0*

TIER 3 Process Models

Data Input Instructions:

115 ▸ *1. Enter value directly....or*

↑ *or*

115 ▸ *2. Calculate by filling in blue cells. Press Enter, then hit "Calculate"*

115 ▸ *3. Value calculated by model. (Don't enter any data.)*

Site Location: Site 18 NNS EE/CA

Constituent: TCE (GW01S)

METHOD 1: DISSOLVED PHASE CONSTITUENTS

Original Constituent Concentration	C_o	0.132	*(mg/L)*
Desired Cleanup Level	C_t	0.005	*(mg/L)*
Length of Source Zone Parallel to Groundwater Flow	L	100	*(ft)*
Groundwater Seepage Velocity	V_x	586	*(ft/yr)*
Retardation Factor	R	36.15	*(-)*
		or	
Soil Bulk Density	Rho	1.86	*(kg/L)*
Partition Coefficient	K_{oc}	126.00	*(L/kg)*
Fraction Organic Carbon	f_{oc}	0.03	*(-)*
Effective Porosity	n_e	0.2	*(-)*

Calculate R

Create Graph | HELP

METHOD 2: NAPL ZONE CONSTITUENTS

Type of Media			
Initial Aqueous-Phase Concentration in Source Zone Under Natural Flow Conditions	C_s		*(mg/L)*
Desired Cleanup Concentration	C_t		*(mg/L)*
Density of NAPL Fluid	Rho		*(g/mL)*
Initial NAPL Saturation in Porous Media	S_o		*(%)*
Uncertainty in NAPL Saturation	± *Factor of*		
Natural Groundwater Seepage Velocity	V_s		*(ft/yr)*
Length of Source Zone Parallel to Groundwater Flow	L		*(ft)*

Is This a Pumping Scenario?

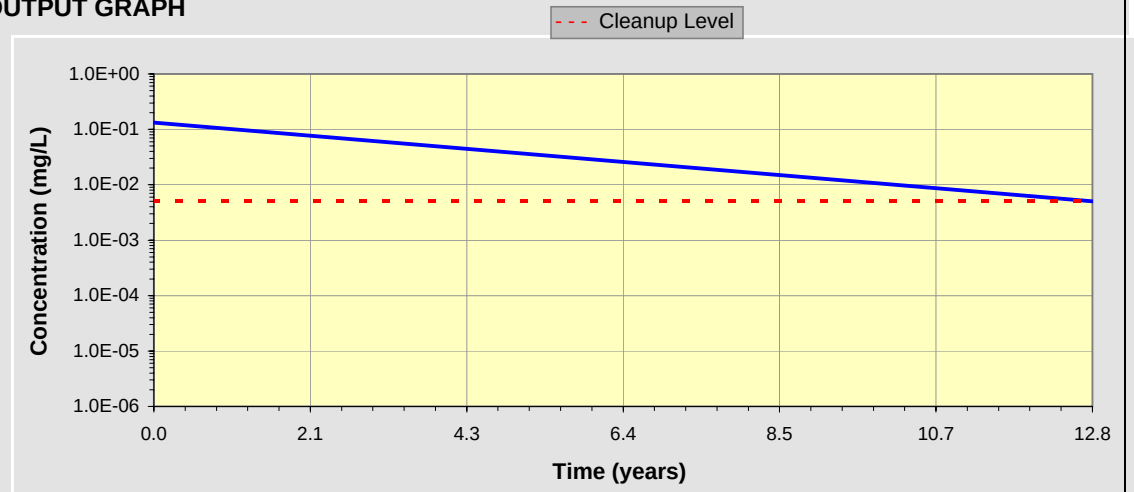
METHOD 2: Continued

What is the Typical Groundwater Seepage Velocity While Pumping? *(ft/yr)*

Concentration in Produced Groundwater as a Result of Mass Transfer Effects is *(mg/L)*

Create Graph | HELP

OUTPUT GRAPH



RESULTS

1) The Number of Pore Volumes Required to Reach Desired Cleanup Level — **7.49E+01** *(-)*

2) Time to Flush Out Constituents and Achieve Desired Cleanup Level — **1.28E+01** *(yrs)*

Return to Main Screen | *New Site/Clear Screen* | *Paste Example Data Set*

SourceDK

Remediation Timeframe Decision Support System

Air Force Center for Environmental Excellence — *Version 1.0*

TIER 3 Process Models

Data Input Instructions:

- 115 — *1. Enter value directly....or*
- ↑ or
- 115 — *2. Calculate by filling in blue cells. Press Enter, then hit "Calculate"*
- 115 — *3. Value calculated by model. (Don't enter any data.)*

Site Location: Site 18 NNS EE/CA

Constituent: Vinyl Chloride (MW03S)

METHOD 1: DISSOLVED PHASE CONSTITUENTS

Original Constituent Concentration	C_o	0.68	*(mg/L)*
Desired Cleanup Level	C_t	0.002	*(mg/L)*
Length of Source Zone Parallel to Groundwater Flow	L	100	*(ft)*
Groundwater Seepage Velocity	V_x	586	*(ft/yr)*
Retardation Factor	R	9.09	*(-)*
		↑ or	
Soil Bulk Density	Rho	1.86	*(kg/L)*
Partition Coefficient	K_{oc}	29.00	*(L/kg)*
Fraction Organic Carbon	f_{oc}	0.03	*(-)*
Effective Porosity	n_e	0.2	*(-)*

Calculate R

Create Graph | HELP

METHOD 2: NAPL ZONE CONSTITUENTS

Type of Media			
Initial Aqueous-Phase Concentration in Source Zone Under Natural Flow Conditions	C_s		*(mg/L)*
Desired Cleanup Concentration	C_t		*(mg/L)*
Density of NAPL Fluid	Rho		*(g/mL)*
Initial NAPL Saturation in Porous Media	S_o		*(%)*
Uncertainty in NAPL Saturation	± *Factor of*		
Natural Groundwater Seepage Velocity	V_s		*(ft/yr)*
Length of Source Zone Parallel to Groundwater Flow	L		*(ft)*

Is This a Pumping Scenario?

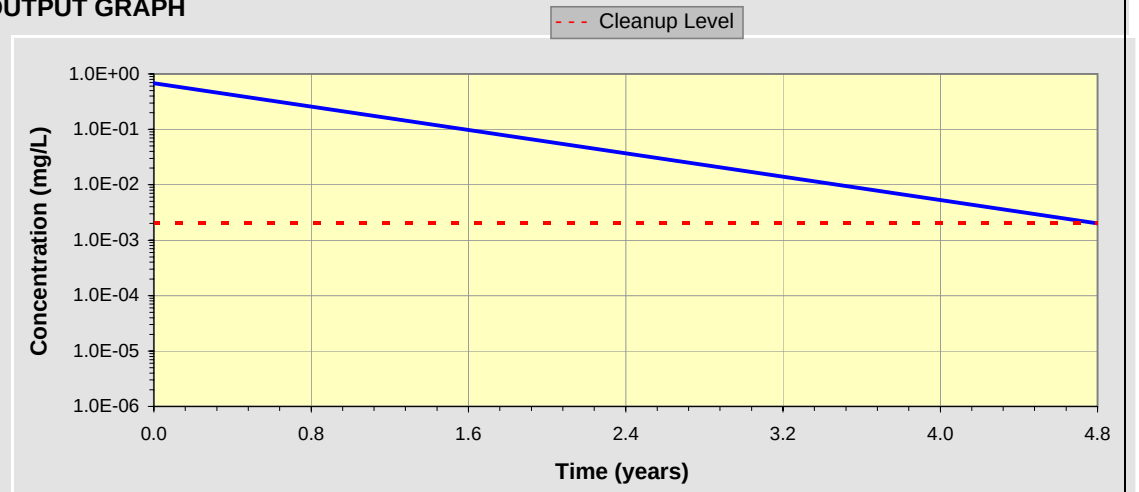
METHOD 2: Continued

What is the Typical Groundwater Seepage Velocity While Pumping? *(ft/yr)*

Concentration in Produced Groundwater as a Result of Mass Transfer Effects is *(mg/L)*

Create Graph | HELP

OUTPUT GRAPH



RESULTS

1) The Number of Pore Volumes Required to Reach Desired Cleanup Level — **2.82E+01** *(-)*

2) Time to Flush Out Constituents and Achieve Desired Cleanup Level — **4.82E+00** *(yrs)*

Return to Main Screen | *New Site/Clear Screen* | *Paste Example Data Set*

Appendix D
Cost Estimates

TABLE D-1a

Cost Estimate for Alternative 2: Monitored Natural Attenuation

Site 18 EE/CA

Naval Station Norfolk

Norfolk, Virginia

Line Item	Cost Item	Unit	Quantity	Unit Cost	Cost	Comments/Notes
	Implementation: Work Plan and LUC Survey/Design					
1	Long-Term Monitoring Plan	Each	1.0	$ 18,000.00	$ 18,000.00	Includes Draft, Draft Final, and Final Monitoring Plans. *NAVFAC-required UFP-QAPP format* . Recent similar projects.
2	Land-Use Control Design	Each	1.0	$ 9,600.00	$ 9,600.00	Includes Draft and Final LUC Plans, survey of LUC boundaries, and Survey Plat. Recent similar projects.
3	***Subtotal***				***$ 27,600.00***	
4	*Project Management multiplier*			*15%*	$ 4,140.00	RS Means (Site) 01 11 31.20 0350 and recent similar projects.
5	***Subtotal Implementation***				***$ 31,740.00***	
	Future Costs: LUCs and Performance Monitoring					
6	Present Value of Future Cost for Performance Monitoring and Managing LUCs for 13 years	*Calculated Table D-1b*	1.0	$ 308,013.08	$ 308,013.08	Recent similar projects; Navy CLEAN BOA rates. Backup provided on Tables D-1b and D-1c, as well as electronically for laboratory analyses and data validation. 3.8% inflation rate per year. 3% discount rate for present value calculation.
7	***Subtotal Future Costs (Present Value)***				***$ 308,013.08***	
	Subtotal Implementation + Future Costs (Present Value)				**$ 339,753.08**	
8	*Contingency multiplier*			*20%*	$ 67,950.62	RS Means (Site) 01 21 16 16.50 0020.
9	***Subtotal***				***$ 407,703.70***	
10	*General Conditions multiplier*			*10%*	$ 40,770.37	RS Means (Site), Page vi, General Conditions.
11	***Subtotal***				***$ 448,474.07***	
12	*Contractor OH/P multiplier*			*10%*	$ 44,847.41	RS Means (Site) 01 31 13.80 0150.
	TOTAL CURRENT COST OF ALTERNATIVE 2 (Implementation and Future Costs [Present Value])				**$ 493,000**	*-30% =* ***$345,000*** / *+50% =* ***$740,000***

References and Source Notes

- Base costs used are 2007 dollars.
- RS Means (Site): RS Means, *Site Work and Landscape Cost Data*, 26th Annual Edition, 2007.
- Recent similar projects include LUC and groundwater monitoring work for all NAVFAC Washington and Mid-Atlantic Navy and Marine Corps IRP Sites under Navy CLEAN II and III and AGVIQ/CH2M HILL JV I, II, and III Contracts
- OMB Circular A-94, Revised January 2007, "Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis"

Assumptions and Exclusions

1. Refer to Tables D-1b and D-1c and electronic lab and data validation backup.
2. Excludes any special handling of purged groundwater. All IDW is assumed nonhazardous and can be disposed onbase at no cost.
3. Excludes fencing, gates, and/or security systems.
4. Assume no ESS Waiver required for sampling and quarterly inspections. Excludes costs associated with ESS Waiver(s).

TABLE D-1b

Cost Estimate for Alternative 2: Monitored Natural Attenuation

Present Value Calcualation for Future Costs Associated with LUCs and Monitoring

Site 18 EE/CA

Naval Station Norfolk

Norfolk, Virginia

3.0% Discount Rate for Estimated 13 year future period

Year		Discount Factor at 3%	Future Cost	Present Value Cost at 3%
0	2007	1.000		$ -
1	2008	0.971	$ 67,124	$ 65,169
2	2009	0.943	$ 35,875	$ 33,816
3	2010	0.915	$ 32,045	$ 29,326
4	2011	0.888	$ 17,750	$ 15,771
5	2012	0.863	$ 23,068	$ 19,899
6	2013	0.837	$ 19,125	$ 16,017
7	2014	0.813	$ 19,851	$ 16,141
8	2015	0.789	$ 30,992	$ 24,466
9	2016	0.766	$ 21,389	$ 16,393
10	2017	0.744	$ 27,797	$ 20,684
11	2018	0.722	$ 23,045	$ 16,648
12	2019	0.701	$ 23,921	$ 16,778
13	2020	0.681	$ 24,830	$ 16,908
		Total Future Cost	$ 366,812	
			Total Present Value	**$ 308,013**

*Discount factor established per Office of Management and Budget, Circular A-94, Appendix C. Revised January 2007. "Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis".
http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

TABLE D-1c

Cost Estimate for Alternative 2: Monitored Natural Attenuation

Additional Backup for Associated LUC and Monitoring costs

Site 18 EE/CA

Naval Station Norfolk

Norfolk, Virginia

5 Year Review - Years 5 and 10

NOTE: Cost estimate for 5-Year Review does not consider that Site 18 will be reviewed or managed by itself. Estimate is based on performing 5-Year Review in conjunction with other sites at NSN. This does not impact the cost comparison between removal alternatives, because this same assumption is used for both Alternatives 2 and 3.

					Year	Cost if performed today	Cost Inflated 3.8% per year
		SUBTOTAL per report	$4,000.00		**5**	$4,000.00	***$4,643.54***
					10	$4,000.00	***$5,595.46***

Quarterly Inspection (1 event) - Years 1-13, Four times per year

NOTE: Cost estimate for quarterly inspections does not consider that Site 18 will be inspected or managed by itself. Estimate is based on performing inspections in conjunction with other sites with LUCs at NSN. This does not impact the cost comparison between removal alternatives, because this same assumption is used for both Alternatives 2 and 3.

Labor (Nonlabor subsumed by working in conjunction with other sites; see note above)

Item	**Description**	**Units**	**Average Rate**	**Quantity**	**Cost**
1	Labor[1]	hour	$ 75.00	4	$ 300.00
2	Project Management[2]	hour	$ 100.00	10	$ 1,000.00
3	Letter Report[3]	each	$ 1,000.00	1	$ 1,000.00
	SUBTOTAL per inspection				$ 1,300.00
	TOTAL each year if performed today				**$ 5,200.00**

[1] Assumes two field technicians for one 2 hour day; To be performed in conjunction with quarterly inspections at other NSN sites.

[2] Project management cost includes general project management for task order, monthly administration and financial management, etc.

[3] Assumes reporting occurs in conjunction with other NSN sites.

Year	Cost if performed today	Cost Inflated 3.8% per year	
1	$2,000.00	***$2,000.00***	*four events*
2	$2,000.00	***$2,076.00***	*four events*
3	$2,000.00	***$2,154.89***	*four events*
4	$2,000.00	***$2,236.77***	*four events*
5	$2,000.00	***$2,321.77***	*four events*
6	$2,000.00	***$2,410.00***	*four events*
7	$2,000.00	***$2,501.58***	*four events*
8	$2,000.00	***$2,596.64***	*four events*
9	$2,000.00	***$2,695.31***	*four events*
10	$2,000.00	***$2,797.73***	*four events*
11	$2,000.00	***$2,904.05***	*four events*
12	$2,000.00	***$3,014.40***	*four events*
13	$2,000.00	***$3,128.95***	*four events*

Monitoring well maintenance (once) - Year 8

Miscellaneous monitoring well maintenance

Year	Cost if performed today	Cost Inflated 3.8% per year
8	$8,000.00	***$10,386.55***

Groundwater Monitoring Event - Year 1 quarterly; Years 2&3 semiannually; Years 4-13 annually

Labor and Nonlabor (1 sample event)

Description	**Units**	**Average Rate**	**Quantity**	**Cost**
Labor (two personnel; 1.5 days x 10 hrs/day)	hour	$ 75.00	30	$ 2,250.00
Shipping/Equipment/Travel	each	$ 800.00	1	$ 800.00
Project Management[1]	hour	$ 100.00	12	$ 1,200.00
Data and Subcontractor Management	hour	$ 75.00	20	$ 1,500.00
Data Tech Memo	each	$ 4,200.00	1	$ 4,200.00
TOTAL per event if performed today				**$ 9,950.00**

[1] Project management cost includes general project management for task order, monthly administration and financial management, etc.

Year	Cost if performed today	Cost Inflated 3.8% per year	
Six monitoring wells: MW03C, 03S, 05S, 08S, 09S, 10S	1	$39,800.00	***$39,800.00***	*four events*
Assume all six sampled each event through Year 13.	2	$19,900.00	***$20,656.20***	*two events*
	3	$19,900.00	***$21,441.14***	*two events*
	4	$9,950.00	***$11,127.95***	*one event*
	5	$9,950.00	***$11,550.81***	*one event*
	6	$9,950.00	***$11,989.74***	*one event*
	7	$9,950.00	***$12,445.35***	*one event*
	8	$9,950.00	***$12,918.28***	*one event*
	9	$9,950.00	***$13,409.17***	*one event*
	10	$9,950.00	***$13,918.72***	*one event*
	11	$9,950.00	***$14,447.63***	*one event*
	12	$9,950.00	***$14,996.64***	*one event*
	13	$9,950.00	***$15,566.51***	*one event*

Laboratory Services (Year 1 quarterly; Years 2&3 semiannually; Years 4-13 annually)							
		Subcontractor cost only. Subcontracting and Data management cost covered above per event. *Six monitoring wells: MW03C, 03S, 05S, 08S, 09S, 10S*		Year	**Cost if performed today**	**Cost Inflated 3.8% per year**	
		Analyses detailed on following sheets (electronic). Analyses differ by event in some instances.		1	$21,949.64	***$21,949.64***	*four events*
				2	$10,974.82	***$11,391.86***	*two events*
		Includes IDW sample per event. IDW purge water to be disposed onbase at no cost.		3	$6,678.94	***$7,196.18***	*two events*
				4	$3,339.47	***$3,734.82***	*one event*
		Full QA/QC		5	$3,339.47	***$3,876.74***	*one event*
				6	$3,339.47	***$4,024.06***	*one event*
				7	$3,339.47	***$4,176.97***	*one event*
				8	$3,339.47	***$4,335.70***	*one event*
				9	$3,339.47	***$4,500.45***	*one event*
				10	$3,339.47	***$4,671.47***	*one event*
				11	$3,339.47	***$4,848.99***	*one event*
				12	$3,339.47	***$5,033.25***	*one event*
				13	$3,339.47	***$5,224.51***	*one event*
Data Validation Services (Year 1 quarterly; Years 2&3 semiannually; Years 4-13 annually)							
		Subcontractor cost only. Subcontracting and Data management cost covered above per event		Year	**Cost if performed today**	**Cost Inflated 3.8% per year**	
		Six monitoring wells: MW03C, 03S, 05S, 08S, 09S, 10S		1	$3,374.32	***$3,374.32***	*four events*
		Analyses detailed on following sheets (electronic). Analyses differ by event in some instances.		2	$1,687.16	***$1,751.27***	*two events*
				3	$1,163.12	***$1,253.20***	*two events*
		IDW data not validated		4	$581.56	***$650.41***	*one event*
				5	$581.56	***$675.12***	*one event*
				6	$581.56	***$700.78***	*one event*
				7	$581.56	***$727.41***	*one event*
				8	$581.56	***$755.05***	*one event*
				9	$581.56	***$783.74***	*one event*
				10	$581.56	***$813.52***	*one event*
				11	$581.56	***$844.44***	*one event*
				12	$581.56	***$876.53***	*one event*
				13	$581.56	***$909.84***	*one event*

Lab&DV Backup Cost Estimate- Alternative 2 (MNA) Naval Station Norfolk CTO-0173, Site 18		
Service	**Year**	**Total Cost (If Performed Today)**
Laboratory	1	$21,949.64
Laboratory	2	$10,974.82
Laboratory	3	$6,678.94
Laboratory	4	$3,339.47
Laboratory	5	$3,339.47
Laboratory	6	$3,339.47
Laboratory	7	$3,339.47
Laboratory	8	$3,339.47
Laboratory	9	$3,339.47
Laboratory	10	$3,339.47
Laboratory	11	$3,339.47
Laboratory	12	$3,339.47
Laboratory	13	$3,339.47
Data Validation	1	$3,374.32
Data Validation	2	$1,687.16
Data Validation	3	$1,163.12
Data Validation	4	$581.56
Data Validation	5	$581.56
Data Validation	6	$581.56
Data Validation	7	$581.56
Data Validation	8	$581.56
Data Validation	9	$581.56
Data Validation	10	$581.56
Data Validation	11	$581.56
Data Validation	12	$581.56
Data Validation	13	$581.56

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 2- MNA
Year 1 (Quarterly)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Quarter 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 1 Subtotal																	**$5,487.41**
Quarter 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 2 Subtotal																	**$5,487.41**
Quarter 3																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 3 Subtotal																	**$5,487.41**
Quarter 4																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 4 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$21,949.64**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 2- MNA
Year 2 (Semiannual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$5,487.41**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 2 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$10,974.82**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA																	
Year 3 (Semiannual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 2 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$6,678.94**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 2- MNA
Year 4 (Annual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 2- MNA
Year 5 (Annual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 6 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 7 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 8 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 9 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 10 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 11 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 12 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 13 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$3,339.47**
TOTAL COST (28 Calendar day TAT)																	**$3,339.47**

Prepared By: _____

Date: 11/14/2007

Assumptions:
MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Alternative 2- MNA
Year 1 (Quarterly)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Quarter 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 1 Subtotal																	**$843.58**
Quarter 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 2 Subtotal																	**$843.58**
Quarter 3																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 3 Subtotal																	**$843.58**
Quarter 4																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 4 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$3,374.32**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 2 (Semiannual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$843.58**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 2 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$1,687.16**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 3 (Semiannual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 2 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$1,163.12**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 4 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 5 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 6 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Alternative 2- MNA
Year 7 (Annual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 8 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 9 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 10 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 11 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 2- MNA Year 12 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Alternative 2- MNA
Year 13 (Annual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrite by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$581.56**
TOTAL COST (14 Calendar day TAT)																	**$581.56**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

TABLE D-2a

Cost Estimate for Alternative 3: Enhanced Reductive Dechlorination

Site 18 EE/CA

Naval Station Norfolk

Norfolk, Virginia

Line Item	Cost Item	Unit	Quantity	Unit Cost	Cost	Comments/Notes
Implementation: Work Plan, LUC Survey/Design, Injection						
1	Work Plan (i.e., Injection and Performance Monitoring Plan)	Each	1.0	$ 24,000.00	$ 24,000.00	Includes Draft, Draft Final, and Final Work Plan: Injection Plan, Performance Monitoring Plan, H&S Plan, QC Plan. *NAVFAC-required UFP-QAPP format*. Recent similar projects.
2	Land-Use Control Design	Each	1.0	$ 9,600.00	$ 9,600.00	Includes Draft and Final LUC Plans, survey of LUC boundaries, and Survey Plat. Recent similar projects.
3	Utility Mark out	Each	1.0	$ 2,000.00	$ 2,000.00	Recent similar project.
4	Injection Substrate Material	55-gallon Drum	29.0	$ 860.00	$ 24,940.00	Assume one injection only. 10-ug/L-contour treatment area = 11,000 ft^2 max Treatment thickness = 10 ft max Saturation 0.001 lbs EOS / lb soil. Soil at 110 lbs/ft^3. (Refer to Table D-2d for EOS dosage calculation) Recent similar projects. Vendor and Subcontractor quotes.
5	Injection Substrate Material Delivery	55-gallon Drum	29.0	$ 200.00	$ 5,800.00	Recent similar projects. Vendor and Subcontractor quotes.
6	Injection Mobilization	Day	1.0	$ 9,450.00	$ 9,450.00	Mob/demob 10% of injection activity total. Subcontractor quote.
7	Injection Substrate Injection Activity	Day	27	$ 3,500.00	$ 94,500.00	Injection labor/equipment/activity. 27 DPT injection points. 2,00 gal per point at 3 to 4 gal/min max inject. One point per day. Recent similar projects. Subcontractor quote.
8	Injection Drum Disposal	55-gallon Drum	29	$ 15.00	$ 435.00	Drum disposal costs only. Recent similar project. No solid IDW generated during DPT injection. Disposal of nonhaz liquids onbase at no cost.
9	***Subtotal***				***$ 170,725.00***	
10	*Performance Bond multiplier*			*0.4%*	$ 682.90	RS Means (Site) 01 31 13.90 0300.
11	*Oversight and Project Management multiplier*			*20%*	$ 34,145.00	RS Means (Site) 01 11 31.20 0350 and recent similar projects.
12	***Subtotal Implementation***				***$ 205,552.90***	
Future Costs: LUCs and Performance Monitoring						
13	Present Value of Future Cost for Performance Monitoring and Managing LUCs for 5 years	*Calculated Table D-2b*	1.0	$ 170,222.25	$ 170,222.25	Recent similar projects; Navy CLEAN BOA rates. Backup provided on Tables D-2b and D-2c, as well as electronically for laboratory analyses and data validation. 3.5% inflation rate per year. 2.6% discount rate for present value calculation.
14	***Subtotal Future Costs (Present Value)***				***$ 170,222.25***	
Subtotal Implementation + Future Costs (Present Value)					**$ 375,775.15**	
15	*Contingency multiplier*			*20%*	$ 75,155.03	RS Means (Site) 01 21 16 16.50 0020.
16	***Subtotal***				***$ 450,930.19***	
17	*General Conditions multiplier*			*10%*	$ 45,093.02	RS Means (Site), Page vi, General Conditions.
18	***Subtotal***				***$ 496,023.20***	
19	*Contractor OH/P multiplier*			*10%*	$ 49,602.32	RS Means (Site) 01 31 13.80 0150.
TOTAL CURRENT COST OF ALTERNATIVE 3 (Implementation and Future Costs [Present Value])					**$ 546,000**	*-30% =* ***$382,000*** *+50% =* ***$819,000***

References and Source Notes

- Base costs used are 2007 dollars.
- RS Means (Site): RS Means, *Site Work and Landscape Cost Data*, 26th Annual Edition, 2007.
- RS Means (Richard R. Rast), *Environmental Remediation Estimating Methods*, 2nd Edition, 2003.
- Subcontractor quotes: Regenesis, Inc.; ARS Technologies, Inc.; Solutions IES, Inc.
- Recent similar projects include LUC and monitoring work for all NAVFAC Washington and Mid-Atlantic Navy and Marine Corps IRP Sites under Navy CLEAN II and III and AGVIQ/CH2M HILL JV I, II, and III Contracts
- Recent similar projects include substrate injection projects at various Navy facilities for NAVFAC Washington and Mid-Atlantic (e.g., White Oak and Little Creek).
- OMB Circular A-94, Revised January 2007, "Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis"

Assumptions and Exclusions

1. Refer to Tables D-1b, D-1c, D-1d, and electronic lab and data validation backup.

2. Excludes any special handling of purged groundwater. All IDW is assumed nonhazardous and can be disposed onbase at no cost.

3. Excludes fencing, gates, and/or security systems.

4. Assume no ESS Waiver required for injection, sampling, and quarterly inspections. Excludes costs associated with ESS Waiver(s).

5. Assume Navy will supply a water source for use during injection.

TABLE D-2b

Cost Estimate for Alternative 3: Enhanced Reductive Dechlorination

Present Value Calculation for Future Costs Associated with LUCs and Monitoring

Site 18 EE/CA

Naval Station Norfolk

Norfolk, Virginia

2.6% Discount Rate for Estimated 5 year future period

Year		Discount Factor at 2.6%	Yearly Cost	Present Value Cost at 2.6%
0	2007	1.000		$ -
1	2008	0.975	$ 67,124	$ 65,423
2	2009	0.950	$ 35,075	$ 33,320
3	2010	0.926	$ 35,606	$ 32,967
4	2011	0.902	$ 19,187	$ 17,315
5	2012	0.880	$ 24,100	$ 21,197
		Total Future Cost	$ 181,092	
			Total Present Value	**$ 170,222**

*Discount factor established per Office of Management and Budget, Circular A-94, Appendix C. Revised January 2007. "Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis".
http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

TABLE D-2c

Cost Estimate for Alternative 3: Enhanced Reductive Dechlorination

Additional Backup for Associated LUC and Monitoring costs

Site 18 EE/CA

Naval Station Norfolk

Norfolk, Virginia

5 Year Review - Year 5

NOTE: Cost estimate for 5-Year Review does not consider that Site 18 will be reviewed or managed by itself. Estimate is based on performing 5-Year Review in conjunction with other sites at NSN. This does not impact the cost comparison between removal alternatives, because this same assumption is used for both Alternatives 2 and 3.

		SUBTOTAL per report	$4,000.00		

	Year	**Cost if performed today**	**Cost Inflated 3.5% per year**
TOTAL	**5**	$4,000.00	***$4,590.09***

Quarterly Inspection (1 event) - Years 1-5, Four times per year

NOTE: Cost estimate for quarterly inspections does not consider that Site 18 will be inspected or managed by itself. Estimate is based on performing inspections in conjunction with other sites with LUCs at NSN. This does not impact the cost comparison between removal alternatives, because this same assumption is used for both Alternatives 2 and 3.

Labor (Nonlabor subsumed by working in conjunction with other sites; see note above)

Item	**Description**	**Units**	**Average Rate**	**Quantity**	**Cost**
1	Labor[1]	hour	$ 75.00	4	$ 300.00
2	Project Management[2]	hour	$ 100.00	10	$ 1,000.00
3	Letter Report[3]	each	$ 1,000.00	1	$ 1,000.00
	SUBTOTAL per inspection				$ 1,300.00
	TOTAL each year if performed today				**$ 5,200.00**

[1] Assumes two field technicians for one 2 hour day; To be performed in conjunction with quarterly inspections at other NSN sites.

[2] Project management cost includes general project management for task order, monthly administration and financial management, etc.

[3] Assumes reporting occurs in conjunction with other NSN sites.

Year	**Cost if performed today**	**Cost Inflated 3.5% per year**	
1	$2,000.00	***$2,000.00***	*four events*
2	$2,000.00	***$2,070.00***	*four events*
3	$2,000.00	***$2,142.45***	*four events*
4	$2,000.00	***$2,217.44***	*four events*
5	$2,000.00	***$2,295.05***	*four events*

Groundwater Monitoring Event - Year 1 quarterly; Years 2&3 semiannually; Years 4-5 annually

Labor and Nonlabor (1 Round)

Item	**Description**	**Units**	**Average Rate**	**Quantity**	**Cost**
1	Labor (two personnel; 1.5 days x 10 hrs/day)	hour	$ 75.00	30	$ 2,250.00
2	Shipping/Equipment/Travel	each	$ 800.00	1	$ 800.00
3	Project Management[1]	hour	$ 100.00	12	$ 1,200.00
4	Data and Subcontractor Management	hour	$ 75.00	20	$ 1,500.00
5	Data Tech Memo	each	$ 4,200.00	1	$ 4,200.00
	SUBTOTAL per event if performed today				**$ 9,950.00**

[1] Project management cost includes general project management for task order, monthly administration and financial management, etc.

	Year	**Cost if performed today**	**Cost Inflated 3.5% per year**	
Six monitoring wells: MW03C, 03S, 05S, 08S, 09S, 10S	**1**	$39,800.00	***$39,800.00***	*four events*
Assume all six sampled each event through Year 5.	**2**	$19,900.00	***$20,596.50***	*two events*
	3	$19,900.00	***$21,317.38***	*two events*
	4	$9,950.00	***$11,031.74***	*one event*
	5	$9,950.00	***$11,417.85***	*one event*

Laboratory Services (Year 1 quarterly; Years 2&3 semiannually; Years 4-5 annually)

Subcontractor cost only. Subcontracting and Data management cost covered above per event. *Six monitoring wells: MW03C, 03S, 05S, 08S, 09S, 10S*	**Year**	**Cost if performed today**	**Cost Inflated 3.5% per year**	
Analyses detailed on following sheets (electronic). Analyses differ by event in some instances.	**1**	$21,949.64	***$21,949.64***	*four events*
	2	$10,974.82	***$11,358.94***	*two events*
Includes IDW sample per event. IDW purge water to be disposed onbase at no cost.	**3**	$10,974.82	***$11,756.50***	*two events*
	4	$5,487.41	***$6,083.99***	*one event*
Full QA/QC	**5**	$5,487.41	***$6,296.93***	*one event*

Data Validation Services (Year 1 quarterly; Years 2&3 semiannually; Years 4-5 annually)

Subcontractor cost only. Subcontracting and Data management cost covered above per event	**Year**	**Cost if performed today**	**Cost Inflated 3.5% per year**	
Six monitoring wells: MW03C, 03S, 05S, 08S, 09S, 10S	**1**	$3,374.32	***$3,374.32***	*four events*
Analyses detailed on following sheets (electronic). Analyses differ by event in some instances.	**2**	$1,687.16	***$1,746.21***	*two events*
	3	$1,687.16	***$1,807.33***	*two events*
IDW data not validated	**4**	$843.58	***$935.29***	*one event*
	5	$843.58	***$968.03***	*one event*

TABLE D-2d
Cost Estimate for Alternative 3: Enhanced Reductive Dechlorination
Backup for EOS Saturation Dosage
Site 18 EE/CA
Naval Station Norfolk
Norfolk, Virginia

EOS Saturation dosages based on soil weight & volume

Location	Area & Volume Description	Volume Soil ft^3	Volume Soil gal	Soil Specific Wt lbs/ft^3
Total Treatment area - 10ug/L	11,000 sq ft x 10 ft thick	110,000	822,800	110
DPT Injection Point (24-ft diameter)	12 ft ROI x 10 ft thick	4,524	33,839	110

RANGE		RANGE		RANGE	
lbs EOS per lb soil		**55-gallon Drums Volume EOS equivalent**		Mixture & water required based on Mobile Porosity	
0.001	0.0015	0.001	0.0015	0.1	0.15
12,100	18,150	28.8	43.2	80,695	121,043
498	746	1.2	1.8	3,319	4,978

Above empirical 2,500 gallons

Lab&DV Backup Cost Estimate- Alternative 3 (ERD) Naval Station Norfolk CTO-0173, Site 18		
Service	**Year**	**Total Cost (If Performed Today)**
Laboratory	1	$21,949.64
Laboratory	2	$10,974.82
Laboratory	3	$10,974.82
Laboratory	4	$5,487.41
Laboratory	5	$5,487.41
Data Validation	1	$3,374.32
Data Validation	2	$1,687.16
Data Validation	3	$1,687.16
Data Validation	4	$843.58
Data Validation	5	$843.58

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 3- ERD
Year 1 (Quarterly)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Quarter 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 1 Subtotal																	**$5,487.41**
Quarter 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 2 Subtotal																	**$5,487.41**
Quarter 3																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 3 Subtotal																	**$5,487.41**
Quarter 4																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Quarter 4 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$21,949.64**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 3- ERD
Year 2 (Semiannual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$5,487.41**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 2 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$10,974.82**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Alternative 3- ERD
Year 3 (Semiannual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$5,487.41**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 2 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$10,974.82**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 3- ERD Year 4 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$5,487.41**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Analytical Laboratory Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 3- ERD Year 5 (Annual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	11	$95.00	$1,045.00	$1,045.00
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$101.09	$909.81	$909.81
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$28.08	$252.72	$252.72
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$48.82	$439.38	$439.38
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$21.91	$197.19	$197.19
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$13.18	$118.62	$118.62
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$128.57	$1,157.13	$1,157.13
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	9	$75.00	$675.00	$675.00
IDW																	
Full TCLP (1311/ 8260B, 8270C, 8151A, 6010B, 7470A, 8081A,	Aqueous	1							0	0		$0.00	1	1	$590.17	$590.17	$590.17
Reactivity to Sulfide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Reactivity to Cyanide	Aqueous	1							0	0		$0.00	1	1	$33.82	$33.82	$33.82
Corrosivity as pH by SW-846 9045C	Aqueous	1							0	0		$0.00	1	1	$8.45	$8.45	$8.45
Ignitability by Pensky Martens	Aqueous	1							0	0		$0.00	1	1	$26.30	$26.30	$26.30
Round 1 Subtotal																	**$5,487.41**
TOTAL COST (28 Calendar day TAT)																	**$5,487.41**

Prepared By: _____

Date: 11/14/2007

Assumptions:

MS/MSDs are not billable per the Navy CLEAN BOA
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time
Full TCLP and RCI for IDW samples

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Alternative 3- ERD
Year 1 (Quarterly)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Quarter 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysi	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 1 Subtotal																	**$843.58**
Quarter 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysi	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 2 Subtotal																	**$843.58**
Quarter 3																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysi	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 3 Subtotal																	**$843.58**
Quarter 4																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysi	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Quarter 4 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$3,374.32**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 3- ERD Year 2 (Semiannual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 1 Subtotal																	**$843.58**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Round 2 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$1,687.16**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Alternative 3- ERD Year 3 (Semiannual)																	
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Round 1 Subtotal																	**$843.58**
Round 2																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Round 2 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$1,687.16**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Alternative 3- ERD
Year 4 (Annual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Round 1 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$843.58**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Cost Estimate
Naval Station Norfolk
CTO-0173, Site 18
Data Validation Services

Alternative 3- ERD
Year 5 (Annual)

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Rinsate Blanks	Field Blanks	Trip Blanks	Matrix Spike	Matrix Spike Duplicate	Total Number of Solid Samples	Total Billable Solid Samples	Solid Unit Price	Solid Subtotal Cost	Total Number of Liquid Samples	Total Billable Liquid Samples	Liquid Unit Price	Liquid Subtotal Cost	Total Analytical Cost
Round 1																	
Groundwater wells																	
TCL Volatile Organic Compounds by CLP OLM04.3	GW	6	1	1	1	2	1	1	0	0		$0.00	13	13	$19.08	$248.04	$248.04
Methane, Ethane, Ethene by RSK-175	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$11.07	$121.77	$121.77
Dissolved Iron and Manganese by SW-846 6010B	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$8.75	$96.25	$96.25
Nitrate, Nitrite, Sulfate by USEPA 300.0	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$10.50	$115.50	$115.50
Sulfide by USEPA 376.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Alkalinity by USEPA 310.1	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$4.33	$47.63	$47.63
Volatile Fatty Acids (Acetic, Butyric, Pyruvic, Propionic, Lactic Acid) by AM23G	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$9.33	$102.63	$102.63
Total Organic Carbon by SW-846 9060 Quadruplicate analysis	GW	6	1	1	1	0	1	1	0	0		$0.00	11	11	$5.83	$64.13	$64.13
Round 1 Subtotal																	**$843.58**
TOTAL COST (14 Calendar day TAT)																	**$843.58**

Prepared By: _____

Date: 11/14/2007

Assumptions:
VOCs by CLP OLM04.3
Full QA/QC for all parameters
Standard turnaround time

Attachment B
Public Notice and Responsiveness Summary

The following notice was placed in *The Virginian Pilot* newspaper on January 25, 2008. No comments were received from the public during the public comment period. As a result, a public meeting was not held.

Public Notices

NAVFAC
Naval Facilities Engineering Command

NOTICE OF THE NAVY'S INVITATION FOR PUBLIC COMMENT ON THE ENGINEERING EVALUATION/COST ANALYSIS FOR SITE 18 NAVAL STATION NORFOLK NORFOLK, VIRGINIA

The Department of the Navy (DoN) invites public comment on the Engineering Evaluation/Cost Analysis (EE/CA) for the Installation Restoration Site 18, Former Naval Magazine Waste Storage Area. This area is associated with historical storage of drums containing waste oil, metal plating solutions and sludges, chlorinated organic solvents, acids, and paint stripping solutions. The EE/CA presents and evaluates alternatives for a non-time critical removal action (NTCRA) to mitigate potential unacceptable human health risk from exposure to groundwater. In accordance with 40 CFR Section 300.415, an EE/CA is required when a NTCRA is planned for a site. The goals of an EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. An EE/CA documents the removal action alternatives and selection process.

The EE/CA is based upon findings of previous site-related documents contained in the DoN's Administrative Record for NSN. The Administrative Record is located at:

Naval Facilities Engineering Command, Atlantic Division
6506 Hampton Boulevard
Norfolk, VA 23508-1278
(757) 322-8005

The EE/CA will be available from January 25, 2008, through February 25, 2008, for public review and comment at the following location:

Kirn Memorial Branch
Norfolk Public Library
301 East City Hall Avenue
Norfolk, Virginia 23510
(757) 664-7323

Provide written comments on the EE/CA from January 25, 2008, through February 25, 2008. Send all written comments on or before (post-marked by) February 25, 2008, to the following address:

Mrs. Terri Davis
Attn: Public Affairs Officer
Naval Station Norfolk
1530 Gilbert Street, Suite 2000
Norfolk, Virginia 23511-2722
(757) 322-2576

If requested, a public meeting will be held by representatives of the DoN to clarify public questions or comments on the EE/CA that supports this NTCRA.

VP January 25, 2008 18213438