Third Five-Year Review Report

for

Former Naval Air Warfare Center

Warminster

Warminster, Pennsylvania

Naval Facilities Engineering Command Mid-Atlantic

Contract Number N62472-08-D-1001

Contract Task Order WE23

November 2011

THIRD FIVE-YEAR REVIEW REPORT

FOR

FORMER NAVAL AIR WARFARE CENTER
WARMINSTER, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Prepared for:
Naval Facilities Engineering Command Mid-Atlantic
9742 Maryland Avenue
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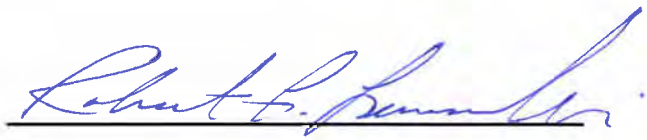
NOVEMBER 2011

APPROVED BY:



11/21/11

ROBERT F. LEWANDOWSKI
BRAC ENVIRONMENTAL COORDINATOR
BRAC PMO NORTHEAST

DATE

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ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criterion
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	contaminant of concern
COPC	chemical of potential concern
CSM	conceptual site model
CTO	Contract Task Order
DCA	dichloroethane
DCE	dichloroethene
DoD	Department of Defense
DNAPL	dense non-aqueous-phase liquid
EBS	Environmental Baseline Survey
EDC	Economic development conveyance
EEQ	Ecological Effects Quotient
EE/CA	Engineering Evaluation/Cost Analysis
EQ	equalization
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FLRA	Federal Lands Reuse Authority
FOST	Finding of Suitability to Transfer
FS	Feasibility Study
GAC	granular activated carbon
gpm	gallon per minute
HHS	Health and Human Services
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System
IR	Installation Restoration
LTM	long-term monitoring
LUC	land use control
LUCIP	Land Use Control Implementation Plan

MCL	Maximum Contaminant Level
NADC	Naval Air Development Center
NAWC	Naval Air Warfare Center
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NPL	National Priorities List
O&M	operations and maintenance
OF	outfall
OPS	Operating Properly and Successfully
OU	Operable Unit
PA	Preliminary Assessment
PADEP	Pennsylvania Department of Environmental Protection
PAH	polynuclear aromatic hydrocarbon
PBC	public benefit conveyance
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PFOA	perfluorooctanic acid
PFOS	perfluorooctane sulfonate
PID	photoionization detector
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SI	Site Inspection
SSL	soil screening level
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TEG	Technical Evaluation Group
Tetra Tech	Tetra Tech NUS, Inc.
TI	technical impracticability
µg/dL	microgram per deciliter
USEPA	United States Environmental Protection Agency

VFD	variable frequency drive
VOC	volatile organic compound
WTMA	Warminster Township Municipal Authority

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name *(from WasteLAN)*: Naval Air Development Center Warminster

EPA ID *(from WasteLAN)*: PA6170024545

Region: 3	**State: PA**	**City/County: Warminster/Bucks**

SITE STATUS

NPL status: ☒ Final ☐ Deleted ☐ Other (specify)

Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☒ Complete

Multiple OUs?* ☒ Yes ☐ No	**Construction completion date:** 9/28/2000

Has site been put into reuse? ☒ Yes ☐ No

REVIEW STATUS

Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency -- United States Navy

Author name: Jeff Dale

Author title: Remedial Project Manager	**Author affiliation:** BRAC PMO Northeast

Review period:** 1/1/2006 to 2/28/2011

Date(s) of site inspection: April 5 and 6, 2011

Type of review:

☒ Post-SARA ☐ Pre-SARA ☐NPL-Removal only
☐Non-NPL Remedial Action Site ☐NPL State/Tribe-lead
☐ Regional Discretion

Review number: ☐ 1 (first) ☐ 2 (second) ☒ 3 (third) ☐ Other (specify) _____

Triggering action:

☐ Actual RA Onsite Construction at OU #____
☐ Construction Completion
☐ Other (specify)
☐ Actual RA Start at OU#_1__
☒Previous Five-Year Review Report

Triggering action date *(from WasteLAN)*: 6 / 2 / 1994

Due date* *(five years after triggering action date)*:** 11 / 23 / 2011

OUs Reviewed:

OU-1A, OU-3, OU-4, OU-7, OU-9, and OU-10.

NFA RODs for OU-2, OU-5, OU-6, and OU-8 were signed prior to or during the last review period. No further reviews are required unless conditions change.

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]
*** Five years after second five-year review period.

Five-Year Review Summary Form (cont.)

Issues:

OU-1A: No deficiencies associated with the OU-1A remedy were identified, and no issues related to current site operations, conditions, or activities prevent the remedy from currently being protective. There are no current issues regarding vapor intrusion for OU-1A. Additional vapor intrusion assessment will be conducted to determine if any additional actions are needed to address potential future vapor intrusion issues associated with future on-site or near-site buildings.

OU-3: No deficiencies were identified for the OU-3 remedy, and no issues related to current site operations, conditions, or activities prevent the remedy from currently being protective. Although the previous vapor intrusion assessment indicated no unacceptable vapor intrusion risks for residential or occupational exposure, further evaluation of potential current risks is ongoing. Additional vapor intrusion assessment will also be conducted to determine if any additional actions are needed to address potential future vapor intrusion issues associated with future on-site or near-site buildings.

OU-4, OU-7, OU-9, and OU-10: No issues related to the protectiveness of the remedies were identified.

Recommendations and Follow-up Actions:

OU-1A: Complete vapor intrusion assessment to determine whether there are any unacceptable potential future risks; address as/if necessary.

OU-3: Complete additional evaluation of potential current vapor intrusion impacts. Complete vapor intrusion assessment to determine whether there are any unacceptable potential future risks; address as/if necessary.

OU-4, OU-7, and OU-9: None.

OU-10: None. No further five-year reviews are required unless conditions change.

Basewide Protectiveness Statement:

The remedial actions that have been implemented and that are ongoing at OU-1A, OU-3, OU-4, OU-7, OU-9, and OU-10 are expected to be protective of human health and the environment, and at all of these sites, LUCs have been implemented to ensure short-term protection by preventing exposure to soil or groundwater that could result in unacceptable risks until completion of the remedies provide long-term protectiveness. In addition, the results of performance monitoring at OU-1A, OU-3, and OU-4 and LUC inspections at all sites are used to evaluate remedy effectiveness and to evaluate potential migration of contamination.

OU-1A, OU-3, and OU-4: The remedial actions that are completed (groundwater extraction and treatment system construction and operation and LUC implementation and maintenance) and performance monitoring are operating as designed and include measures that prevent potentially unacceptable exposure. At OU-4, groundwater extraction and treatment has been discontinued based on monitoring results consistently less than cleanup levels, although performance monitoring and LUCs continue. Based on vapor intrusion evaluations included in the previous Five-Year Review Report, vapor intrusion is not a current concern at any of the sites; however, further evaluation of current vapor intrusion impacts was conducted for OU-1A and OU-4 and is ongoing for OU-3. To evaluate whether further actions are needed to address potential future vapor intrusion risks for new buildings, additional vapor intrusion assessment will be conducted for the OU-1A and OU-3 areas. The OU-4 vapor intrusion evalution did not indicate the need for further action.

OU-7 and OU-9: The remedial actions that are completed (soil cover and erosion controls, respectively, and LUC implementation and maintenance at both sites) are operating as designed and include measures that prevent potentially unacceptable exposure. Stream monitoring was suspended at OU-9 in 2001 but may be restarted if necessary based on the results of LUC (erosion control) inspections.

OU-10: Based on the results of 2007 post-ROD sediment sampling to confirm that the OU-7 remedial action mitigated potential unacceptable risks, no action is necessary to directly address the sediments.

This five-year review shows that the Navy is meeting or exceeding the requirements of the RODs for the OUs at former NAWC Warminster. The Navy is constantly re-evaluating to utilize permanent remedies and alternative treatment technologies to the maximum extent practical for each OU.

Five-Year Review Summary Form (cont.)

Signature of U.S. Department of the Navy and Date

Robert F. Lewandowski
BRAC Environmental Coordinator

11/21/11
Date

1.0 INTRODUCTION

1.1 INTRODUCTION

The purpose of five-year reviews is to determine whether implemented remedies are protective of human health and the environment. The methods, findings, and conclusions of the reviews are documented in Five-Year Review Reports. In addition, Five-Year Review Reports identify issues found during the reviews that may affect remedy protectiveness, if any, and identify recommendations to address them.

The United States Environmental Protection Agency (USEPA) is responsible for implementing statutory five-year reviews pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121 states:

> "If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than every five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the president shall take or require such action. The President shall report to Congress a list of facilities at which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."

USEPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

> "If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."

For federal facility sites under the jurisdiction, custody, or control of the Department of Defense (DoD), Executive Order 12580 relieves USEPA of this responsibility and delegates the responsibility to DoD. The Navy is the lead agency responsible for five-year reviews at the former Naval Air Warfare Center (NAWC) Warminster, working with USEPA Region 3 and the Pennsylvania Department of Environmental Protection (PADEP) through the Federal Facility Agreement (FFA) signed September 20, 1990.

This Five-Year Review Report has been prepared under Contract Task Order (CTO) WE23 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) IV Contract No. N62467-08-D-1001 for Naval Facilities Engineering Command Mid-Atlantic. Tetra Tech NUS, Inc. (Tetra Tech) conducted this five-year review of the pending, completed, and ongoing remedial actions implemented at 6 of the 10 Operable Units (OUs) at the former NAWC located in Warminster Township and Ivyland Borough, Bucks County, Pennsylvania (Figure 1-1). The facilty, formerly known as Naval Air Development Center (NADC) Warminster, was renamed the NAWC Aircraft Division in January 1993 and was disestablished on September 30, 1996, in response to the requirements of the Base Realignment and Closure (BRAC) Act. This Five-Year Review Report was prepared based on remedial actions conducted up to February 2011, although supplemental data from subsequent groundwater sampling event were incorporated as part of vapor intrusion evaluations.

This is the third five-year review for the former NAWC Warminster OUs. The triggering action for the statutory review was the initiation of the remedial action for OU-1, which began on January 15, 1995. The First Five-Year Review Report was completed in February 2001, and the Second Five-Year Review Report was completed in November 2006. Because hazardous substances, pollutants, or contaminants remain at some of the OUs at NAWC Warminster in excess of concentrations that allow for unlimited use and unrestricted exposure, subsequent five-year reviews are required.

The actual and potential hazardous waste disposal locations at the base have been grouped into four areas: Area A (Sites 1, 2, 3, and the Impoundment Area), Area B (Sites 5, 6, and 7), Area C (Sites 4 and 8), and a fourth general area, Area D, located west of Jacksonville Road and primarily including the main building complex at the base (see Figure 1-2).

Section 300.430(a)(1)(ii)(A) of the NCP, 40 CFR Section 300.340(a)(1)(ii)(A), provides that CERCLA National Priorities List (NPL) sites “should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phase analysis or response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of a total cleanup.” In the case of NAWC Warminster, the Navy organized work into 10 OUs:

- OU-1: Contaminated shallow groundwater attributable to Areas A and B (interim remedy only)
  - OU-1A: Contaminated groundwater attributable to Area A (final remedy)
  - OU-1B: Contaminated groundwater attributable to Area B (final remedy)
- OU-2: Contamination of domestic well water for residences near the base
- OU-3: Contaminated groundwater attributable to Area C
- OU-4: Contaminated groundwater attributable to Area D (interim and final remedy)
- OU-5: Soils, sediment, and surface water associated with Site 8 at Area C

- OU-6: Soils, sediment, and surface water associated with Site 4 at Area C
- OU-7: Soils and wastes associated with Sites 6 and 7 at Area B
- OU-8: Soils associated with Area D
- OU-9: Soils, surface water, and sediment associated with Area A
- OU-10: Soils, surface water ,and sediment associated with Site 5 at Area B

This five-year review did not include OU-2, OU-5, OU-6, or OU-8 because no further action (NFA) is required at these sites, as documented in their respective Records of Decision (RODs) (i.e., no hazardous substances, pollutants, or contaminants remain in excess of concentrations that allow for unlimited use and unrestricted exposure), and there have been no changes in site conditions or other factors associated with the assumptions underlying the NFA decisions. Although an NFA ROD was signed for OU-10, post-ROD sediment performance monitoring was required and was completed during this five-year review period (see Section 8).

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This report consists of eight sections and one appendix, as follows:

- Section 1.0 discusses the purpose of the report, provides a summary of the history and site chronology of NAWC Warminster, and evaluates the changes that have occurred in Applicable or Relevant and Appropriate Requirements (ARARs).

- Section 2.0 provides descriptions of each of the four areas at NAWC Warminster (A, B, C, and D), including descriptions of physical characteristics, land and resource uses, history of contamination, and initial response and basis for taking action at each of the areas.

- Sections 3.0 through 8.0 are the five-year reviews for OU-1, OU-3, OU-4, OU-7, OU-9, and OU-10, respectively, at NAWC Warminster. Each section includes an OU chronology, background, summary of remedial actions performed, and five-year review findings, assessment, deficiency list, protectiveness issues and associated recommendations, and protectiveness statement.

- Section 9.0 provides a general summary, conclusions, and protectiveness statement for the former NAWC Warminster facility. This section also identifies when the next five-year review is required and the other tasks that should be performed as part of that five-year review.

- Appendix A includes the Five-Year Review Site Inspection Checklists and photographs.

Administrative Components and Community Involvement

This Five-Year Review consisted of a review of relevant documents, interviews, and a site inspection. In addition, an announcement about the release of the Five-Year Review Report was provided to the Restoration Advisory Board (RAB), which is open to concerned citizens and is supported by the Technical Evaluation Group (TEG) made up of representatives of USEPA, PADEP, and the Navy and its contractors. The completed report will be available in the Information Repository located at the Bucks County Library, 150 South Pine Street, Doylestown, Pennsylvania.

The next five-year-review for NAWC Warminster is required by 2016, 5 years from the date for the finalization of this review.

1.2 SITE CHRONOLOGY

USEPA officially recognized the NAWC Warminster sites as possibly needing investigation in September 1979. In 1980, the Department of the Navy began its environmental investigative work at the facility. The first study, known as the Clay/Law Report, inventoried disposal activities at each of eight sites. Since 1980, several environmental consultants under Navy contracts have studied these sites. The first of the resulting reports, prepared by JRB Associates in 1983, concluded that on-base contamination existed but was probably not affecting off-base water supply wells.

In June 1985, USEPA completed a CERCLA Preliminary Assessment (PA)/Site Inspection (SI) report. In June 1986, NAWC Warminster was proposed for inclusion on the NPL based on a Hazard Ranking System (HRS) score greater than 28.50. USEPA used the HRS to assess the relative threats from releases of hazardous substances from the eight NAWC Warminster sites to surrounding groundwater and surface water. The facility score was based on the likelihood that hazardous substances would be released from the sites, the toxicity and amount of hazardous substances at the sites, and the people and sensitive environments potentially affected by contamination at the sites.

On October 4, 1989, NAWC Warminster was placed on the final NPL. That same year, USEPA submitted a draft Interagency Agreement to the Navy for formalizing and scheduling remedial activities. The contents of this agreement were negotiated in 1990. In 1989, the Navy began conducting CERCLA Remedial Investigation (RI)/Feasibility Study (FS) activities at the facility in the four areas of concern, Area A, Area B, Area C, and Area D. The RI/FS work was divided into three phases. The Phase I RI was performed between October 1989 and April 1991, and the Phase II RI/FS was performed between May 1992 and April 1993. Both Phase I and Phase II primarily addressed groundwater, surface water, and sediment contamination attributable to the base. In October 1993, focused RI/FS work for groundwater contamination attributable to the base began; this work was completed in August 2000.

The Phase III RI/FS, which primarily focused on potential source areas and their impacts to soil, surface water, and sediment, began in January 1995 and was completed in August 2000. During the performance of the RI/FS, OUs were established to help expedite the completion of environmental cleanup activities at the base. Between 1993 and 1998, both focused and comprehensive removal actions were conducted at the sites, with the exception of Site 5, where removal work was not necessary.

A list of important NAWC Warminster historical events and relevant dates is shown below. The identified events are illustrative, not comprehensive.

Date	Event
1944	NADC Warminster commissioned for research, development, and testing of Naval aircraft systems
1940 to 1973	Operation of burn pits, unlined impoundments, lagoons, and a trench disposal site
September 1979	Initial discovery of contamination
1980	Navy initially reported potential locations of hazardous substances disposal
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
June 10, 1986	Proposed NPL listing
October 4, 1989	NPL listing
October 1989	Basewide Phase I RI activities began
September 20, 1990	FFA signed
April 1991	Basewide Phase I RI activities completed
May 1992	Basewide Phase II RI and FS activities began
January 1993	Facility name was changed from NADC to NAWC Aircraft Division
April 1993	Basewide Phase II RI and FS activities completed
September 30, 1996	NAWC Warminster operations ceased pursuant to BRAC
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
February 2001	First Five-Year Review Report signed
November 2006	Second Five-Year Review Report signed
August 2007	Final Optimization Report for OU-1A, OU-3, and OU-4
October 2007	Operable Unit 10 Sediment Sampling Report
December 2007	Area C Source Assessment Report
June 2009	Updated Operations and Maintenance (O&M) Manual for the groundwater treatment system
August 2009	Final Land Use Control (LUC) Implementation Plan and Final 2008 LUC Inspection Report

Date	Event
June 2010	Area D groundwater treatment system taken off line
August 2010	Hydrogeologic Conceptual Site Model (CSM) Update
October 2010	Final Sampling and Analysis Plan (SAP) for Long-Term Monitoring (LTM) at OUs 1A, 3, and 4
December 2010	2010 LUC Inspection Report
1996 to 2011 (ongoing)	Quarterly to semi-annual performance monitoring reports for OU-1A, OU-3, and OU-4

1.3 FACILITY DESCRIPTION AND HISTORY

1.3.1 Facility Description

The former NAWC Warminster, an 824-acre facility in Warminster Township, Ivyland Borough, Bucks County, Pennsylvania, is located in a populated suburban area surrounded by private homes, various commercial and industrial activities, and a golf course. The area encompassing the former NAWC includes various buildings and other structures connected by paved roads, mowed fields, and a small wooded area. The former facility is located on a ridge, generally oriented east-west, with elevations ranging from 297 feet above mean sea level at the northwestern property boundary to 377 feet at the eastern boundary. Slopes are gentle and average 3 to 5 percent. The northern portion of the former facility (about 65 percent) drains into small unnamed tributaries of Little Neshaminy Creek. The remaining portions drain into unnamed tributaries of Pennypack Creek.

The main runway was generally located along the topographically highest area at the facility. Many of the primary facility buildings were located west of the airstrip along Jacksonville Road. A housing development for military enlisted personnel associated with nearby Naval Air Station (NAS) Willow Grove, located off Bristol Road in the southeastern portion of the former NAWC Warminster, is still under Navy control. This housing area is scheduled to be vacated soon, and a reuse plan is pending. A municipal wastewater treatment plant is now located in the northwestern corner of the facility.

A number of commercial businesses currently operate at and surrounding the former NAWC. Additionally, a portion of the former NAWC has been developed as a retirement community (Ann's Choice Retirement Community), and the surrounding land use is also residential. These residents are the nearest population centers. The closest off-base home is approximately 200 feet away.

NAWC Warminster is underlain by the Stockton Formation, which provides water for more than 100,000 people within the area. Local surface water bodies are used for recreational and industrial purposes.

1.3.2 Facility History

The facility was originally the location of Brewster Aeronautical Corporation, a manufacturer of military aircraft. In 1944, the Navy assumed full control of the Brewster plant. The Naval Air Modification Unit was installed at the base to add design modifications to military aircraft produced at other locations. After World War II, activities at the base were altered; in 1949, the facility was designated an NADC, and its main mission, research, development, testing, and evaluation for Naval aircraft systems, was established. These activities varied over the years but included the development, research, and testing of aircraft components, coatings, electronics, and control devices. Concurrent with these activities, aircraft continued to be used and maintained at the facility. The NADC also conducted studies in anti-submarine warfare systems and software development.

Historically, wastes were generated during aircraft maintenance and repair, pest control, firefighting training, machine and plating shop operations, spray painting, and various materials research and testing activities in laboratories. These wastes included paints, solvents, sludges from industrial wastewater treatment, and waste oils that were disposed of in several pits, trenches, and landfills throughout the facility property. None of the sites are currently used for waste disposal.

The facility was placed on the NPL in October 1989 as Naval Air Development Center Warminster (Eight Waste Areas). The NPL includes sites where uncontrolled hazardous substance releases present the most significant potential threats to human health and the environment. Areas reported by the Navy to have been potentially used for disposal of hazardous substances include the following nine locations covering more than 15 acres:

- Three waste disposal locations (Sites 1, 3, and 6)
- Two sludge disposal pit locations (Sites 2 and 7)
- Two landfills (Sites 4 and 5)
- One fire training location (Site 8)
- A series of eight unlined impoundments (Impoundment Area)

As mentioned above, these disposal locations have since been grouped within the following areas on NAWC property: Area A (Sites 1, 2, and 3 and the Impoundment Area), Area B (Sites 5, 6, and 7), and Area C (Sites 4 and 8). A fourth general area, Area D, is located west of Jacksonville Road and primarily includes the main building complex at the former NAWC. Figure 1-2 shows the locations of these areas.

The facility name was changed from NADC to NAWC Aircraft Division in January 1993. In 1996, NAWC Warminster was realigned under the BRAC Program managed by the DoD. This realignment was implemented in September 1997. The realignment resulted in the relocation of NAWC Warminster

activities to NAS Patuxent River, Maryland. The base is now closed and has been redeveloped for non-military use by the Bucks County Federal Lands Reuse Authority (FLRA).

1.4 ARAR AND SITE-SPECIFIC ACTION LEVEL CHANGES

The technical assessment of the five-year review provides a framework for organizing and evaluating data and ensures that relevant issues are considered when determining the protectiveness of the selected remedies. The technical assessments of the remedies also review the risk parameters on which the original remedy decisions were based to determine whether the assumptions or anticipated conditions used to select remedies at the base are still valid or appropriate. The following items were evaluated as part of the technical assessment:

- Changes in ARARs and to be considered (TBC) criteria
- Changes in exposure pathways
- Changes in toxicity and other contaminant characteristics
- Changes in risk assessment methodologies

The ARARs identified in each of the RODs were reviewed, as were new federal and state regulations that have been promulgated. No federal and state ARARs have changed since the second five-year review. No significant changes in the physical conditions at the sites of concern that affect exposure pathways were identified as part of the five-year review. The results of the five-year review did not reveal that contaminant characteristics have changed in a manner that could affect the protectiveness of the remedies selected for the various OUs at the base. No current or planned changes in land use (as described in the various RODs) were identified, and no new contaminants, suspected sources of contamination, or routes of exposure have been identified.

Toxicity factors for groundwater contaminants of concern (COCs) as defined in the RODs have not been revised in a manner that could affect the protectiveness of the remedies because the cleanup goals for contaminants in groundwater are the federal MCLs, which have not changed.

The risk assessments for the OUs were performed in accordance with standardized USEPA and Navy risk assessment methodologies. These methodologies have not changed significantly since the last five-year review was conducted. Minor changes to the risk assessment process since the last five-year review are summarized as follows:

- USEPA Region 3 Risk-Based Concentrations, Region 6 Human Health Media-Specific Screening Levels, and Region 9 Preliminary Remediation Goals were recently updated and combined as Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (USEPA Regions

3, 6, and 9, 2009). Screening levels are generally used during initial investigations to determine if potentially significant levels of contamination are present that warrant further investigation such as an RI/FS and are not generally used to determine cleanup levels.

- Risk-based screening levels for benzo(a)pyrene and carcinogenic polynuclear aromatic hydrocarbons (PAHs) decreased as a result of classifying the carcinogenic PAHs as mutagens. The revised classification for PAHs altered how risks, and consequently risk-based screening levels, are derived, thus resulting in reductions in the screening levels. As stated above, screening levels are not generally used to determine cleanup levels.

- The method for evaluating lifetime residential risk associated with exposure to benzo(a)pyrene and associated carcinogenic PAHs results in an increase to the incremental lifetime cancer risk. The method for evaluating industrial risks did not change. To evaluate whether this change in risk characterization methodology could affect the protectiveness of remedies, risks were recalculated as part of this five-year review for OUs with unrestricted use and for which carcinogenic PAHs were retained as COCs based on the results of their risk assessments. These include OU-5, OU-6, OU-8, and OU-10, all of which had RODs documenting NFA as the remedial decision. PAHs were not COCs at OU-1, OU-2, OU-3, OU-4 or OU-7, and at OU-9, residential land use is prohibited via LUCs (the change in methodology did not affect evaluation of industrial risks). Because based on updated toxicity information, risks associated with carcinogenic PAHs increased approximately six times, the previously calculated risk for each carcinogenic PAH was multiplied by six and then the total risk for all COCs was recalculated with these new risks. In all cases, the revised risks were still within USEPA's target risk range of $1X10^{-4}$ to $1X10^{-6}$, supporting the continued protectiveness of the NFA decisions.

The results of the five-year review indicate that none of these recent risk assessment changes are expected to affect the protectiveness of the remedies established for the base.

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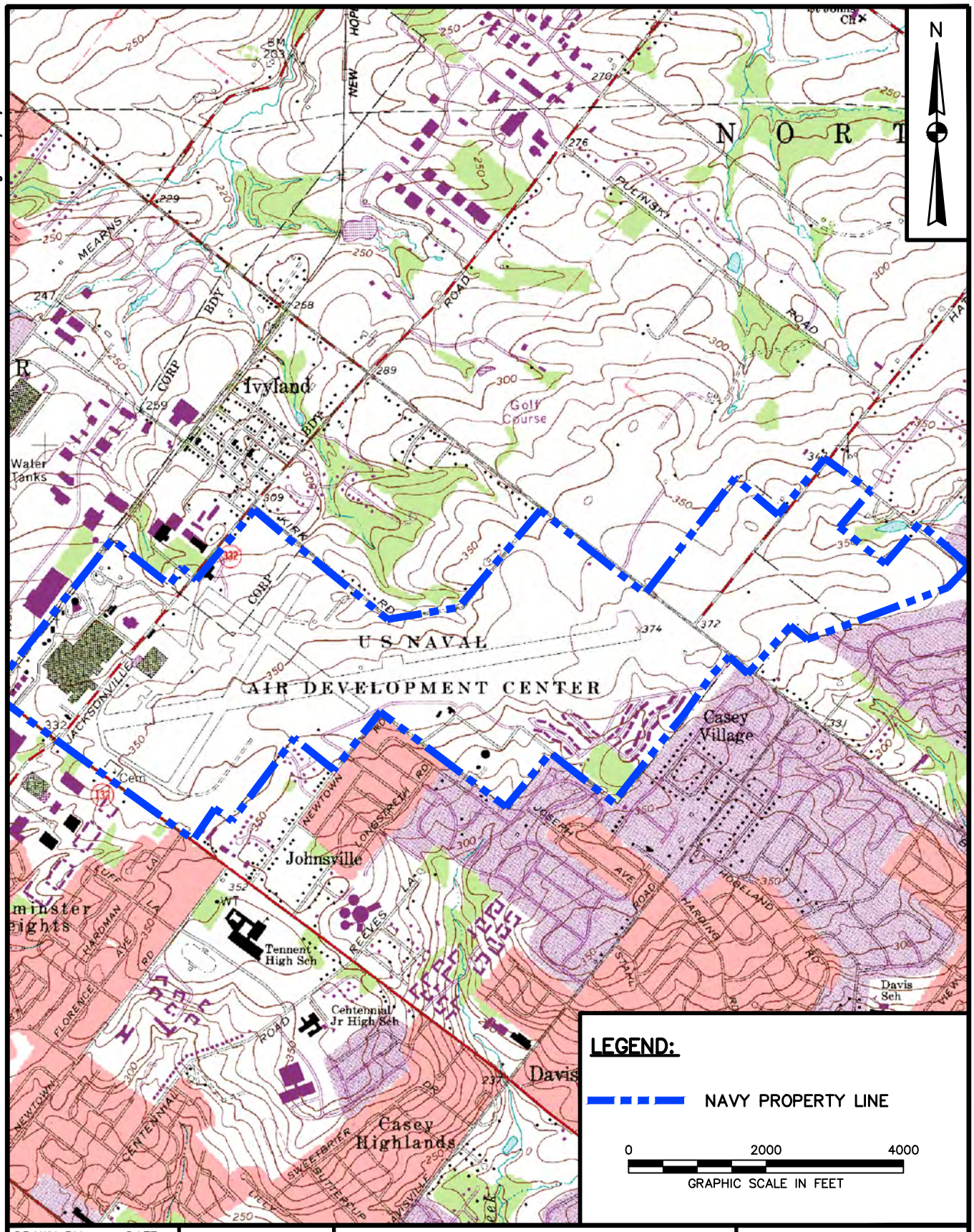

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REVISED BY	DATE		APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 / REV. 0

FORM CADD NO. TTNUS-AV.DWG - REV 1 -9/10/98

ACAD: 0182GM02.dwg 02/01/06 MF PIT

FORMER NAWC WARMINSTER

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AREA A

AREA B

AREA C

AREA D

TRACT I = 70.36 Ac.

TRACT III = 38.08 Ac.

TRACT IV

IVYLAND BORO

NORTHAMPTON COUNTY

WARMINSTER TOWNSHIP

BUCKS COUNTY

RUNWAY 9/27

RUNWAY 14/32

BRISTOL ROAD

PERIMETER ROAD

PATROL ROAD

OFFICER HOUSING AREA

ENLISTED MENS HOUSING AREA

CASEY VILLAGE AREA

ELECTROMAGNETIC MEASUREMENTS RANGE

INERTIAL GUIDANCE TEST FACILITY

HANGAR

FIRE & SECURITY STATION

BEGINNING POINT TRACT I

BEGINNING POINT TRACT III

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LEGEND:

NAWC WARMINSTER PROPERTY LINE

APPROXIMATE ON-BASE AREA OF STUDY

0 800 1600

GRAPHIC SCALE IN FEET

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SCALE AS NOTED	

Tetra Tech NUS, Inc.

ON-BASE
AREAS OF INVESTIGATION
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. 0182	
OWNER NO. 0000	
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DRAWING NO. FIGURE 1-2	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

2.0 AREA DESCRIPTIONS AND BACKGROUND

As mentioned in Section 1.0, for initial investigations at NAWC Warminster, sites were grouped into four areas based on actual and potential hazardous waste disposal locations. After these initial investigations, the Navy organized the work at these areas and sites into 10 OUs according to type, potential for a common remedy, proximity, contamination of a common resource, and funding priority. Descriptions of the four areas and disposal locations are presented below.

2.1 AREA A

2.1.1 Physical Characteristics

Area A generally consists of Sites 1, 2 and 3 and adjacent areas in the northwestern corner of the former NAWC. In addition to Sites 1, 2, and 3, Area A includes the location of eight former impoundments used for storage of industrial wastewater treatment sludge. Area A includes two OUs, OU-1A, which consists of contaminated groundwater attributable to Area A, and OU-9, which consists of Area A surface and subsurface soils and sediment and surface water associated with Area A. Site locations within Area A are shown on Figure 2-1.

Area A is a flat-lying area approximately 1,200 feet by 270 feet in size that covers approximately 7.4 acres. A substantial portion of the soil within Area A consists of fill materials. The topography of the area of Sites 2 and 3 has been significantly altered since the Navy first occupied the property. A former tributary of Little Neshaminy Creek, an associated ravine, and surface drainage pathways in the area of Site 2 were filled in and leveled in the 1950s. This area is now underlain by a storm sewer that drains the majority of former NAWC property west of Jacksonville Road. A relatively steep slope descends from the leveled area of Site 2 to the subject tributary. Similarly, although the area of Site 3 formerly consisted of a more gradual slope to a tributary of Little Neshaminy Creek, this area was also regraded by placement of fill in the 1950s. As with the area of Site 2, a steep slope descends from the area of Site 3 to the remaining tributary. Although the topography of Site 1 does not appear to have been altered substantially during Navy ownership of the property, the area of Site 1 contains a substantial amount of fill material. The eight former impoundments located in the northwestern portion of Site A have been filled in with materials consisting primarily of silt and clay, with minor amounts of sand and rock fragments. Typically, the soil grades into weathered bedrock at depths of about 8 to 10 feet below ground surface (bgs) and to competent bedrock at a depth of about 15 feet bgs. The transition from soil to weathered bedrock to competent bedrock occurs gradually and varies somewhat in depth across Area A.

Groundwater in the vicinity of Area A occurs primarily within the bedrock units of the Stockton Formation. Groundwater is encountered in discrete fractures within the rock mass, and interconnected networks of fractures within the bedrock serve as the primary groundwater migration pathways. Within the bedrock, sandstone units function as the primary water-transmitting units, and fine-grained mudstone units act as semi-confining layers to groundwater flow. Both sandstones and mudstones are fractured to varying degrees; however, fractures in the sandstones tend to have higher yields, and as a result, the sandstone units act as preferential zones of groundwater flow. Below depths of about 80 to 100 feet, groundwater occurs under semi-confined conditions. The overall groundwater flow direction beneath Area A is generally to the north and northwest.

2.1.2 Land and Resource Uses

Area A is bordered by an industrial area to the west and northwest and a wooded lot to the immediate north. An unnamed tributary of Little Neshaminy Creek is located along the northern edge of this area, and the former NAWC/current Warminster municipal wastewater treatment facility, former jet fuel storage area, and parking lots are immediately to the south. Site 1 currently includes an extraction well network constructed as part of the remedy for Area A groundwater (OU-1A), a gravel access road, and grass. The area of Site 2 currently includes paved and gravel roads, a paved parking lot, an extraction well network for Area A groundwater, erosion controls, and maintained lawn. The stream bank of the unnamed tributary of Little Neshaminy Creek is adjacent to Site 3, and an asphalt access road lies within 10 to 20 feet of this site. Most of the area of Site 3 is a sparsely vegetated lot. The area of the former impoundments currently includes level ground, two concrete-lined basins constructed prior to 1977, and a groundwater treatment plant constructed as part of the remedy for contaminated groundwater attributable to the base.

The off-base properties adjacent to Area A consist of land used for industrial purposes and a wooded lot. Warminster Township Municipal Authority (WTMA) operates a supply well, located about 1,900 feet north of Area A, that intercepts groundwater migrating from Area A. Off-base groundwater is considered part of a Class IIA aquifer under USEPA's groundwater protection strategy. No other supply wells are known to be in use on property underlain by Area A groundwater.

2.1.3 History of Contamination

Site 1

In 1980, the Navy initially reported Site 1 as a potential location of hazardous substance disposal. At the time, Site 1 was reported to include a burn pit, operated from 1940 to 1955, located along the base property boundary, northwest of the base wastewater treatment plant, at the embankment of a ravine formed by erosion. Waste materials, reportedly including inorganics, solvents, acids, bases, and firing

range waste, were reportedly dumped over the bank and burned. The volume of material disposed of at Site 1 is unknown. Site 1 was reportedly closed by covering the site with excess soil generated by grading an extension of an aircraft runway.

Site 2

In 1980, the Navy reported Site 2 to be the location of a 200-foot by 12-foot by 8-foot trench used for the disposal of approximately 1,400 cubic yards of industrial wastewater treatment sludge. The disposal area was reported to be southwest of Site 1, along the northeastern NAWC property boundary, and was used from 1965 to 1970, when the site was closed with 2 feet of cover and revegetated.

Site 3

Site 3 is immediately southeast of Site 2, along the northeastern base property boundary. It was reportedly used from 1955 to 1965 as a burn pit for solvents, paints, acids, bases, mixed municipal waste, and other unspecified chemicals. The pit was reportedly approximately 20 feet wide by 30 feet long by 10 feet deep and was covered by a large metal screen enclosure. Residue from the pit was reportedly removed periodically and deposited at an unspecified on-base "sanitary landfill." Upon closure in 1965, Site 3 was reportedly backfilled with on-base soil and regraded.

CRC Industries

Groundwater contamination was discovered at CRC Industries, an industrial facility located adjacent to Area A, in 2007. Site characterization data indicate significant groundwater impacts in the bedrock aquifer, primarily PCE (including some evidence of DNAPL). PCE concentrations at WMA 26 have been steadily increasing over the past decade, which is considered to be a result of the release(s) at CRC Industries because little PCE has been detected in Area A. The increase in PCE concentrations (in the 700 µg/l range in 2010) has resulted in the need for an upgrade to the WMA 26 treatment system, which was completed in 2010.

Impoundment Area

Eight former unlined impoundments or lagoons located immediately south of Site 1 received sludge generated from treatment of industrial wastewaters generated by NAWC. Each lagoon was approximately 60 feet wide by 75 feet long, with depths of approximately 8 to 10 feet. The first impoundments were installed as early as 1940 and reportedly closed in 1973. Wastewaters included liquids from electroplating operations, photographic operations, aircraft maintenance and washing activities, and several laboratories. The industrial wastewater was treated through neutralization and metals precipitation. No treatment for organic compounds was performed. The solid phases of the sludges reportedly stored in these impoundments were periodically removed and disposed of at other locations at the base.

2.1.4 Initial Response and Basis for Taking Action

In response to the February 1980 identification of on-base volatile organic compound (VOC) groundwater contamination**,** two soil borings were installed in the vicinity of one of the two concrete basins in the Impoundment Area to identify potential sources of VOCs. Soil samples from these two borings had trichloroethene (TCE) concentrations up to 78 µg/kg.

The following sections briefly summarize the RI activities and pre-ROD response actions for Area A at former NAWC Warminster.

Phase I (1989 - 1991): Area A Phase I RI activities involved mapping VOCs in soil gas and detecting magnetic and conductive anomalies through electromagnetic surveys. Approximate site boundaries were identified, and confirmation of site contamination was made through soil borings and installation and sampling of overburden and shallow bedrock groundwater monitoring wells. Surface water and sediment samples were collected from the unnamed tributary draining Area A, and a biological characterization of the tributary was performed. No soil or waste samples were collected for analysis. The draft Phase I RI report for the entire base, including Area A, was issued in April 1991.

Phase II (1992 - 1993): Additional RI/FS activities were conducted to determine the nature and extent of groundwater contamination, to evaluate shallow groundwater flow and add to the hydrogeologic database, and to evaluate possible remedial alternatives. Activities included installing additional overburden and shallow bedrock monitoring wells; sampling and analyzing groundwater, surface water, sediment, and soil; and evaluating aquifer characteristics through water level monitoring and a pumping test. Groundwater-related RI/FS reports for OU-1 were released in April 1993. At the end of Phase II, the Navy and USEPA selected an interim remedy for contaminated shallow groundwater attributable to Area A and Area B at the base, referred to as OU-1.

Focused RI/FS for Groundwater (1993 - 2000): From 1993 through 1995, the Navy expanded Area A groundwater studies to address deep aquifers and off-base downgradient areas. The focus of these investigations was determination of both the lateral and vertical extent of groundwater contamination and hydrogeologic conditions within Area A. Previous and new monitoring wells were sampled, and a water level study was performed. The results of these investigations indicated that Area A groundwater contaminants had migrated to off-base areas at levels of concern. In addition, the detection of high concentrations of contaminants on base suggested the potential presence of dense non-aqueous-phase liquid (DNAPL) contamination in the bedrock aquifer. In response to the findings of the ongoing RI, the Navy upgraded an air stripper on a nearby municipal supply well (WTMA Well 26) to ensure that the water supply was protected. The Navy also connected an adjacent commercial facility to the public water system.

In 1996 and 1997, the Navy conducted additional investigations to better characterize groundwater flow and hydrogeologic conditions in and around Area A. An inactive, off-base, commercial, production well was tested in December 1996 to evaluate hydrogeologic conditions in the area of the well, to investigate the hydraulic connection between the well and Area A groundwater, and to evaluate groundwater quality conditions at different depths within the well.

In September 1997, the Navy performed a water level study of Area A groundwater that addressed off-base/downgradient areas. The study was performed to determine the impacts of the operation of WTMA Well 26 on groundwater levels and flow direction in the area between the well and the base. In December 1997, the Navy conducted a comprehensive round of groundwater monitoring that included the available monitoring wells in and downgradient of Area A. The comprehensive round of groundwater monitoring was performed to provide an updated "snapshot" of groundwater conditions and included the collection of comprehensive rounds of water level measurements.

A final RI/FS report for Area A groundwater (designated as OU-1A) was submitted in June 2000. This report considered the information generated for Area A groundwater since the interim remedy was selected and the results from operation of the interim remedy since July 1999.

Phase III (1995 - 2000): The primary objective the Phase III RI was to characterize sources of contamination, primarily soil and waste, at known and potential waste disposal sites. RI work for OU-9, defined as Area A soil, surface water, and sediment, included a soil gas survey, multiple surface geophysical surveys, test pits and soil borings, and soil and waste sampling and analysis. A surface water and sediment sampling and analysis program was performed to evaluate the impacts of Area A on the nearby stream, and an assessment of wetlands near Area A was conducted. A final RI/FS report for OU-9 was released in April 2000.

2.1.5 Nature and Extent of Contamination

Potential sources of hazardous substances within Area A include various pits, trenches, dumps, and miscellaneous disposal features associated with Sites 1, 2, and 3 and the former unlined impoundments. Conclusions of the RI regarding conditions after the Area A soil removal actions are summarized below.

2.1.5.1 Site 1 Soil

During test pit and soil boring activities as part of subsurface investigations at Site 1, non-native materials such as wood, fabric, blankets, cinders, charred material, and fill material were encountered. In addition, an area of multicolored silty clay material was observed in the subsurface. This material covered an area

of about 0.25 acre and was observed to be present from approximately 2 to 8 feet bgs. Sampling of the multicolored material consistently identified elevated concentrations of cadmium and antimony that were determined to present an unacceptable risk to industrial receptors exposed via dermal contact.

In response to these findings, the Navy performed a removal action in 1998 to excavate the subject material. The RI/FS report for OU-9 provided data regarding the quality of soil left in place at Site 1 after the removal action. The RI risk assessment determined that none of the remaining substances in subsurface soil posed an unacceptable risk to human health under reasonably anticipated land uses, and the ecological risk assessment determined that this soil did not pose an unacceptable risk to environmental receptors. As a result, there were no COCs for Site 1 subsurface soil under reasonably anticipated land uses. In addition, the surface soil was replaced by clean fill and soil as part of the removal action. As a result, there were also no COCs for Site 1 surface soil.

2.1.5.2 Site 2 Soil

During test pit and soil boring activities during subsurface investigations at Site 2, non-native materials such as cinders, glass fragments, ceramic pieces, brick fragments, metal fragments, charred debris, and fill material were encountered. In addition, a blue-green crystalline material was observed in surface and subsurface soil in several portions of Site 2, and samples of soil containing this blue-green material had elevated concentrations of lead, antimony, copper, and zinc. Detected concentrations of lead and antimony were determined to present an unacceptable risk to industrial receptors.

In response to these findings, the Navy performed a removal action to excavate the soils of concern. The RI report for OU-9 provided data regarding the quality of soil left in place at Site 2 after the removal action. The RI risk assessment determined that none of the remaining substances in surface or subsurface soil posed an unacceptable risk to human health under reasonably anticipated land uses. However, the ecological risk assessment determined that Site 2 surface and subsurface soils presented a potential threat to ecological receptors if allowed to migrate to the unnamed tributary of Little Neshaminy Creek. The COCs for Site 2 soil included metals, PAHs, and pesticides.

2.1.5.3 Site 3 Soil

Non-native materials encountered during Site 3 subsurface investigations included cinders, glass fragments, ceramic pieces, brick fragments, metal fragments, charred debris, and fill material. A layer of charred material was encountered several feet below the ground surface, but no evidence of the presence of the reported 2-foot-deep burn pit was encountered during the RI. Elevated concentrations of organic vapors were detected in the charred layer with a photoionization detector (PID), and petroleum odors were evident. Similar observations were noted for several soil borings advanced in the paved

access road in the area of Site 3. Elevated concentrations of PAHs such as benzo(a)pyrene were detected in surface soil samples at Site 3.

The detected concentrations of PAHs were determined to present an unacceptable risk to sediment quality. In response, the Navy performed a removal action to excavate the soil of concern. The RI Report for OU-9 provided data regarding the quality of soil left in place in the area of Site 3 after the removal action. The RI risk assessment determined that none of the remaining substances in surface or subsurface soils posed an unacceptable risk to human health under reasonably anticipated land uses. However, the ecological risk assessment determined that Site 3 subsurface soil presented a potential threat to ecological receptors if allowed to migrate to the unnamed tributary of Little Neshaminy Creek. The COCs for Site 3 subsurface soil included metals and PAHs.

2.1.5.4 Impoundment Area Subsurface Soil

The primary objective of RI sampling at the Impoundment Area was to characterize the quality of soil below the fill material reportedly placed in the former impoundments as part of the closure process. As a result, surface soil samples were not collected. Soil borings encountered non-native materials such as rock, cinders, roots, concrete, and brick at certain locations. Elevated concentrations of several metals including beryllium, chromium, and manganese and Aroclor-1260, a polychlorinated biphenyl (PCB), were detected at concentrations greater than risk-based soil screening concentrations in samples collected at the location of former impoundment IM8. The detected concentrations were determined to present an unacceptable risk to human health. In response, in 1995, the Navy performed a removal action to excavate the soil of concern.

The RI Report for OU-9 provided data regarding the quality of subsurface soil in the Impoundment Area. The risk assessment determined that this soil did not pose an unacceptable risk to human health under reasonably anticipated land uses or to ecological receptors. Therefore, there were no COCs in Impoundment Area soil.

2.1.5.5 Area A Surface Water and Sediment

Outfall (OF) 3 is the location of an outfall that discharges surface runoff from both Jacksonville Road and former NAWC property west of Jacksonville Road. OF1 discharges surface runoff from the majority of NAWC property west of Jacksonville Road, and OF2 discharges runoff from the parking lot south of Sites 2 and 3. Area A surface water sample results were compared to Ambient Water Quality Criteria (AWQCs) protective of aquatic life developed pursuant to the federal Clean Water Act. Exceedances of lead, copper, zinc, and iron, which were detected at elevated concentrations in Site 2 soil, occurred only in samples collected downstream of OF1 and Site 2.

The RI determined that many of the detected concentrations of organics and inorganics in sediment samples exceeded available screening criteria indicative of a potential risk to ecological receptors. PAHs, which were detected in excess of screening criteria in most of the samples collected, were detected at the greatest concentrations next to OF3, upgradient of the majority of Area A and the entrance point of surface drainage from Jacksonville Road. Lead was also detected at concentrations greater than screening levels at this location. PAHs and numerous metals were also elevated at sample locations immediately downstream of OF1 and Site 2.

2.1.5.6 Area A Groundwater

Significant conclusions of the RI for Area A groundwater were as follows:

- Groundwater investigations in Area A focused primarily on three hydrogeologic units, designated in order of decreasing depth, A, B, and C.

- Hydrogeologic unit B was of most importance to the investigation in terms of groundwater contaminant occurrence and migration from Area A. This hydrogeologic unit comprises the sandstone unit found at depths of 15 to 100 feet along the northern edge of Area A. Flow within this unit was to the north and northwest.

- Hydrogeologic unit B was the unit with the greatest levels of TCE, carbon tetrachloride, and other contaminants.

- The performance data from operation of the OU-1 interim remedy indicated that the existing extraction well system was containing the source area of contamination.

- The suspected source of persistently observed Area A groundwater contamination was residual DNAPL present within the bedrock fracture network and to a lesser degree within the intergranular pores of the rock.

- A diffuse contaminant plume that extends downgradient of the capture zone area of the extraction well network appeared to be captured and treated by WTMA Well 26.

The RI work addressing Area A groundwater was summarized in a final RI Report for OU-1A issued in June 2000.

2.1.6 Assessment of Risks

As part of the RI, risk assessments were conducted with available data to estimate potential risks posed to human health and the environment by Area A soil, surface water, sediment, and groundwater. In the case of soils, the risk assessment addressed conditions after the performance of the removal actions. The results of these risk assessments are summarized below.

2.1.6.1 Area A Surface and Subsurface Soil

No carcinogenic and non-carcinogenic risks greater than USEPA's target risk levels of 1×10^{-4} and 1.0, respectively, were estimated for industrial and commercial receptors evaluated for exposure to chemicals of potential concern (COPCs) in Area A surface or subsurface soil. These were the exposure scenarios with the greatest carcinogenic risks identified under intended reuse and fall within the USEPA's target risk range (10^{-4} to 10^{-6}) associated with the most likely future land use scenario (industrial/commercial).

Both non-carcinogenic and carcinogenic risks exceeding USEPA's target risk levels of 1.0 and 1×10^{-4}, respectively, were estimated for hypothetical future residential children exposed to COPCs in Area A surface and subsurface soil. Specifically, unaceptable non-cancer risks were identified for Site 2 surface soil and for subsurface soil in the four Area A sites (Sites 1, 2, and 3 and Impoundment Area), and unacceptable cancer risks were identified for subsurface soil in Site 3. The removal action at Site 3 was not intended to remove contaminants to a level protective of this scenario because the intended reuse is expected to be industrial/commercial.

2.1.6.2 Area A Surface Water and Sediment

The individual non-carcinogenic Hazard Quotients (HQs) were less than the USEPA target hazard of 1.0 for ingestion and dermal contact with contaminants in Area A stream sediment by recreational child receptors. The combined estimated cancer risks were 1.5×10^{-6} for ingestion of and 3.1×10^{-7} for dermal contact with sediment for recreational child receptors.

Potential risks to the environment from metals in surface water in the tributary of Little Neshaminy Creek were generally low, as were potential risks from organics in surface water. In sediments, inorganic Ecological Effects Quotients (EEQs) were also mostly indicative of low potential risk, although some elevated EEQs were calculated for lead, manganese, and zinc, and concentrations of these metals were elevated downstream of Area A. EEQs for PCBs and some pesticides were indicative of moderate to high potential risk, but potential risks were heavily mitigated by several factors. Potential ecological risks for several PAHs in sediment were moderate to high, and frequencies of detection were generally high. Also, elevated concentrations of some PAHs were detected in samples taken several hundred feet from

Area A and far downstream of Area A near Bristol Road. Heavily developed areas exist off base near the tributary that contribute PAHs to the waterway, but the presence of highly elevated concentrations of PAHs adjacent to Area A suggested significant contaminant inputs from former base-related activities.

2.1.6.3 Area A Groundwater

The human health risks associated with potential exposure to Area A groundwater were evaluated as part of the RI for OU-1A. Because Area A groundwater is hydraulically connected with groundwater captured by an operating municipal supply well, the risk assessment assumed that Area A groundwater may potentially be used by residents for domestic purposes. The interim RI Report and interim remedy ROD for OU-1 presented the baseline risk assessment for Area A groundwater. The final RI for Area A groundwater presented a qualitative risk assessment that compared groundwater quality data generated since the interim RI to federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs).

The baseline risk assessment for Area A groundwater found that carcinogenic and non-carcinogenic risks were unacceptable. Carcinogenic risks were estimated to be as high as 9.9×10^{-4}. The primary contributors to the carcinogenic risk were identified as TCE, carbon tetrachloride, tetrachloroethene (PCE), 1,1-dichloroethene (DCE), chloroform, vinyl chloride, and arsenic. Non-carcinogenic risks were estimated to correspond to Hazard Indices (HIs) of up to 93. The primary contributors to the non-carcinogenic risk were TCE, carbon tetrachloride, PCE, cis-1,2-DCE, arsenic, barium, and thallium. In addition, TCE and PCE concentrations exceeded MCLs at multiple well locations, and concentrations of carbon tetrachloride, vinyl chloride, 1,2-dichloroethane (DCA), cadmium, manganese, nickel, arsenic, and barium each exceeded MCLs at one well location.

As stated above, the final RI for OU-1A included a qualitative risk assessment that compared groundwater quality data generated since the interim RI to MCLs. This assessment found MCL exceedances of TCE, carbon tetrachloride, PCE, 1,1-DCE, cis-1,2-DCE, 1,1,1-trichloroethane (TCA), 1,1,2-TCA, vinyl chloride, and benzene. These are the COCs in Area A groundwater according to the final RI, with the exception of 1,1,1-TCA, which is attributable to non-site related sources, and 1,2-DCA, which was detected in only one well during 12 rounds of sampling.

The final RI also further assessed risks presented by metals in Area A groundwater by evaluating sampling results generated since the interim RI. Only thallium and iron were detected at concentrations exceeding MCLs. Thallium (MCL of 2 µg/L) was detected in unfiltered samples from 2 of 20 wells at concentrations of 4.3 and 5.3 µg/L. However, in each case, no thallium was detected in filtered samples, which are more representative of groundwater pumped for domestic use. Therefore, thallium is not considered a groundwater COC. Iron was detected at concentrations greater than the MCL in wells

constructed with steel casing. As a result, the detected iron does not appear attributable to the site and is not a COC.

An evaluation was also conducted to determine if Area A groundwater quality was threatened by Area A soils. Contaminant concentrations in Area A soils were compared to soil screening levels (SSLs) protective of groundwater quality, and none of the soil contaminants exceeding these criteria are COCs in Area A groundwater. As a result, Area A soils do not present a threat to groundwater quality.

2.1.7 Area A Pre-ROD Response Actions

OU-1: The OU-1 Interim ROD, signed in September 1993, selected an interim remedial action to minimize migration of contaminated groundwater while additional RI work was performed to determine the full nature and extent of Area A groundwater contamination. The interim remedy included pumping and treatment of Area A groundwater and periodic testing of groundwater in monitoring wells and other wells near the base.

Construction of the groundwater treatment system began in July 1996, but drilling and installation of Area A extraction wells were deferred while additional RI work addressing Area A soil and groundwater was completed. Construction of the interim remedy for Area A groundwater was completed in July 1999. In 1996 during construction of the OU-1 remedy, the Navy excavated contaminated soil beneath the footprint of the treatment plant building and along the route of groundwater transfer piping near Area A. Excavated soils were disposed of in an off-base landfill.

Using Navy funds, one commercial property located north of Site 2 with a contaminated well was connected to the WTMA system in the summer of 1995.

OU-9: During construction of the groundwater treatment plant, elevated concentrations of metals were detected adjacent to and within the former Impoundment Area. A removal action was conducted in 1996 to remove soil at two locations beneath the footprint of the treatment plant building and surrounding property. Approximately 430 cubic yards of soil were removed from within the excavation areas to achieve contaminant concentrations either within the range established for background soil concentrations or less than risk-based soil screening concentrations for industrial use.

During the Phase III RI, several removal actions were performed in response to the detection of hazardous substances at concentrations that presented a risk to human health and the environment. Based on preliminary RI results, about 6,700 tons of non-hazardous Area A surface and subsurface soils were excavated, transported, and disposed of in an off-base landfill between August 1998 and January 1999. The soils were excavated from two separate locations within Site 1, three locations within Site 2,

and one location near Site 3. An Action Memorandum for the Area A soil removal action was signed by the Navy in June 1998. A small amount (about 100 pounds) of flammable solids or corrosive liquids was also disposed of during this action. Post-removal soil sampling was performed to confirm that cleanup goals established for the protection of groundwater and human health were attained with the designated removal action areas.

Approximately 3,600 cubic yards of material were removed from Excavations 1A and 1B at Site 1. At Site 2, approximately 800 cubic yards of soil within Excavation 2A were removed from the surface to depths of 2 to 4 feet bgs. Soil was also removed from two other areas at Site 2, Excavation 2B and Excavation 2C. Soil in Excavation 2B was removed based on the detection of petroleum products. Petroleum products were also detected in subsurface soil adjacent to Excavation 2B under the paved access road. Soil in Excavation 2C was removed to a depth of 2 feet based on detection of elevated concentrations of benzo(a)pyrene determined to present an unacceptable risk to receptor sediment quality. A total of 30 cubic yards of soil were removed from Excavation 2C. For Site 3, soil within the excavation area (Excavation 3) was removed from the surface to depths of 2 to 3 feet bgs. Surface soil was removed until contaminant concentrations on the sidewalls of the excavation area were less than cleanup concentrations. Approximately 380 cubic yards of soil were removed from Excavation 3.

2.2 AREA B

2.2.1 Physical Characteristics

Area B is located in the southeastern section of the former NAWC and encompasses part of the Shenandoah Woods Navy housing area. Area B comprises Sites 5, 6, and 7 and has been divided into four OUs. OU-1B consists of contaminated groundwater attributable to Area B, OU-2 addresses contamination of domestic well water for residences near the base, OU-7 addresses soil and wastes associated with Sites 6 and 7, and OU-10 consists of Site 5 soils and sediment and surface water associated with Area B. Site locations in Area B are shown on Figure 2-2.

Surface topography across parts of Sites 6 and 7 slopes toward Site 5. The slope across Site 5 is about 3 percent. Stormwater collecting in the vicinity of Site 5 is designed to be discharged through two stormwater drain and is then piped underground to OF11 at the south-central base property boundary. OF11 also collects surface runoff in the form of sheet flow from Area B. From OF11, stormwater flows to the south in a subsurface channel for 500 feet where it is discharged to a surface concrete channel.

The geology of Area B consists of a thin veneer of residual soils overlying sedimentary bedrock of the Stockton Formation. The soils consist primarily of silt and clay, with some sand, and extend to an average depth of about 10 feet bgs. Soils at Site 5, primarily silt loam with slow to moderate permeability,

extend to depths of 4 to 14 feet, where weathered bedrock is encountered. Soils at Sites 6 and 7 primarily consist of silt and clay with minor amounts of sand and extend to an average depth of 10 feet bgs, where a transition to weathered bedrock begins. Competent bedrock begins at a depth of 10 to 20 feet. The bedrock surface within Area B slopes gently to the south and southeast, mimicking ground topography. The overall direction of groundwater flow across Area B is to the south.

2.2.2 Land and Resource Uses

Site 5 is located in the southeastern portion of the former NAWC and is within the enlisted personnel housing area that has been retained by the Navy as part of the Willow Grove base. The 2005 Base Realignment and Closure Commission targeted Willow Grove for closure, and this housing area is scheduled to be vacated soon and will subsequently be transferred out of DoD ownership. There is no definite timetable for this transfer; however, it is expected to occur prior to the next five-year review.

The area of Sites 6 and 7, located within Warminster Township, is currently undeveloped and consists of open space covered with grass, shrubs, and trees. There are no structures in the area of Sites 6 and 7 at this time. The reuse plan developed by the FLRA and approved by Warminster Township and other municipalities identifies the future use of the area of Sites 6 and 7 as recreational. Available information suggests that residential use of the property is not reasonably anticipated, but limited industrial and commercial use of Sites 6 and 7 may be possible.

The enlisted housing area is serviced by public water. The closest groundwater supply users are located about 0.5 mile from Area B and are not immediately downgradient.

2.2.3 History of Contamination

Site 5

Site 5, which is located within the enlisted personnel housing area, was initially reported in the Navy Shore Facility Fact Form. Site 5 reportedly consisted of up to eight trenches used for the disposal of demolition wastes, paint, solvents, scrap metal, aircraft paints, cans, and asphalt. The trenches were reportedly operated from 1955 to 1970 and were approximately 12 feet by 70 feet by 8 feet in dimension and were covered with 2 feet of fill, graded, and seeded.

Sites 6 and 7

Sites 6 and 7 are located within the same area north of Site 5. Site 6 was reportedly used for disposal of unknown quantities of waste paints, solvents, oil, flammable wastes, grease trap waste, and demolition debris from 1960 to 1980. These materials were reportedly disposed of in pits excavated by backhoe through general dumping and backfilling throughout the area. Site 7 reportedly consisted of two disposal

trenches used from 1950 to 1955 to receive sludge from the wastewater treatment plant. The trenches were reportedly 100 feet long by 12 feet wide and 8 feet deep, with an estimated potential capacity of 356 cubic yards each. The trenches were reportedly backfilled with fill after each dumping episode. Upon site closure in 1955, the trenches were covered with 2 feet of soil, graded, and seeded. The area of Sites 6 and 7 was also used for the disposal of demolition and construction debris from the mid-1950s to the 1970s. Large quantities of concrete and asphalt from demolished runways and parking aprons were deposited over part of the area of Sites 6 and 7. The area of debris deposition is now partly covered by a woodlot.

2.2.4 Initial Response and Basis for Taking Action

Initial investigations of Area B, consisting of the installation and sampling of shallow overburden wells, were performed in 1982. RI work addressing Area B was conducted in several phases. Field work included soil gas sampling, geophysical surveys, surface soil sampling and analysis, subsurface soil sampling and analysis, and a wetlands assessment. The subsurface studies included drilling soil borings to determine subsurface conditions. In addition, surface water and sediment sampling and analysis were conducted to evaluate the potential impacts of Area B on surface water and sediment within the unnamed tributary of Southampton Creek.

The following sections briefly summarize the investigations and pre-ROD response actions for Area B at the former NAWC Warminster.

Phase I (1989 - 1991): Area B Phase I RI activities were similar in scope to those in Area A and included a cursory soil gas study and electromagnetic survey to better define the disposal site boundaries and potential source areas. Limited test pitting was also conducted to delineate the disposal areas. Shallow and overburden wells were installed and sampled to characterize groundwater quality and to determine groundwater flow direction. An air sampling program was also performed to evaluate the potential for atmospheric contamination in nearby residences.

Phase II (1992 - 1993): Phase II RI/FS work was similar to that in Area A and included installing additional overburden and shallow bedrock monitoring wells; sampling and analyzing groundwater, surface water, sediment, and soil samples; and evaluating aquifer characteristics through water level monitoring and a pumping test. Several off-base well samples were also collected for analysis. Groundwater-related RI and FS reports for OU-1, which was defined as contaminated overburden and shallow bedrock groundwater attributable to Area A and Area B at the base, were released in April 1993. Based on TCE concentrations in three monitoring wells slightly in excess of the MCL, the Phase II RI and FS reports projected the presence of a TCE contamination plume attributable to Area B.

Focused RI for Groundwater (1993 - 2000): Focused RI activities involved investigation of groundwater conditions within and downgradient of Sites 5, 6, and 7 and was similar to the Area A focused groundwater scope of work. Activities included installing and sampling monitoring wells at multiple depths in and around Area B. Groundwater quality trends and hydrogeologic characteristics within the study area were evaluated to further define the nature and extent of the contamination and potential migration patterns. Water level studies and pumping tests were performed to better define the nature of the hydrogeologic setting. Based on this work, a final RI Report for Area B groundwater (designated as OU-1B) was released in July 2000.

Phase III (1995 - 1999): The Phase III RI objective was to characterize sources of contamination, primarily soil and wastes at known and potential waste disposal sites. Phase III RI work within Area B was similar to that conducted for Area A and consisted of soil gas and electromagnetic studies to define potential source and/or disposal areas, surface and subsurface soil sampling, and sampling of area streams and sediments. The Phase III RI did not address groundwater. The draft Phase III RI Report was issued in November 1996.

Based on the findings of the draft Phase III RI Report, a supplemental RI was performed at Sites 6 and 7 in 1997 to support limited removal actions for these sites. In November 1999, a final RI report was issued for soil/waste at Sites 6 and 7 (designated as OU-7). This report considered the previous RI work and characterized conditions at Sites 6 and 7 after removal actions. Following the removal actions, RI and FS reports for Sites 6 and 7 were prepared in 1998.

A supplemental soil investigation was conducted for Site 5 in December 1999, and the RI Report for Site 5 soils and Area B surface water and sediment (designated as OU-10) was submitted in July 2000.

2.2.5 Nature and Extent of Contamination

2.2.5.1 Site 5 Soil

The potential sources of contamination at Site 5 include several disposal trenches. Based on observations during the RI, the general area of Site 5 was used for subsurface disposal of waste and placement of fill material. Based on data from soil borings, buried waste materials occur from 2 to 10 feet bgs. Fill material placed at Site 5 occurred at 3.5 to 8 feet bgs. Wastes were found north, east, and south of Building 401 and west of Building 403. The wastes included ash, wood, glass, cardboard, paper, tree limbs, roots, brick fragments, wire, charcoal, and scrap metal pieces in a matrix of fill material. Waste observations suggest that subsurface disposal did occur as reported; however, the pattern of subsurface wastes observed during the RI, apparently scattered within the subsurface area of disposal, suggested that the wastes were either not disposed of in linear trenches or that the contents of the trenches had been moved since placement.

Based on the RI for Site 5 soil and OU-10, lead, copper, and vanadium were the inorganics detected at concentrations greater than preliminary SSLs protective of residential use in more than one soil/waste sample. The organics detected in more than one soil/waste sample at concentrations greater than residential SSLs were Aroclor-1254 and benzo(a)pyrene. Numerous sediment screening criteria protective of aquatic life were exceeded in sediment potentially impacted by Area B.

2.2.5.2 Sites 6 and 7 Soil

The primary findings of the RI with regard to site conditions after completion of the Sites 6 and 7 removal actions are as follows:

- Disposal activities occurred over an area of approximately 5 acres. Although discrete disposal locations such as pits or trenches were found within the site, materials related to disposal activities, including waste, residuals associated with waste, and/or fill materials, were found throughout the 5-acre site.

- Although not significantly elevated, site-wide surface soil concentrations of chromium and thallium were greater than background concentrations. Organic compounds were not detected at significant concentrations or frequencies in surface soil.

- Site-wide surface soil also contained elevated concentrations of metals apparently related to disposal activities, including chromium, thallium, cadmium, iron, and lead. No organic compounds were detected at significant concentrations or frequencies. Elevated concentrations of TCE, PCE, and PCBs detected prior to removal actions were excavated and disposed of during these response actions.

- Concentrations of metals in subsurface soil were greater within three zones, identified as Zones 1, 2, and 3, which apparently included the discrete pits or trenches used for disposal of waste.

- VOCs were not detected in groundwater in the area at concentrations that exceeded groundwater protection criteria. These data suggest that response actions met the objective of removing soil known to present threats to groundwater quality.

2.2.5.3 Area B Stream

Area B surface water sample results were compared to AWQCs protective of aquatic life developed pursuant to the federal Clean Water Act. The manganese concentration in one surface water sample

exceeded the AWQC. Many Area B sediment sample results exceeded available screening criteria indicative of a potential risk to ecological receptors. Exceedances at multiple sample locations were found for a group of PAHs. Other organics detected at high concentrations were DDT and n-nitrosodiphenylamine. Aroclor-1260, a PCB, was detected at 1,900 µg/kg in a sample from the drainage swale receiving flow from the area of Building 108; however, Aroclor-1260 concentrations in three subsequent samples from this swale ranged from 270 to 580 µg/kg.

2.2.5.4 Area B Groundwater

The results of RI activities for Area B groundwater, including work performed since the interim RI, were included in a final RI Report dated May 2000. Based on the results of the final RI, it was determined that although there were low concentrations of TCE in Area B groundwater, there was no discernible plume that exceeded the MCL of 5 µg/L, and subsequent investigations supported this conclusion. During the RI, inorganic analysis of unfiltered (total metals) and filtered (dissolved metals) samples detected a variety of metals, but the detections were not considered indicative of a pattern that would suggest a release from Area B. A review of RI data also found no information suggesting that Area B groundwater would adversely impact surface water quality.

2.2.6 Assessment of Risks

2.2.6.1 Site 5 Soil

A risk assessment was conducted to estimate potential risks posed to human health by Site 5 soil and Area B surface water and sediment (OU-10) if no action was taken. For Site 5 soil, the assessment was conducted assuming residential use of the property. In addition, although industrial use of the property was not reasonably anticipated, potential risks under industrial use were also assessed. The area of Site 5 is expected to continue to be used for residential purposes.

The maximum carcinogenic risk estimated by the risk assessment was 1.2×10^{-5}, within the acceptable risk range, for a lifetime resident exposed to subsurface soil. Therefore, carcinogenic risks associated with both surface and subsurface soil were acceptable. Non-carcinogenic risks posed by surface soil to residential children and adults were considered acceptable (less than 1.0) on a target-organ basis, and non-carcinogenic risks posed by subsurface soil at Site 5 were also acceptable. An evaluation was also performed to determine if groundwater quality was threatened by Site 5 soil. Contaminant concentrations in Site 5 soil were compared to USEPA SSLs protective of groundwater quality. Only thallium, silver, and methylene chloride exceeded these criteria. However, the final ROD for Area B groundwater determined that no substances in Area B groundwater presented an unacceptable risk; therefore, Site 5 (OU-10) soil was determined not to present a threat to groundwater quality.

2.2.6.2 Sites 6 and 7 Soil

As part of the RI for OU-7, a risk assessment was conducted with available data to estimate the potential risks to human heath posed by soil associated with Sites 6 and 7 after the removal action. To assess these risks, hypothetical residential and recreational exposure scenarios were evaluated.

Analytical results for surface and subsurface soils were evaluated to estimate risks associated with the recreational use planned for the property. Although not reasonably anticipated, risks were also estimated for potential residential land use. Under recreational land use, site-wide surface soil was estimated to present a carcinogenic risk of 2.0×10^{-6}, and HIs for non-carcinogenic risks were less than 1. In each case, no unacceptable risk was identified.

Although exposure to subsurface soil is not currently occurring, an evaluation was conducted to estimate the risk presented by subsurface soil in the event that these soils are displaced to the surface during recreational use of the property. In this case, the total carcinogenic risk presented by site-wide subsurface soil for recreational use was 1.0×10^{-5}, within the acceptable range. For non-carcinogenic risk, the HI for chromium in site-wide subsurface soil was estimated to range from 1.0 to 4.2. As a result, non-carcinogenic risks associated with site-wide subsurface soil were considered to be unacceptable. Risks associated with subsurface soil within three separate locations in the vicinity of Sites 6 and 7 (Zones 1, 2, and 3) were also estimated. The total carcinogenic risk for each zone was acceptable. With regard to non-carcinogenic risks, the three zones had HIs in exceedance of 1.0, with the greatest risk in Zone 3. As a result, non-carcinogenic risks for each zone were estimated to be unacceptable.

Assuming residential land use, the risks were generally similar to those associated with recreational land use, with two primary exceptions. Both carcinogenic and non-carcinogenic risks associated with surface soil were estimated to be unacceptable. In this case, the HI for chromium was estimated at 6.47, and the HI for thallium was estimated at 1.22. In addition, with regard to subsurface soil, thallium and iron were also found to present unacceptable non-carcinogenic risk.

In summary, site-wide subsurface soil presented an unacceptable risk under the planned recreational use if these soils were excavated or brought to the surface by other means. In addition, although residential use is not reasonably anticipated, site-wide surface soil presented an unacceptable risk under this use scenario.

2.2.6.3 Area B Surface Water and Sediment

An evaluation of potential risks posed to children by surface water and sediment impacted by Area B found that carcinogenic and non-carcinogenic risks were within the acceptable range. An ecological risk assessment was also performed to identify whether Area B surface water and sediment presented a potential for adverse impact to aquatic and semi-aquatic receptors. The focus of the ecological risk assessment was a portion of Southampton Creek and its headwaters that receive runoff, channelized stormwater, and discharges from Area B. The discharges from the stormwater collection systems within Area B comprise a substantial portion of the flow at the headwaters of the creek. Surface water downstream of Area B was estimated to present a very low potential risk. Sediment downstream was estimated to present a low to moderate potential risk to both aquatic and semi-aquatic receptors.

2.2.6.4 Area B Groundwater

The interim ROD for OU-1 estimated that Area B groundwater presented a maximum incremental carcinogenic risk of 8.4×10^{-5}, and non-carcinogenic risk was estimated to correspond to a maximum HI of 28. The primary contributors to the carcinogenic risk were identified as TCE, PCE, carbon tetrachloride, and arsenic, and contributors to the non-carcinogenic risk were identified as arsenic, barium, cadmium, and manganese. The calculation of these risks incorporated the results of unfiltered groundwater analyses; however, the interim RI suggested that metals concentrations in unfiltered samples may be less than or comparable to background levels and not attributable to releases from Area B. During the interim RI, TCE concentrations exceeded the MCL of 5 µg/L in three shallow bedrock monitoring wells.

The final RI for OU-1B re-evaluated risks based on data generated after the interim RI. Although Area B groundwater was not known to be used, the risk assessment assumed that this groundwater may potentially be used by residents for domestic purposes. The revised assessment estimated a carcinogenic risk of 1.8×10^{-6} for potential future residential groundwater user, within the acceptable range. Since the interim RI, TCE was detected at concentrations of 5 to 12 µg/L in two monitoring wells, exceeding the MCL of 5 µg/L. However, the RI concluded that there was no continuous discernible plume of TCE that exceeds the MCL. Based on this conclusion, TCE in Area B groundwater did not present an unacceptable risk. The non-carcinogenic risk was found to correspond to an HI of 4.1, exceeding the acceptable HI of 1.0. Manganese was the primary contributor to the non-carcinogenic risk, with an HI of 3.52. A review of RI data found that manganese concentrations of concern were present in one well cluster and were less than background concentrations identified in the Phase II RI. Based on this review, the manganese concentrations did not appear to be attributable to Sites 5, 6, and 7, and Area B groundwater did not present an unacceptable non-carcinogenic risk.

2.2.7 Area B Pre-ROD Response Actions

OU-1: At the end of the Phase II RI, an interim remedy ROD was signed for OU-1 in September 1993 documenting the selection of an interim remedy to minimize the migration of contaminated groundwater while additional studies were performed to determine the full nature and extent of groundwater contamination. The interim ROD included pumping and treating Area B groundwater (as well as Area A groundwater), with continued periodic testing of groundwater in monitoring wells and other wells near the base over a 30-year period.

In December 1994 and January 1995, the Navy installed two planned extraction wells and six observation wells downgradient of Sites 5, 6, and 7 and within the projected TCE plume. The two planned extraction wells were sampled while pumping tests of various durations were performed. No TCE or other contaminants were detected at concentrations greater than MCLs in the pumped water. After completion of the extraction well yield tests and hydrogeologic investigation report of 1995, contaminant trends were evaluated, and it was concluded that TCE concentrations in the well with the maximum concentrations of TCE (up to 13 µg/L) appeared to be stable and that TCE concentrations were either not detected or were consistently less than the MCL in downgradient monitoring wells. Considering this contaminant trend along with extraction well results, a decision was reached to discontinue the plan to pump Area B groundwater but to continue monitoring and conduct additional investigations during Area B source investigation and removal activities, in accordance with the interim ROD.

In accordance with the interim ROD, Area B groundwater was regularly monitored between 1994 and 2000 as part of a base-wide groundwater monitoring program that included 14 rounds of groundwater monitoring in and downgradient of Area B.

OU-2: Following the Phase II RI, the Navy performed sampling of off-base drinking water wells in the vicinity of NAWC Warminster, and results indicated that, at several residences, groundwater had concentrations of VOCs greater than MCLs. Beginning in April 1993, the Navy provided bottled water and installed water treatment systems at these residences despite the lack of clear evidence that the Navy was responsible for the elevated contaminant concentrations of concern. In the summer of 1994, USEPA and the Navy connected homes in the Casey Village Area (located south of Area B) to the WTMA and Upper Southampton Water and Sewer Authority public water supply systems. This remedial action was designated as OU-2. Due to the time-critical nature of the remedial action, a ROD was not issued for OU-2.

OU-7: Based on Phase III RI findings, including the results of several supplemental investigations, the Navy conducted a response action at Sites 6 and 7 between May 1997 and September 1997. Actions included the excavation and off-site disposal of about 3,700 tons of soil and debris from three discrete excavations

and the removal of construction debris and concrete from the surface area. Contaminated soil and wastes excavated during this action included potential source areas for groundwater contamination. The removed soil contained elevated concentrations of TCE and PCE. The excavations extended in depth to the bedrock surface and laterally to the point where sample analysis confirmed the lack of contamination greater than action levels protective of groundwater quality.

Final RI and FS reports were issued for OU-7 in November 1998 and December 1998, respectively. The ROD for OU-7 was signed in June 2000.

2.3 AREA C

2.3.1 Physical Characteristics

Area C includes Sites 4 and 8 and nearby locations where hazardous substance releases may have resulted in groundwater contamination, which has been identified both on and off base in this area. Area C has been divided into four OUs. OU-2 addresses contamination of domestic well water for residences near the base, OU-3 consists of contaminated Area C groundwater, OU-5 addresses soil, surface water, and sediment associated with Site 8, and OU-6 addresses soil, sediment, and surface water associated with Site 4. Site locations in Area C are shown on Figure 2-3.

Area C is in a gently to moderate rolling area located adjacent to Kirk Road and Newtown Road in the north-central portion of the former NAWC. The sites of concern cover approximately 10 acres. Ann's Choice Retirement Community was built over much of Area C following closure of the base. Scattered single-family houses and two local parks are just north of Area C. Two unnamed tributaries of Little Neshaminy Creek, just north of the base boundary, collect drainage from Area C.

Soils observed within Area C during RI activities ranged from 2 to 15 feet in thickness. Soil types included orange-red, brown, and maroon-red mixtures of silt, clay, and sand, with finer-grained soils dominant. Site 4 soils are classified as Duncannon silt loam and Chalfont silt loam, and Site 8 soils are mapped as Urban Land-Lansdale Complex, indicating that these soils were reworked from their natural state. Area C soils overlie highly weathered bedrock that is encountered at approximately 5 to 15 feet bgs. The weathered bedrock gradually transitions into competent bedrock that belongs to the Stockton Formation, which within Area C comprises a multi-aquifer system of relatively discrete water-bearing zones separated by thicker less-permeable zones. As stated above, groundwater occurrence and movement through the Stockton Formation is primarily through secondary porosity (fractures) that exist within the rock mass. Some minor primary porosity, especially in the sandstone units, also contributes to groundwater occurrence and movement. The overall groundwater flow direction beneath Area C is generally to the north and northwest.

2.3.2 Land and Resource Uses

As stated above, Ann's Choice Retirement Community was built over much of Area C primarily in the vicinity of Site 8. Residential development for Ivyland Borough has occurred west of Site 8, and other adjacent property in the vicinity of Site 4 is used for open-space recreational land use (i.e., park land) by Warminster Township. WTMA operates a supply well (Well 13) located about 1,700 feet north of Area C. A few private drinking water wells are also located northwest and northeast of Area C; the nearest active private well is about 500 feet northeast of Site 4 and the base boundary.

2.3.3 History of Contamination

Site 4

Site 4 is a 7-acre grassy area just north of the former main runway and just south of Kirk Road. Site 4 is the largest of the NAWC Warminster waste disposal locations and is less than 100 feet from the facility boundary. The Navy initially reported Site 4 as a disposal site in a Navy Shore Activity Disposal Fact Form in 1980. The site reportedly was operated from 1966 to 1970. A review of historical aerial photographs initially verified the presence of at least two trenches at Site 4 and indicated that Site 4 was active through 1973. Several trenches on the site reportedly were used to dispose of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge from the sewage treatment plant.

Site 8

As reported by the Navy, Site 8 was used as a 2-acre fire-training area from 1961 to 1988. The fire-training activities were conducted at the northeastern end of the old runway located in Area C and involved pouring contaminated jet fuels onto a runway area that was contained by berms. The fuel was then ignited and extinguished to simulate fire-fighting procedures. In addition, an area of the runway immediately south of the fire-training area was used to test the resistance of aviation suits to fire. This area consisted of a corrugated metal building (Structure S1) where flight suits were passed through flames to test the durability of the suits. Although it was not initially reported as a disposal site, the former location of this test area is considered to be part of Site 8.

2.3.4 Initial Response and Basis for Taking Action

Initial investigations of Area C were performed in 1982 and consisted of installing and sampling shallow overburden wells. RI activities addressing Area C was conducted in several phases. Field work included soil gas sampling, geophysical surveys, surface and subsurface soil sampling and analysis, and wetlands assessment. Subsurface studies included drilling soil borings and excavating test pits to determine subsurface conditions. In addition, surface water and sediment sampling and analysis were conducted to

evaluate the potential impacts of Area C on nearby surface water and sediment. A series of groundwater investigations was also performed as part of Phase I and Phase II RI work and as part of the focused RI for Area C groundwater.

The following sections briefly summarize the investigations and pre-ROD response actions for Area C at NAWC Warminster.

Phase I (1989 - 1991): Area C Phase I RI activities were similar in scope to Areas A and B.

Phase II (1992 - 1993): Phase II RI/FS work was similar to Areas A and B. For Area C groundwater, the Phase II RI included the installation of additional monitoring wells, sampling of groundwater, and performance of hydraulic tests to assess aquifer characteristics. One off-base well was also sampled.

Focused RI for Groundwater (1993 - 1994): The Area C focused groundwater scope of work was similar to Areas A and B and involved investigation of groundwater conditions within and downgradient of Sites 4 and 8. Based on this work, separate RI and FS reports were submitted for Area C groundwater in August 1994. A schematic design for shallow groundwater remediation was completed in July 1994.

Phase III (1995 - 1999): The Phase III RI objectives and field work were similar to those for Areas A and B and included further investigation of the nature and extent of potentially contaminated soil, buried wastes, surface water, and sediment associated with this area. An Engineering Evaluation/Cost Analysis (EE/CA) was prepared to help support a removal action for Site 4 (designated as OU-6) in July 1995. A supplemental study for Site 8 was conducted between July 1998 and March 1999 to complete RI work for this site. The RI report for Site 8 soil, surface water, and sediment (designated as OU-5) was issued in August 1999.

Source Area Investigation (2007): Prior to the 2007 investigation, elevated PCE concentrations (up to approximately 300 µg/L) were detected in a relatively new monitoring well in Area C (HN-23A) during long-term performance monitoring. HN-23A is 60 feet deep with a fracture zone at a depth of approximately 52 feet (the primary water-yielding zone). In 2004, ECOR Solutions Inc., injected 30 gallons of HRC®, a proprietary liquid that releases lactic acid to promote anaerobic biodegradation of chlorinated ethenes in groundwater, into HN-23A in an effort to reduce PCE concentrations. The primary objectives of the Area C Source Assessment were to delineate the extent of groundwater contamination in the vicinity of HN-23A and to characterize any contaminant source areas identified. The main conclusions of the 2007 source area investigation (Tetra Tech, 2007) were as follows:

- A plume of PCE-contaminated groundwater is present across the study area, extending north to the vicinity of Kirk Road. The plume extends upgradient of HN-23A to the vicinity of the nearby Ann's Choice retirement community residence building based on the presence of significant PCE concentrations in HN-103S. The OU-3 extraction system is well positioned to capture the contaminant plume.

- No residual source for the PCE contamination was found within the area of investigation. Based on the data collected, the original source was likely located somewhere south of HN-23A.

- Plume concentrations appear to be declining, based on decreasing PCE concentrations in the most contaminated well (HN-23A) from a historical maximum of 300 µg/L to approximately 120 µg/L. The role of the 2004 HRC® injection into HN-23A in reducing concentrations is uncertain.

The recommendation based on the results of the investigation was continued monitoring.

2.3.5 Nature and Extent of Contamination

2.3.5.1 Site 4

Although the RI for OU-6 also characterized the conditions at Site 4 prior to the removal action, the primary objective of the RI was to characterize conditions after the removal action. The findings of the RI were as follows:

- No visible wastes remain on site.

- The remaining contaminant concentrations in soil were less than soil cleanup levels established prior to the action.

- Site 4 did not appear to be a past or current source of Area C groundwater contamination.

- Contaminant releases from Site 4 to downstream surface water and sediment have not produced observable impacts on the subject stream.

2.3.5.2 Site 8

The RI Report for OU-5 characterized the nature of the site prior to and after the removal action. The primary findings of the RI after the removal action were as follows:

- The removal action significantly reduced lead concentrations in Site 8 soil.

- Soil sampling results suggested that Site 8 is not a past or present source of Area C groundwater contamination.

- PAHs were the organic compounds detected in Site 8 soil at significant frequencies and concentrations. PAHs are commonly associated with burning activities.

- With the exception of the lead concentrations addressed by the soil removal action, metals were not detected at concentrations greater than background levels at significant frequencies.

- Concentrations of organics and metals in surface water and sediment associated with Site 8 were found to be only slightly greater than background levels.

- Low levels of compounds commonly associated with fuels were detected in both surface and subsurface soils at Site 8.

2.3.5.3 Area C Groundwater

The findings of the RI with respect to contaminated groundwater in overburden and shallow bedrock aquifers attributable to Area C were detailed in the OU-3 RI Report. The primary findings were as follows:

- PCE was detected in 10 of 34 monitoring wells sampled at concentrations ranging from 1 to 29 µg/L. In addition, acetone was detected in 9 of 24 monitoring wells at concentrations ranging from 8 to 74 µg/L. These were the only organics detected at significant concentrations or frequencies.

- Groundwater samples from wells in Area C contained manganese, arsenic, antimony, beryllium, and thallium at concentrations that resulted in elevated estimated risks. With the exception of thallium, concentrations of these metals appeared to be less than or consistent with natural background levels.

- Groundwater flow from Area C within overburden and shallow bedrock is to the north.

- PCE attributable to Area C has migrated north to residential wells along Kirk Road. In addition, 2 µg/L of PCE was detected in a monitoring well located 800 feet north of Area C. The affected residences were provided with water treatment systems and were connected to a public water supply under remedial actions conducted by the Navy and USEPA.

- The specific locations of the releases of organic groundwater contaminants and elevated concentrations of inorganics are unknown.

2.3.6 Assessment of Risks

As part of the RIs for OU-5 and OU-6, risk assessments were conducted with available data to estimate the potential risks to human health and the environment posed by soil, sediment, and surface water associated with both Site 4 and Site 8 after the respective removal actions. To assess these risks, hypothetical residential and recreational exposure scenarios were evaluated. A human health risk assessment was also performed for Area C groundwater.

2.3.6.1 Site 4

Following the removal action, the RI risk assessment found the HI for exposure to Site 4 soil to be significantly less than 1.0 for child and adult receptors under both residential and recreational land use, indicating that no adverse non-cancer effects were expected from exposure to soil at Site 4. The incremental carcinogenic risk for the residential child was 1.05×10^{-5}, and the incremental cancer risk for a recreational user was 5.3×10^{-7}. These carcinogenic risks were within or less than the acceptable risk range.

2.3.6.2 Site 8

The RI risk assessment for Site 8 found that maximum carcinogenic risk would occur if lifelong residential exposure to surface soil was assumed. In this case, the total incremental carcinogenic risk was determined to be 2.94×10^{-5}, which is within the acceptable range. In assessing non-carcinogenic risks posed by Site 8 soil, the maximum HI of 0.6 was associated with exposure of a residential child to surface soil. This value is less than the acceptable level of 1.0. The assessment of risk posed by lead in Site 8 soil found that the estimated percentage of children with a blood-lead level greater than 10 micrograms per deciliter (µg/dL) was 0.35 percent, which is less than the protective level of 5 percent.

Estimated cancer and non-cancer risks for human receptors under a recreational scenario were found to be acceptable for downstream surface water and sediments. These findings indicated that sediment and surface water associated with Sites 4 and 8 do not present a threat to human health. The ecological risk assessment did not indicate that the stream downstream of Sites 4 and 8 was threatened by contamination related to these sites or Area C. No apparent stress on aquatic species was observed during the RI.

Finally, an evaluation of Site 4 and Site 8 soil data indicated that these sites did not present a threat to groundwater quality.

2.3.6.3 Area C Groundwater

The risk assessment for contaminated Area C groundwater found that the carcinogenic risk for hypothetical exposure to this groundwater was 1.2×10^{-4}. The carcinogenic risk associated with PCE, the only organic contaminant contributing to this risk, was 3.1×10^{-6}. The carcinogenic risks for arsenic and beryllium were calculated at 8.7×10^{-5} and 3.3×10^{-5}, respectively. However, the detected concentrations of arsenic and beryllium may be attributable to natural geologic conditions. Although the overall carcinogenic risk attributable to groundwater contaminated by Area C could potentially be considered acceptable, PCE was detected in residential wells formerly used for drinking water and bathing purposes at concentrations ranging up to 31 µg/L, in exceedance of the MCL of 5 µg/L for PCE.

The total HI and individual chemical HIs were calculated using unfiltered monitoring well sample results. Using these data, the total HI was determined to be significantly greater than 1.0, primarily due to elevated concentrations of manganese downgradient of Site 5, and to a lesser extent, antimony and thallium in wells elsewhere in Area C. However, manganese and antimony are naturally occurring, and detected concentrations may be within background ranges.

2.3.7 Area C Pre-ROD Response Actions

OU-2: Following Phase II, the Navy performed sampling of off-base drinking water wells in the vicinity of Area C. In 1994, USEPA and the Navy connected homes along Kirk Road to the WTMA water supply system.

OU-5: Based on Phase III RI findings, including the results of several supplemental investigations, the Navy determined that lead concentrations in certain surface soil at Site 8 presented an unacceptable risk to human health. The soils of concern were located adjacent to the western side of the runway Structure S1, the former flight suit test area. In response, the Navy completed a time-critical removal action at Site 8 in February 1999, eliminating the unacceptable risk associated with lead-contaminated soil. An Action Memorandum for the removal action was prepared and signed in February 1999. This action included the excavation and removal of soil with elevated lead levels and disposal in an off-base landfill. Sampling was conducted after the action to ensure removal of the soils of concern. Based on the results of this sampling, an NFA ROD for OU-5 was signed in September 1999.

OU-6: Based on the results of the investigations summarized in the EE/CA, the Navy determined that soil at Site 4 presented an unacceptable risk to human health and the environment. In response, the Action

Memorandum for the Site 4 removal action was signed in June 1996. The Navy began excavating trenches at Site 4 in August 1996. More than 22,000 tons of soil and debris were excavated and transported to an off-base landfill. Waste/soil characterization sampling and analysis were performed before, during, and after excavation work. Excavation continued until bedrock was encountered or until the contaminated soil was removed. The excavated areas at Site 4 were backfilled with clean fill material, covered with 4 inches of topsoil, graded, and seeded. A vegetative cover was established over the disturbed areas. The excavation work was completed in December 1996, and remaining site restoration work was finished in July 1997. An NFA ROD for OU-6 was signed in June 2000.

2.4 AREA D

2.4.1 Physical Characteristics

Area D includes former NAWC property west of Jacksonville Road, outside Area A, and a smaller area east of Jacksonville Road (see Figure 2-4). Area D was divided into two OUs, OU-4 consisting of contaminated Area D groundwater, and OU-8 consisting of Area D soil. There are no surface water bodies within Area D. The majority of the area is covered with pavement and/or buildings. Surface water runoff and water from roof drains enter a series of on-base stormwater collection and management structures. The majority of stormwater from Area D drains to the north toward Area A and discharges to an unnamed tributary to Little Neshaminy Creek. Surface water runoff from the southwestern part of Area D drains to the south and discharges to the Warminster Township stormwater system.

2.4.2 Land and Resource Uses

OU-8 is located in the western portion of the former NAWC, west of Jacksonville Road and north of Street Road. The area consists of industrial and office-type buildings, parking lots, and paved roadways. The property was transferred to the FLRA and local municipalities under an economic development conveyance (EDC) in August 2000. The reuse plan for this area, prepared by the FLRA and approved by the local municipalities, identified light industrial use as the designated use for this land, and the area is currently being used for an industrial office park complex.

2.4.3 History of Contamination

Area D was not reported as a disposal area but was identified as an area where contaminant releases to groundwater may have occurred. The largest buildings used by the Navy in Area D were Buildings 1 and 2 east of Jacksonville Road and Building 4 west of Jacksonville Road. Brewster Aeronautical Corporation, the owner of the property before the Navy, constructed the three buildings as aircraft hangers in 1942. The laboratories necessary to support associated research and development operations were constructed within Buildings 1 and 2, and Building 4 was continually used as an aircraft

hangar. Numerous other support facilities were also constructed throughout Area D. The Navy operated the research and development laboratories and support facilities until 1994, when the base was selected for closure. The research and development operations ceased in 1996. During the period that aircraft were assembled at the facility, the main assembly line, including parts fabrication and finishing, was located within Building 1. Parts storage and sub-assembly lines occupied much of Building 2. The fabrication, finishing, and assembly of parts and aircraft involved several metal shops where parts were formed, treated, plated, and painted.

During the initial years of operation, liquid wastes generated within Area D were conveyed via sewer lines to an on-base wastewater treatment plant built by Brewster and the Navy. The wastewater treatment plant, which was operated by the Navy until base closure, is located north of Area D within Area A, and accepted both sanitary and industrial wastes from facility operations. Industrial wastewater was pretreated before it entered the sanitary wastewater treatment plant. Waste collection and transfer lines serving the main building complex and the associated support buildings are located throughout Area D.

Groundwater contamination attributable to releases within Area D is addressed under OU-4. The primary contaminant in Area D groundwater is TCE. An interim remedial action was implemented to address OU-4. Although TCE was detected in Area D soil, no soil samples had TCE concentrations greater than the USEPA SSL for protection of groundwater quality. These data indicated that Area D soils were not a significant source of TCE in Area D groundwater. In addition, no other contaminants were determined to present a threat to groundwater quality.

2.4.4 Initial Response and Basis for Taking Action

Groundwater investigations in Area D began in the late 1970s when TCE was identified in two on-base supply wells located within Area D. The Navy initiated CERCLA RI work addressing Area D in 1994. A series of groundwater investigations in several phases was also performed as part of focused RI for Area D groundwater.

The following sections briefly summarize the investigations and pre-ROD response actions for Area D at NAWC Warminster.

Focused RI for Groundwater (1993 - 2000): The Area D focused RI groundwater scope of work was similar to the investigations for Areas A, B, and C and included evaluation of groundwater conditions within and downgradient of Area D. In October 1996, the Navy issued an interim RI Report that described the nature and extent of Area D groundwater contamination based on information available at the time. The interim RI found that groundwater in wells located within Area D contained TCE and other substances at concentrations that presented unacceptable risk to groundwater users. The interim RI

indicated that additional investigations were necessary to confirm the nature and extent of the subject contamination. An interim FS was also completed in October 1996 to evaluate remedial alternatives for minimizing migration of the contaminated groundwater while these investigations were completed.

Area D RI (1996 - 1998): The Area D RI objective was to characterize sources of contamination, primarily soil and wastes, at potential waste disposal sites within the main building complex at the base, including the hangar area east of Jacksonville Road. Other potential locations of contaminant releases within Area D were investigated by the Navy as part of an Environmental Baseline Survey (EBS), conducted in response to the requirements of BRAC and CERCLA Section 120(h).

Surface soil samples were collected at Buildings 15/130, where hazardous waste storage was permitted under the Resource Conservation and Recovery Act (RCRA). Field investigations beneath buildings consisted of a more limited number of soil borings and soil samples under Building 1 and 2. RI field work consisted of soil gas surveys to detect chlorinated VOCs (including TCE), soil borings, and soil sampling. Soil gas surveys addressed areas outside of the buildings, and the results of these surveys were used to select exterior soil boring and sample locations. Exterior soil gas sampling stations were located, and subsurface soil samples were collected along sewer lines, loading docks, railroad spurs, and drainageways. The RI Report for Area D soil was released in September 1998. Based on the Area D RI results for soil, an FS was not warranted.

2.4.5 Nature and Extent of Contamination

2.4.5.1 Area D Soil

Significant conclusions of the RI for Area D soil were as follows:

- Chlorinated VOCs were detected in soil gas samples collected at sampling stations throughout Area D. The greatest concentrations and frequencies of elevated detections were along part of a sewer line that conveyed industrial wastewater from Building 1, and to a lesser extent, in the vicinity of Buildings 15 and 130. The subject sewer line had reportedly been damaged and subsequently repaired.

- Concentrations of VOCs in soil samples collected in and around the Former Metal Plating Shop, Building 1, loading docks at Buildings 15 and 130, and along the sewer line were less than groundwater and human health protection criteria.

- Low concentrations of chlorinated VOCs, including TCE, were detected in soil samples collected throughout the study area, including locations under Buildings 1 and 2. However, only one isolated

sample result for PCE exceeded the groundwater protection criterion, and no results exceeded human health protection criteria. Samples collected at depths below the surrounding surface soil did not contain PCE at concentrations greater than screening criteria.

- Observations during performance of soil borings and other RI data did not suggest the presence of disposal areas or substantial releases of hazardous substances.

2.4.5.2 Area D Groundwater

Significant conclusions of the final RI/FS for Area D groundwater were as follows:

- Groundwater flow directions under non-pumping ambient conditions varied within the units. A groundwater divide was present, resulting in groundwater flow to the northwest, north, and northeast.

- Groundwater in hydrogeologic units A and B were contaminated with VOCs. The detected TCE concentrations exceeded the MCL and presented an unacceptable risk to human.

- Contamination was primarily in the area west of the main building complex and extending to the base boundary. TCE concentrations ranged from 480 µg/L in well HN-32S adjacent to the building to approximately 20 µg/L at well HN-33I.

- Concentrations of contaminants in groundwater from unit C did not present a risk to human health or the environment.

- Contamination patterns and groundwater flow data for hydrogeologic unit A indicated the presence of an additional source of contamination not related to NAWC Warminster.

- The then-current extraction network, implemented as the interim remedy, contained the on-base portion of the Area D-related TCE plume, and continued operation would control potential migration of contamination and eventually restore the aquifer to its beneficial use.

- Based on site data, TCE concentrations greater than the MCL were projected to extend approximately 200 feet and downgradient of the base boundary.

- Natural attenuation processes were projected to reduce off-base Area D-related TCE concentrations to MCLs within 2 to 3 years following successful operation of the extraction well system.

Historical and performance monitoring data indicated that Area D groundwater was contaminated with VOCs. TCE was the major COC for Area D groundwater. Although other VOCs were present, their concentrations were neither consistent nor greater than MCLs, with the exception of 1,1-DCE. These data suggested an off-base source of the 1,1-DCE contamination.

2.4.6 Assessment of Risks

2.4.6.1 Area D Soil

As part of the RI for OU-8, a risk assessment was conducted to estimate the potential risks to human health posed by Area D soil. The primary objective was to determine whether Area D soil might impact groundwater quality to the extent that affected groundwater may present an unacceptable risk to human health. The RI also assessed potential risks posed by incidental ingestion of and dermal contact with soil sampled during the RI. Finally, the RI assessed whether the intrusion of contaminant vapors from groundwater and soil into Buildings 1 and 2 may present an unacceptable risk to human health.

To assess the risk presented by Area D soil to groundwater, contaminant concentrations were initially compared to screening criteria protective of groundwater quality. The screening criteria were contaminant concentrations in soil that if exceeded may result in groundwater quality that presents an unacceptable non-carcinogenic or carcinogenic risk. Contaminant concentrations in 1 of 129 soil samples collected during the RI exceeded these screening criteria. An evaluation of RI data for the area where this sample was collected found the detected concentration was isolated and not representative of a significant quantity of soil. As a result, soil characterized during the RI was not expected to impact groundwater quality to an extent that the groundwater presents an unacceptable health risk.

The human health risk assessment assessed risks from potential exposure via incidental ingestion of and dermal contact with Area D soil characterized during the RI. Risks from exposure to subsurface soil throughout Area D and both surface and subsurface soils in the area of Buildings 15 and 130 were assessed. Risks were calculated for potential residential and industrial use and for construction workers. The calculated HIs were less than 1.0 for subsurface soil in Area D and for surface and subsurface soils in the vicinity of Buildings 15 and 130. In addition, incremental carcinogenic risks were calculated to be within or less than the acceptable range. Based on these risk assessment results, incidental ingestion of and dermal contact with Area D and Buildings 15 and 130 soil were not found to present an unacceptable risk to human health. The assessment of the incremental carcinogenic risk posed by the potential intrusion of VOC vapors into Buildings 1 and 2 estimated this risk to be less than the acceptable range.

2.4.6.2 Area D Groundwater

The risk assessment for Area D groundwater was initially performed as part of the interim RI, which concluded that Area D groundwater presented unacceptable carcinogenic and non-carcinogenic risks. Primary contributors to the unacceptable carcinogenic risk were TCE, 1,1-DCE, arsenic, and beryllium, and primary contributors to the unacceptable non-carcinogenic risk were TCE, manganese, iron, and aluminum. In addition, TCE, aluminum, barium, beryllium, cadmium, iron, lead, and manganese were detected in at least one well at concentrations greater than MCLs.

The final RI for OU-4 re-evaluated risks based on data generated after the interim OU-4 RI. Additional sampling for metals was performed to determine whether metals concentrations were at background concentrations or were due to releases from Area D. The results indicated that metals concentrations in Area D groundwater were within background ranges for the base.

2.4.7 Area D Pre-ROD Response Actions

OU-4: At the end of the focused groundwater RI for Area D groundwater, an interim ROD for OU-4 was signed in September 1997. The interim remedy documented in the ROD and completed by July 1999 included installing extraction wells and connecting these wells to the existing groundwater treatment system. In April 2000, the Navy issued a final RI/FS for Area D groundwater that considered information generated since the issuance of the interim RI/FS and performance monitoring information for the operating interim pump-and-treat remedy.

OU-8: No CERCLA response actions for specific Area D sources were conducted; however, the Navy removed several petroleum-related aboveground storage tanks and underground storage tanks within Area D. Based on RI findings, a no-action ROD for OU-8 was signed in June 2000.

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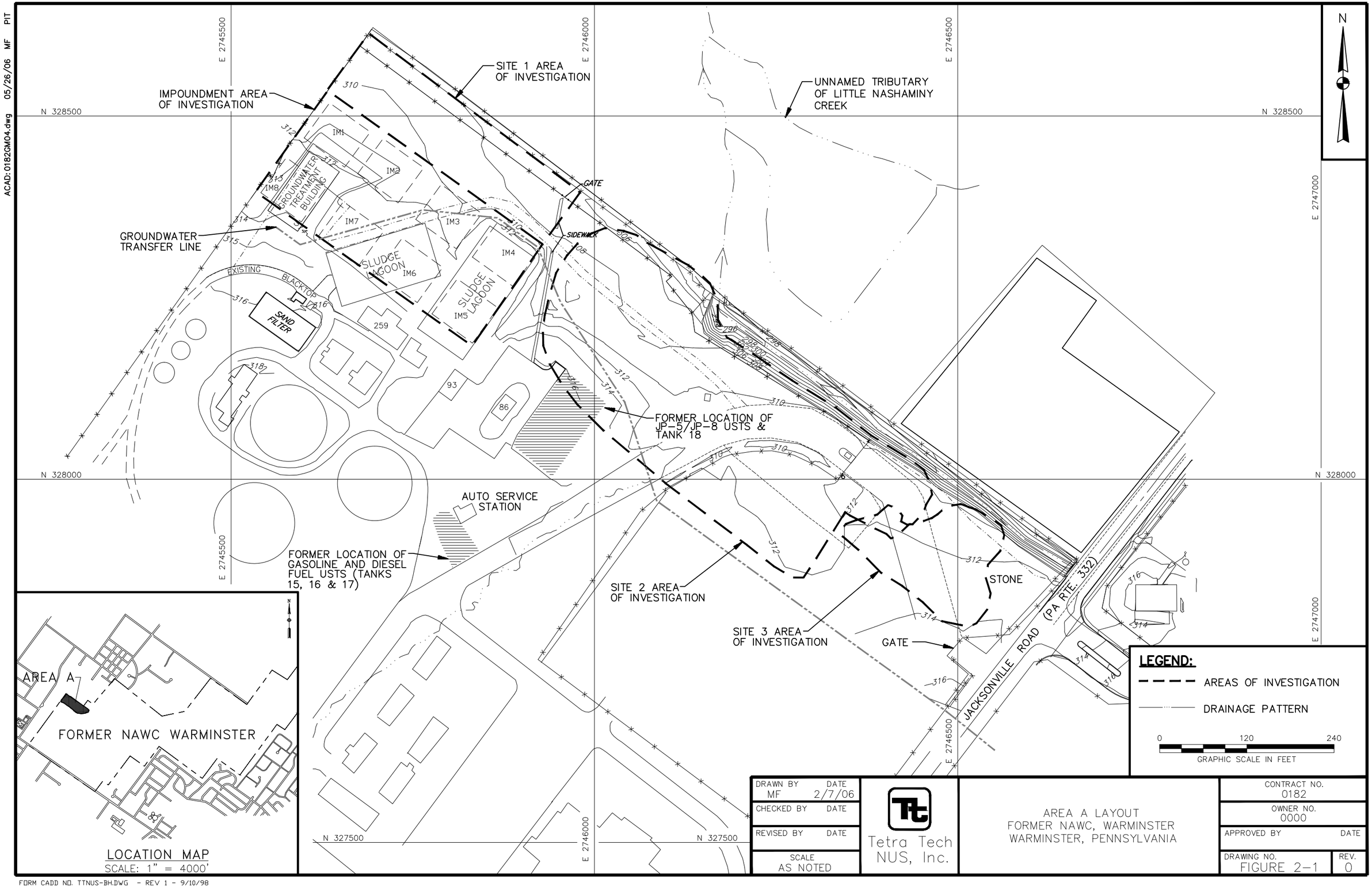

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Tetra Tech NUS, Inc.

AREA A LAYOUT
FORMER NAWC, WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. 0182	
OWNER NO. 0000	
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SITES 6 & 7

SITE 5

TR 12

POSS P 7

TR 11

TR6C

TR6B

P6A

TR6D

TR6G

TR6E

P6F

TR 4

TR 5

TR 3

87

GATE

CONCRETE PAD

PATROL ROAD

PLAYGROUND

403

401

405

402

404

407

406

SKYHAWK DRIVE

BASEBALL FIELD

ASPHALT WALK

104.66'

N 53° 53' 57"

360 362 364 350 340 330

N

LEGEND

TR–5 EPIC FEATURE

0 150 300

GRAPHIC SCALE IN FEET

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SCALE AS NOTED			

CONTRACT NO. 0182	
OWNER NO.	
APPROVED BY	DATE
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FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

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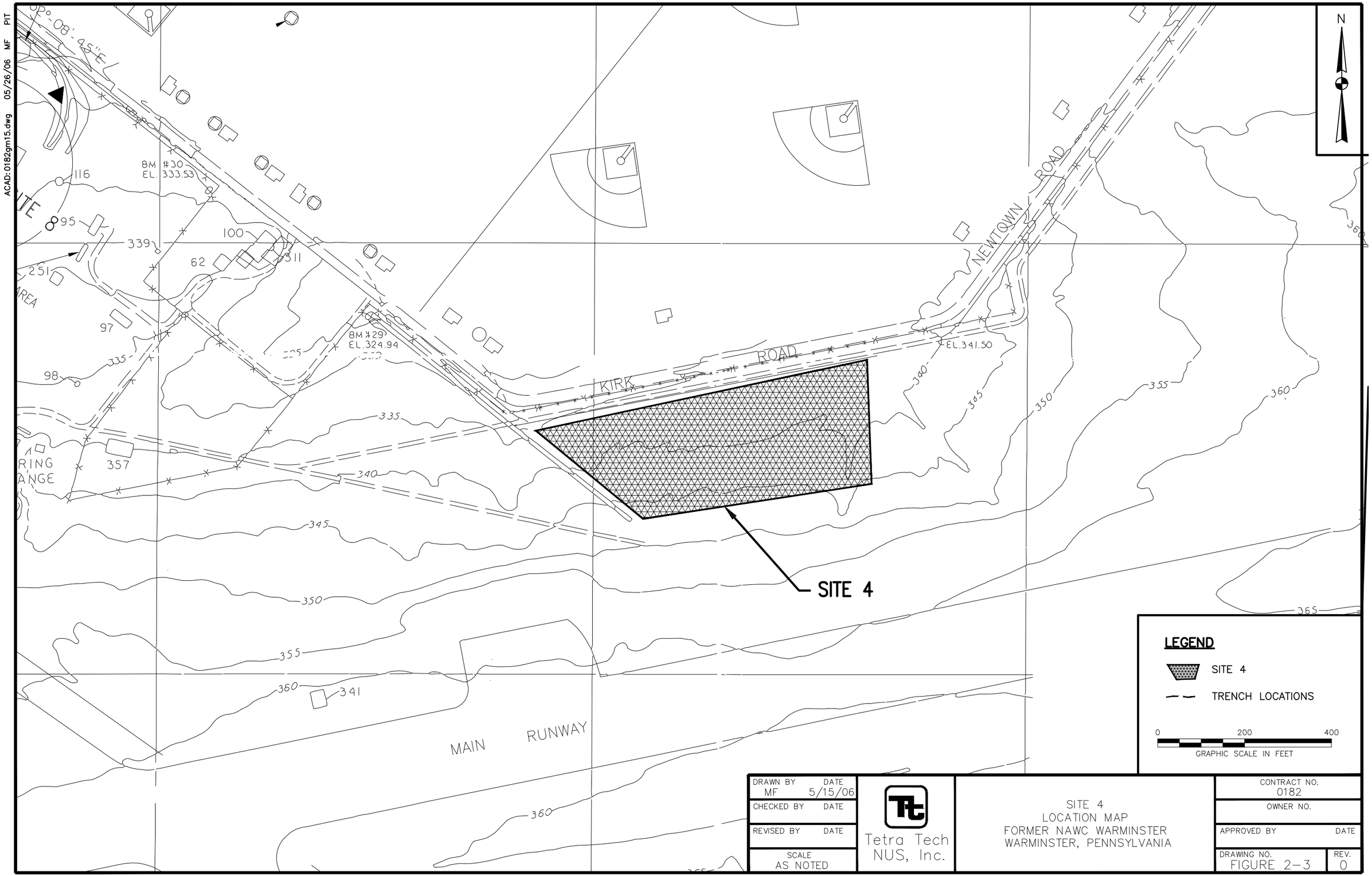

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REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-3 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

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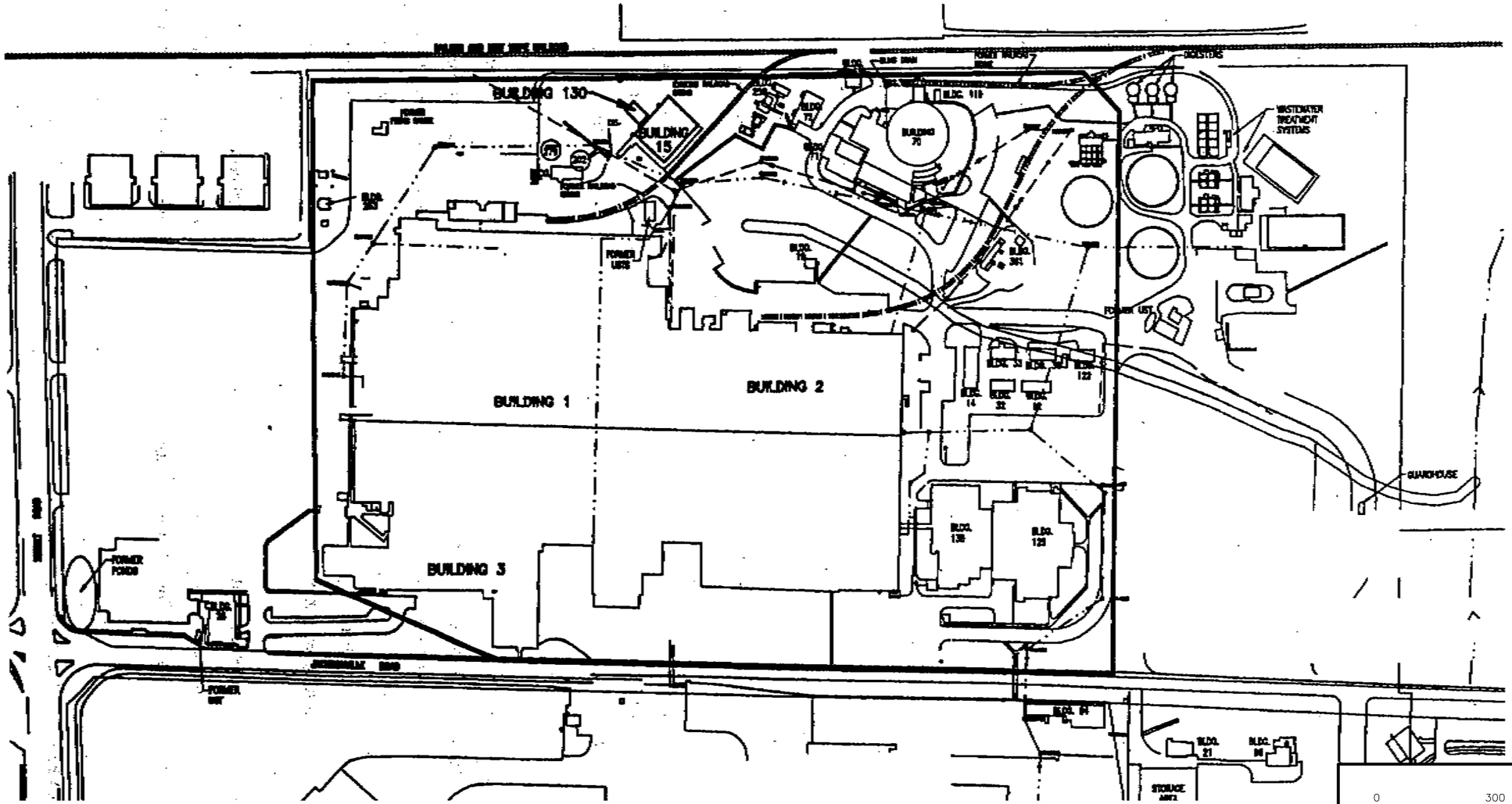
- = SANITARY SEWER LINE
- = INDUSTRIAL WASTE LINE
- = AREA D STUDY AREA



DRAWN BY MF DATE 5/26/06	Tetra Tech NUS, Inc.	AREA D – KEY FEATURES FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
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3.0 OPERABLE UNITS 1, 1A, AND 1B

3.1 INTRODUCTION

Implementation of interim remedial actions at OU-1 began in approximately 1993, and implementation of the final remedial action at OU-1A began in approximately 2000 and is ongoing. The ROD for OU-1B documented the selected remedy of NFA. This five-year review includes an evaluation of approximately 11 years of data after the final OU-1A ROD and provides a current status update. This review is required because OU-1A groundwater has contaminant concentrations that do not allow for unlimited use and unrestricted exposure.

3.2 BACKGROUND AND SITE CHRONOLOGY

OU-1 was initially defined as the shallow contaminated groundwater attributable to Areas A and B, and an interim remedy was implemented for this OU while RI activities continued to determine a final remedy. Based on the results of additional RI activities, OU-1 was divided into OU-1A, contaminated groundwater attributable to Area A (Sites 1, 2, and 3 and adjacent areas and the Impoundment Area), and OU-1B, contaminated groundwater attributable to Area B (Sites 5, 6, and 7), and final remedies were determined separately for OU-1A and OU-1B.

A list of important OU-1, OU-1A, and OU-1B historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE	EVENT
1989 to 1991	Basewide Phase I RI
1992 to 1993	Basewide Phase II RI and FS
April 1993	Phase II RI Report and Focused FS Report for OU-1
September 30, 1993	Interim OU-1 ROD signed
October 1, 1993	Final (Focused) RI/FS for OU-1A and OU-1B began
1993/1994	OU-1 remedial design
1995	Interim OU-1 actual remedial action construction
July 6, 1999	Interim OU-1 groundwater extraction and treatment system start up
January to April 2000	Final OU-1A remedial action construction
May 2000	Final RI for OU-1B
June 29, 2000	Final RI/FS for OU-1A completed
1994 to 2000	OU-1B groundwater monitoring (as part of basewide monitoring program) per the 1993 Interim ROD

DATE	EVENT
September 6, 2000	OU-1B NFA ROD signed
September 27, 2000	OU-1A ROD signed
September 28, 2000	OPS for OU-1A signed
July 11, 2002	OU-1 interim remedial action completed
1999 to 2008	OU-1A remedial action quarterly performance monitoring
2007 - Present	Groundwater investigations at CRC Industries
August 2007	Optimization Report
2008 to Present	OU-1A remedial action semi-annual performance monitoring
June 2009	Updated O&M Manual for the OU-1A system
August 2009	Basewide LUCIP finalized
August 2010	Hydrogeologic CSM Update
October 2010	Annual Performance Monitoring Report for Fiscal Year 2010 at OUs 1A, 3, and 4
October 2010	Final SAP for LTM at OUs 1A, 3, and 4
1999 to 2011 (ongoing)	Quarterly to semi-annual performance monitoring reports for OU-1A, OU-3, and OU-4

OU-1, OU-1A, and OU-1B background information, including information about physical characteristics, land and resource use, history of contamination, and initial response and basis for taking action, is presented in Section 2.0.

3.3 REMEDIAL ACTIONS

3.3.1 Remedy Selection for OU-1

The interim ROD established the following Remedial Action Objectives (RAOs) for OU-1:

- Minimize the migration of contaminated shallow groundwater.
- Initiate aquifer restoration while further studies were performed to determine the full nature and extent of contamination in these aquifers.

The interim remedy included the following major components:

- Installation, operation, and maintenance of an on-base groundwater extraction and treatment system.
- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek or an unnamed tributary of Southampton Creek.

- Performance monitoring.

The OU-1 ROD did not specify groundwater cleanup concentrations for the interim remedy.

3.3.2 Remedy Selection for OU-1A

The September 2000 ROD established the following RAOs for the final OU-1A remedy:

- Prevent further migration of Area A groundwater that presented an unacceptable risk.
- Prevent use of Area A groundwater that presented an unacceptable risk.
- Restore Area A groundwater, where technically practicable, to usable standards and cleanup goals established in the ROD.

The remedial action cleanup goals were the federal MCLs for each COC: TCE - 5 µg/L; PCE – 5 µg/L; carbon tetrachloride - 5 µg/L; 1,1-DCE - 7 µg/L; cis-1,2-DCE - 70 µg/L; 1,1,2-TCA - 5 µg/L; vinyl chloride - 2 µg/L; chloroform - 80 µg/L; and benzene - 5 µg/L.

Groundwater data collected during the installation and operation of monitoring and extraction wells identified the presence of DNAPL contaminants in bedrock within Area A. This DNAPL contains TCE and potentially carbon tetrachloride and PCE at saturation levels within the bedrock fracture network and, to a lesser degree, within the intergranular pores of the rock. This DNAPL zone contains groundwater that is technically impracticable to restore to beneficial use. Because of the high concentrations of TCE and potentially of carbon tetrachloride and PCE, a technical impracticability (TI) waiver was approved for this area. The area where remedial action cleanup goals were determined to be impracticable to attain was referred to as the TI zone (see Figure 3-1). Federal and state ARARs associated with the restoration of groundwater to drinking water standards for these three specific contaminants were waived within this TI zone. The waiver does not apply to the dissolved-phase contaminant plume (i.e., Area A groundwater downgradient of the TI zone) or to other compounds within the TI zone. The TI waiver and the OU-1A ROD required that contamination associated with the TI zone and the DNAPL present within the TI zone be contained.

The final remedy included containment of the source area (DNAPL zone), containment and remediation of the source area dissolved contaminant plume, remediation of a portion of the downgradient contaminant plume via the existing groundwater extraction system, and capture and remediation of the remainder of the downgradient groundwater contaminant plume was via ongoing pumping of WTMA Well

26. The final remedy also included continued performance monitoring and additionally required implementation of LUCs to prevent use of Area A-impacted groundwater.

As presented in the 2000 final ROD, the groundwater extraction and treatment system was estimated to require operation for at least 10 years before achieving cleanup levels outside the designated TI zone. The time required for cleanup will be determined by actual sampling results over time.

The final selected remedy was determined to be protective of human health and the environment, to attain ARARs (considering the TI waiver), and to be cost effective. The remedy complies with action- and location-specific ARARs, and eventual compliance with chemical-specific ARARs, to the extent practicable, will be verified by monitoring.

3.3.3 Remedy Selection for OU-1B

The interim remedy ROD for OU-1 (overburden and shallow groundwater contamination attributable to Areas A and B) issued in September 1993 documented selection of pumping and treatment of both Area A and Area B groundwater to limit groundwater contaminant migration and to initiate aquifer restoration (see Section 3.3.1). However, based on the results of further investigations, as summarized below, it was determined that NFA was required for Area B groundwater.

As discussed in Section 2.3.7, in December 1994 and January 1995, the Navy installed two extraction wells and six observation wells in response to the interim OU-1 ROD. The extraction wells were sampled while pumping tests of various durations were performed. No TCE or other contaminants were detected at concentrations greater than MCLs in the pumped water. After completion of the extraction well yield tests and other Area B groundwater studies, an evaluation of VOC contaminant trends concluded that TCE concentrations in the well with maximum concentrations of TCE (up to 13 μg/L) appeared to be stable and that TCE was either not detected or was present at concentrations consistently less than the MCL in downgradient monitoring wells. Considering this contaminant trend along with the extraction well results, a decision was reached to discontinue the plan to pump Area B groundwater but to continue monitoring and conduct additional investigations during Area B source investigation and removal activities, in accordance with the interim ROD.

Based on investigations completed after the interim ROD, a no-action final remedy was selected for OU-1B in September 2000. Groundwater monitoring in the vicinity of Area B, which had been prescribed in the interim OU-1 ROD, was discontinued in September 2000 based on the final ROD.

3.3.4 Remedy Implementation for OU-1 and OU-1A

Interim OU-1 Remedy

The interim remedy for OU-1 included the following major components:

- Installation, operation, and maintenance of groundwater extraction wells.
- Installation, operation, and maintenance of an on-base groundwater treatment system including precipitation, filtration, air stripping, carbon adsorption, and/or other necessary means of treatment.
- Periodic sampling of treated water to ensure the effectiveness of the treatment system.
- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek or an unnamed tributary of Southampton Creek.
- Installation, operation, and maintenance of vapor-phase carbon adsorption as necessary.
- Off-base treatment and/or disposal of solid residuals generated during water treatment.
- Monitoring of groundwater in monitoring wells and residential wells.
- Installation and periodic sampling of observation wells to ensure the effectiveness of the groundwater extraction wells.
- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction wells.
- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations.

The remedial design for OU-1 began in October 1993 and was completed by the Navy in April 1994. The Navy contracted with OHM Corporation to construct the OU-1 remedy, and construction began in June 1994. Although the groundwater treatment system was constructed by July 1996 (and began operations to treat groundwater from Areas C and D), drilling and installation of Area A extraction wells were deferred while Area A soil removal actions and necessary groundwater investigations were completed. Following Area A removal activities in 1998, 18 potential extraction and/or performance monitoring wells were drilled on base within Area A from January through March 1999. Of the 18 wells, 14 were subsequently completed as groundwater extraction wells, and four were completed as monitoring wells. The OU-1 interim remedy groundwater extraction system began operation in July 1999, with 12 extraction wells (EW-A1, EW-A2, EW-A3, EW-A4, EW-A6, EW-A7, EW-A8, EW-A10, EW-A11, EW-A12, EW-A13, and EW-A15) pumping at an average cumulative discharge rate of approximately 40 gallons per minute

(gpm). The extraction wells are completed in and draw water from hydrogeologic unit B (see Section 2.1.5.6).

A second phase of Area A extraction and observation well drilling was performed from December 1999 through January 2000. Six wells were drilled on the property immediately north of Area A, using procedures similar to those used for the on-base Area A extraction wells. One of the six wells was completed as a potential extraction well, and the remaining five wells were completed as monitoring wells.

As part of the interim remedy, the Navy implemented a performance monitoring program to monitor the effectiveness and operation of the interim remedy extraction system. Performance monitoring activities for the Area A extraction system began in June 1999 immediately prior to start-up of the on-base extraction system and continued until the start of monitoring activities implemented in accordance with the final remedy.

Final OU-1A Remedy – Groundwater Extraction and Treatment System

The major components of the final remedy for OU-1A included the following:

- Containment of the source area (DNAPL zone), containment and remediation of the source area dissolved contaminant plume, and remediation of a portion of the downgradient contaminant plume via the existing groundwater extraction system constructed as part of the interim OU-1 remedy. Capture and remediation of the remainder of the downgradient groundwater contaminant plume was via ongoing pumping of WTMA Well 26.

- Treatment of extracted Area A groundwater via the existing groundwater treatment system, including O&M of the existing system and monitoring of its performance.

- Continued discharge of treated Area A groundwater from the existing treatment system to the chlorine contact chamber and to OF001 through the existing pipeline to Little Neshaminy Creek, including regular monitoring and reporting of the quality of discharged water.

- Implementation of institutional controls for Navy and non-Navy property to prevent the use of Area A groundwater as long as this groundwater presents an unacceptable risk and to protect the integrity and effectiveness of the extraction well network.

- Groundwater monitoring including regularly collecting water level measurements and analyzing groundwater samples both from within and outside the contaminant plume to assess the progress of remediation and to evaluate contaminant migration.

In accordance with the September 2000 OU-1A final ROD, operation of the interim remedy extraction and treatment system was continued. When the final system became operational, 15 extraction wells, EW-A1 through A13, EW-A15, and EW-A18, were operating. Wells EW-A14, A16, and A17 were never installed as extraction wells. Extraction well EW-A18 was permanently taken off line in November 2008, and a new extraction well, EW-A19, was installed (in the former HN-69 well cluster borehole) and became operational in 2008. Within the area of greatest TCE concentrations, the presence of DNAPL was inferred based on detections of TCE in groundwater at concentrations of greater than 100 mg/L (the solubility of TCE is approximately 1,100 mg/L) and has been confirmed through dye testing. Selective pumping of the extraction wells containing DNAPL and maximum dissolved TCE concentrations (EW-A6 and EW-A7) is performed. Adjacent extraction wells EW-A5 and EW-A9 are not being pumped to avoid causing migration of DNAPL from the immediate vicinities of these two wells. After TCE concentrations in EW-A6 and EW-A7 decrease to concentrations similar to those in surrounding wells, it is anticipated that extraction wells EW-A5 and EW-A9 may be activated. The current treatment system includes the pumping of 13 extraction wells, EW-A1 through EW-A4, EW-A6 through EW-A8, EW-A10 through 13, EW-15, and EW-19.

As stated above, the extraction wells are completed in and draw water from hydrogeologic unit B, and the system is designed to capture the highly contaminated portion of the Area A-related contaminant plume and hydraulically isolate the source area from downgradient areas. Extracted groundwater is routed to the groundwater treatment plant located along the western edge of Area A for treatment via air stripping and carbon adsorption. Further downgradient from the source area extraction system, WMA Well 26 is pumped continuously at an average rate of approximately 200 to 250 gpm. Water from this well is routed through an air stripping unit for treatment before entering the municipal water system. The portion of the Area A-related groundwater plume not captured by the source area groundwater extraction system is captured by this well and treated.

Long-Term Groundwater Monitoring

The OU-1A long-term groundwater monitoring program is currently being implemented in accordance with the Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Long-Term Monitoring, Operable Units 1A, 3, and 4 (Tetra Tech, 2010a). This SAP replaces previous monitoring program documents including the Long-Term Performance Monitoring Plan for Operable Units 1A, 3, and 4 (ECOR, 2005a), QAPP for Long-Term Environmental Monitoring at OUs 1A, 3, and 4 (ECOR, 2005b), SAP for Former NAWC, Warminster (ECOR, 2006c), and Final Diffusion Sampling Plan for Long-Term Environmental Monitoring at the Former NAWC Warminster (Battelle, 2002).

Performance monitoring has included the collection and analysis of groundwater samples from extraction wells and selected nearby monitoring wells, collection and mapping of periodic rounds of water levels,

and evaluation of the resultant data. Many performance monitoring reports have been generated to date, including the Pre-Startup and Startup Performance Monitoring Report (EA Engineering, 2000b), Performance Monitoring Reports for quarterly events conducted from 1999 to 2008, and Performance Monitoring Reports for semi-annual events conducted in 2009 and 2010. As of February 2011, 16 performance monitoring events have been conducted, including 13 quarterly and three semi-annual events. The most recent event included in this five-year review was conducted in November 2010.

The results of May/June and November 2010 long-term performance monitoring indicate that hydraulic containment of OU-3 groundwater contamination is being achieved (see Figure 3-2). The combined instantaneous pumping rate for OU-1A measured on November 2, 2010, was 57.6 gpm, and the calculated average pumping rate for the 5-month period from May 23, 2010, to November 10, 2010, was 53.3 gpm. As of November 2010, the total volume of water pumped since system startup is 273,169,954 gallons (Tetra Tech, 2011b). The 2010 Semi-Annual and Annual Performance Monitoring Reports also indicate that progress is being made to restore groundwater quality to levels protective of human health and the environment (see Figure 3-3). Extraction rate data coupled with contaminant concentration trends indicate that contaminant mass is being removed by the extraction well network (Tetra Tech, 2011a and 2011b). It should be noted that groundwater contamination associated with an adjacent industrial facility (CRC Industries) has impacted municipal well WMA 26 to a significant degree and is now the primary source of the contamination being detected in this well.

Land Use Controls

The Navy transferred land in the vicinity of Site 1 to WTMA as part of a public benefit conveyance (PBC) through the United States Department of Health and Human Services (HHS) and transferred land associated with the forensics unit building built near Site 2 to Bucks County as part of a second PBC, also through HHS. The remaining property in the vicinity of Area A, including Site 3, was transferred to the FLRA of Bucks County as part of an EDC. LUCs and restrictions specified in the OU-1A ROD were included in the conveyance documents for this property. As specified in these documents, extraction and use of Area A groundwater by current and future landowners is prohibited. The portion of OU-1A that includes the groundwater treatment plant, extraction wells, and area immediately downgradient of those wells is still owned by the Navy.

An LUC Implementation Plan (LUCIP) was prepared in 2009 to ensure and document compliance with LUCs and/or deed restrictions required for sites at the former NAWC Warminster, including Navy property, previously transferred property, and other private property impacted by Navy Installation Restoration (IR) sites (ECOR Solutions, Inc., 2009).

LUCs were implemented to prevent the use of Area A groundwater as long as it presents an unacceptable risk and to protect the integrity and effectiveness of the extraction well network. LUCs must remain in place as long as a threat to human health and the environment is posed by Area A groundwater, and the LUCs include those that address currently owned Navy property and those that address private property that was never owned by the Navy. The groundwater LUCs addressing Navy property consist of restrictions on the future installation of wells and/or the use of water from wells installed in the future. Supply wells will not be installed, and groundwater will not otherwise be withdrawn without the approval of the Navy and USEPA. When Navy-owned property is eventually transferred, these restrictions will be included in leases for affected property and deeds entered into for the transfer of the property.

LUCs for affected current private property within Warminster Township consist of the continued enforcement by the Township of Warminster of its Ordinance No. 32, which regulates well drilling in Warminster Township (Township of Warminster, 1955). The Navy will provide copies of performance monitoring reports for consideration by the township in enforcing this ordinance. These reports will provide the locations of extraction and monitoring wells and operational information including groundwater elevation measurements. Analytical data will be provided to demonstrate constituent trends with time both in the area of extraction well hydraulic containment and the downgradient area associated with the capture of constituents by WMA-26. LUCs for affected private property in the Borough of Ivyland include enforcement of a similar ordinance (Ordinance No. 2001-3) for regulating well drilling within the borough (Borough of Ivyland, 2001).

Annual LUC inspections are conducted to document continued maintenance of the required restrictions. For OU-1A, this includes confirmation that Area A-impacted groundwater is not being used for any purpose. The results of 2007 through 2010 annual LUC inspections indicate that the Area A groundwater LUCs are being implemented as required (Tetra Tech, 2010b).

Remedy Optimization Study

As detailed in the 2007 Final Optimization Report for Former NAWC Warminster, an optimization study was conducted for the groundwater extraction and treatment system and operation of extraction well networks at Areas A (OU-1A), C (OU-3), and D (OU-4) and the associated performance monitoring program (Battelle, 2007). The study included an evaluation of extraction well locations, extraction rates, and overall adequacy of the respective extraction systems at preventing downgradient plume migration and reducing contaminant concentrations. The results of the study indicated that in Areas C and D, all concentrations greater than MCLs are contained by groundwater extraction, and in Area A, the most highly contaminated source area groundwater with VOC concentrations greater than 1,000 µg/L is contained. By design and as documented in the OU-1A final ROD, the diffuse plume not contained by the

Area A extraction well network is captured by WMA-26 and subsequently treated. The Optimization Report included the following treatment system modification recommendations:

- Installing a new extraction well near monitoring well HN-69D and adjusting the extraction flow rates in Area A.
- Discontinuing pumping from extraction well EW-D4 in Area D.
- Reconfigure the variable frequency drive (VFD) pumping system on the equalization (EQ) tank to allow the pumping rates to be controlled in response to changing tank levels to maximize pump cycling (EQ tank and VFD controls were reprogrammed after the draft report in accordance with this recommendation).
- Collecting monthly hexavalent chromium samples from the ion exchange influent and effluent to monitor treatment effectiveness.
- Taking the metals removal equipment off line to minimize pumping and O&M costs (Metals removal equipment was taken offline after the draft report in accordance with this recommendation).
- Installing an air stripper with a higher VOC removal efficiency.
- Operating the existing vapor-phase granular activated carbon (GAC) units in parallel and installing one additional unit to operate in series with the others. (An additional vapor-phase GAC unit was installed and is operating in series with the two existing units, in accordance with this recommendation in the draft report).

The Optimization Report also included the following performance monitoring recommendations:

- Implementing quarterly monitoring in Area A and D transect monitoring wells for two quarters following extraction well pumping rate modifications, and quarterly collection of groundwater level measurements in these wells for the same two quarters.
- Reducing sampling frequency from quarterly to semi-annually in all Area C and Area D extraction wells.
- Reducing sampling frequency from quarterly to semi-annually in all Area A extraction wells after two quarters of monitoring following installation of the new extraction well and implementation of extraction well pumping rate modifications.

- Adding the new extraction well at HN-69D to the monitoring program. Collecting groundwater samples and groundwater level measurements quarterly for two quarters following implementation of pumping rate modifications and continuing semi-annual monitoring thereafter.

- Removing Area A monitoring wells HN-69S and HN-69D from the monitoring program.

- Reducing the sampling frequency in upgradient Area C monitoring wells BG-05A, HN-23A, HN-27S, and HN-28S from quarterly to semi-annually.

- Streamlining monitoring reports to include only pumping rates, sampling results, groundwater level measurements, and any notable issues, in accordance with TEG recommendations.

- Creating and maintaining a database with current and historical monitoring data and submitting the database as a deliverable with monitoring reports.

These recommendations were implemented as appropriate following the 2007 finalization of the Optimization Report.

3.3.5 Remedy Cost

The Navy estimated the capital cost for implementation of the selected interim remedial alternative in the 1993 OU-1 interim ROD at $3,515,000. This estimate included costs associated with site preparation, groundwater extraction, on-site treatment, and discharge to surface water. The Navy estimated the capital cost for implementation of the selected final remedial remedy in the 2000 OU-1A ROD at $7,688. This estimate included costs associated with maintaining and operating the existing interim groundwater remedy, implementing institutional controls (including a TI zone) to prevent the use of Area A groundwater and to protect the integrity and the effectiveness of the extraction well network, and implementing a monitoring system to evaluate the progress of the remediation and ensure that migration of contamination is not occurring. The actual cost for implementation of the OU-1A remedy has not yet been tabulated.

The results of the OU-1B risk assessment and RI indicate that Area B groundwater did not present an unacceptable risk, and the selected final remedy for OU-1B is no action. There are no costs associated with this remedy.

3.3.6 System Operations/Operation and Maintenance

The O&M plan in place and being implemented for the OU-1A remedy provides operating information, troubleshooting, and maintenance relative to the extraction well pumps and pump controllers, transfer

sump and pump, and treatment system. A revised O&M Manual was finalized in June 2009 to incorporate changes to the system over time based on changes in contaminants and concentrations (Tetra Tech, 2009a). The treatment system was originally designed to remove organic and inorganic contaminants and initially included pH adjustment, chemical oxidation, precipitation, clarification, sand filtration, neutralization, sludge thickening, and sludge dewatering. These units were taken off line in 2006 and have not been used since. The sludge dewatering equipment was never used. To simplify the O&M Manual, references to the off-line units were deleted.

Operation, maintenance, and system monitoring activities associated with the groundwater extraction and treatment system are conducted in accordance with the current O&M Manual.

The Navy's original annual O&M cost estimate for OU-1 long-term performance monitoring was approximately $628,000. The Navy's updated annual O&M cost estimate for long-term performance monitoring based on the OU-1A ROD was approximately $402,500. The Navy estimates that the groundwater O&M costs for OU-1, OU-1A, OU-3, and OU-4 average about $500,000 per year; however, the actual cost for implementation of the remedial design has not yet been tabulated because the remedial actions are ongoing.

OPS Determination

On September 27, 2000, the Navy submitted a technical demonstration document to support the determination that the OU-1A remedy was Operating Properly and Successfully (OPS). USEPA approved the OPS demonstration on September 28, 2000. OU-1A remedy performance was evaluated through the analysis of technical data collected in accordance with sampling and monitoring plans approved by USEPA and PADEP. The basis for the OPS demonstration was the evaluation of remedy performance using groundwater monitoring well and extraction well data as they relate to the applicable RAOs and medium-specific cleanup goals specified in the ROD. The Navy demonstrated in the OPS demonstration that a well-developed cone of depression has formed within the hydrologic unit with maximum observed concentrations of TCE and other VOCs around the Area A extraction wells, which indicates that inward gradients have been achieved in the plume area. The capture zone analysis showed that capture of the plume exists to a point off base and that the source area or DNAPL zone has been hydraulically controlled. Analysis of these data showed that the groundwater plume was contained in the vicinity of the base boundary and that overall groundwater contaminant concentrations were steady state or decreasing outside of the DNAPL zone.

3.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-1A.

Recommendations/ Required Actions	Previous Milestone Date	Current Status
O&M manual revisions and updating (as needed) to reflect intended operating procedures.	Ongoing	A revised O&M Manual was submitted in June 2009.
Develop a strategy to terminate the pumping and treating of contaminated groundwater.	Ongoing	Although potential source area treatment options are currently being evaluated (chemical oxidation, thermal, in-situ chemical reduction), it is not expected that pumping and treatment of groundwater will be terminated in the near future.
Implement institutional controls.	Ongoing	A LUCIP for the facility was finalized in August 2009, and annual LUC inspections are ongoing.
Finalize the remediation optimization report and make it available to O&M and inspection contractors. For Area C, address any residual PCE source (near HN-23A and BG-05A) and recommend source treatment measures.	ASAP	The Optimization Report was finalized in August 2007. The Area C Source Assessment Report was finalized in December 2007. No residual PCE source was identified, and no further action, other than continued monitoring, was recommended.

Although an OU-1 vapor intrusion screening assessment using the Johnson and Ettinger model (USEPA, 2004) was included in the previous Five-Year Review Report, additional evaluation is in progress. The results of the previous assessment indicated unacceptable risk for future residents, and although the total inhalation cancer risk based on maximum concentrations exceeded the upper limit of USEPA's target risk range ($1x10^{-4}$ to $1x10^{-6}$), the remedy remained protective because LUCs are in place to prevent residential use of the site. Estimated cancer risks and non-cancer hazards for occupational workers were less than USEPA goals. Additional evaluation was conducted to assess potential vapor intrusion impacts to the Bucks County Forensics Unit building located south of Flamingo Road and west of Eagle Boulevard within Area A. Activities conducted included sampling of nearby wells OW-A17 and E (northwest of the building) for VOC analysis and determination of whether a vapor barrier or sub-slab ventilation system was installed during construction of the building. Wells OW-A17 and E were sampled on May 17, 2011, and results are presented in Table 3-1 and on Figure 3-1. VOCs were detected at low concentrations in both wells. Concentrations of PCE and TCE at OW-A17, 7.6 and 6.6 µg/L, respectively, slightly exceeded their MCLs (both 5 µg/L). During drilling at OW-A17, water was first noted at approximately 43 feet bgs. The Forensics Unit building and a smaller maintenance building to the north are within 100 feet of OW-17A. Based on a conversation with the building design engineer, the forensics unit was constructed with a vapor barrier, and the other building within 100 feet of OW-17A is a maintenance building associated

with the WTMA wastewater treatment plant. Based on the minimal exceedances of MCLs, depth to water at OW-17A, the presence of a vapor barrier at the Forensics Unit building, and the use of the smaller building, it is not expected that vapor intrusion is a current concern in this area.

Sampling and analysis for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in Area A groundwater was also recently conducted. No PFOA or PFOS was detected, and results were provided to the TEG.

3.5 FIVE-YEAR REVIEW PROCESS

3.5.1 Document and Analytical Data Review

This third five-year review consisted of a review of relevant documents for OU-1, OU-1A, and OU-1B including the ROD, O&M Manual, and performance monitoring reports. Construction of the remedial action (extraction well and groundwater treatment system installation) has been completed, and O&M of the treatment system and long-term performance monitoring is ongoing.

3.5.2 Site Inspection

A site inspection was conducted in April 2011. No unusual observations were documented during the visit, and fencing around the groundwater treatment plant was secure. The Five-Year Review Site Inspection Checklist and photographs from the April 2011 inspection are included in Appendix A.

3.6 TECHNICAL ASSESSMENT

3.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The final remedy selected for OU-1A was groundwater extraction, on-site treatment, and discharge to surface water and implementing institutional controls (including a TI zone) and a long-term performance monitoring plan. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD.

Based on the activities that have completed (groundwater extraction and treatment system installation and operation) and activities that are ongoing (system O&M, performance monitoring, and LUCs), the intent and goals of ROD have been or will be met, and there are no deficiencies or early indicators of potential remedy failure.

3.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no significant changes in the physical conditions for OU-1, OU1A, and OU-1B, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. There have also been no changes in the risk assessment methodologies or exposure assumptions that would affect the protectiveness of the remedy. Therefore, there have been no significant changes in cleanup goals established for OU-1, OU1A, and OU-1B.

Based on the results of the vapor intrusion assessment included in the previous Five-Year Review Report, current occupational risks associated with potential vapor intrusion are acceptable, and LUCs prevent residential land use, for which potentially unacceptable risks were estimated during the screening evaluation. In addition, additional evaluation during this five-year review did not indicate current unacceptable risks associated with vapor intrusion. Potential future vapor intrusion risks associated with construction of new buildings in the area will be addressed through completion of a vapor intrusion assessment to determine:

- Whether or not vapor intrusion issues present an unacceptable potential risk to future receptors

and if so:

- The specific area(s) where potential future vapor intrusion risks need to be addressed

The Navy will work with USEPA and PADEP to complete the vapor intrusion assessment and implement actions to address vapor intrusion risks if necessary. If additional actions (i.e., LUCs) are determined to be needed, the ROD and current LUCs will be reviewed to determine the appropriate mechanism(s) for implementing the additional actions.

3.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No additional human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come to light that could call into question the protectiveness of the remedy.

3.6.4 Technical Assessment Summary

The remedy as specified in the ROD is groundwater extraction, on-site treatment, and discharge to surface water and implementing institutional controls (including a TI zone) and a long-term performance monitoring plan. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD.

There have been no significant changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

3.7 ISSUES

No deficiencies were identified during this five-year review of the OU-1A remedy, and no issues related to current site operations, conditions, or activities prevent the remedy from currently being protective. There are no current issues regarding vapor intrusion for OU-1A. Additional vapor intrusion assessment will be conducted to determine if any additional actions are needed to address potential future vapor intrusion issues associated with future on-site or near-site buildings. This issue is summarized in the table below.

Issue	Affects Protectiveness?	
	Current	Future
Vapor intrusion assessment needs to be completed	No	TBD

3.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and second five-year review are as follows.

Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
				Current	Future
Complete vapor intrusion assessment to determine whether there are unacceptable potential future risks; address if/as necessary	Navy	USEPA and PADEP	2012-2013	No	TBD(1)

1 Could potentially affect future protectiveness if future vapor intrusion risks are determined to be unacceptable and if future buildings are constructed without appropriate mitigation measures over areas with unacceptable risks.

3.9 PROTECTIVENESS STATEMENT

The implemented remedy at OU-1A is protective of human health and the environment. The contaminated groundwater treatment remedy was implemented as designed and has been determined to be OPS. Contaminant migration is being adequately contained, and removal of contamination is progressing towards attainment of cleanup goals (except in the TI zone). LUCs to prevent exposure to and use of groundwater have been implemented, are being maintained and monitored, and provide a significant amount of protection until completion of the remedy is achieved (outside of the TI zone) to provide full protectiveness. The results of future monitoring will be used to continue to evaluate the effectiveness of the remedy. The groundwater remedial actions have been implemented as designed and include measures that prevent exposure. The remedial actions that are completed (implementation of LUCs) and ongoing (groundwater extraction and treatment and performance monitoring) are operating as designed. Future protectiveness of the remedy will be verified by continued monitoring in accordance with the SAP and by continuation of existing LUCs. In addition, a vapor intrusion assessment will be completed, and based on the results, any additional actions that may be required to ensure future protectiveness will be implemented. Based on the activities that are completed and ongoing, the intent and goals of the OU-1A final ROD have been or will be met.

The presence of a non-Navy significant groundwater contamination source/release (at CRC Industries) and its demonstrated impact on municipal well WMA 26 do not affect the protectiveness of the Navy's OU-1A remedy; however, the impacts from the CRC source/release should be factored into future evaluations/decisions related to the OU-1A remedy (especially in regard to delineation of the plume footprint, concentration trends, and impacts to WMA 26).

TABLE 3-1
MAY 2011 AREA A GROUNDWATER RESULTS
THIRD FIVE-YEAR REVIEW REPORT
FORMER NAWC WARMINSTER, PENNSYLVANIA

PARAMETER	MCL	OW-A17	E
1,1,1-TRICHLOROETHANE	200	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	NC	0.4 U	0.4 U
1,1,2-TRICHLOROETHANE	5	0.4 U	0.4 U
1,1,2-TRICHLOROTRIFLUOROETHANE	NC	3 U	3 U
1,1-DICHLOROETHANE	NC	0.2 U	0.2 U
1,1-DICHLOROETHENE	7	0.2 U	0.2 U
1,2,3-TRICHLOROBENZENE	NC	0.4 U	0.4 U
1,2,4-TRICHLOROBENZENE	70	0.8 U	0.8 U
1,2-DIBROMO-3-CHLOROPROPANE	0.2	1.6 U	1.6 U
1,2-DIBROMOETHANE	NC	0.2 U	0.2 U
1,2-DICHLOROBENZENE	600	0.2 U	0.2 U
1,2-DICHLOROETHANE	5	0.2 U	0.2 U
1,2-DICHLOROPROPANE	5	0.2 U	0.2 U
1,3-DICHLOROBENZENE	NC	0.2 U	0.2 U
1,4-DICHLOROBENZENE	75	0.4 U	0.4 U
2-BUTANONE	NC	3.2 UR	3.2 UR
2-HEXANONE	NC	3.2 UR	3.2 UR
4-METHYL-2-PENTANONE	NC	3.2 U	3.2 U
ACETONE	NC	6.4 UR	6.4 UR
BENZENE	5	0.2 U	0.2 U
BROMODICHLOROMETHANE	80*	0.2 U	0.2 U
BROMOFORM	80*	0.4 U	0.4 U
BROMOMETHANE	NC	0.4 U	0.4 U
CARBON DISULFIDE	NC	0.8 U	0.8 U
CARBON TETRACHLORIDE	5	**2.2**	0.4 U
CHLOROBENZENE	100	0.2 U	0.2 U
CHLORODIBROMOMETHANE	NC	0.4 U	0.4 U
CHLOROETHANE	NC	1.6 U	1.6 U
CHLOROFORM	80*	**0.63 J**	0.2 U
CHLOROMETHANE	NC	1.6 U	1.6 U
CIS-1,2-DICHLOROETHENE	70	**0.33 J**	**0.21 J**
CIS-1,3-DICHLOROPROPENE	NC	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE	80*	0.8 U	0.8 U
ETHYLBENZENE	700	0.2 U	0.2 U
ISOPROPYLBENZENE	NC	0.4 U	0.4 U
M+P-XYLENES	NC	0.8 U	0.8 U
METHYL TERT-BUTYL ETHER	NC	0.4 U	**0.48 J**
METHYLENE CHLORIDE	5	0.4 U	0.4 U
O-XYLENE	NC	0.4 U	0.4 U
STYRENE	100	0.4 U	0.4 U
TETRACHLOROETHENE	5	**7.6**	**3.1**
TOLUENE	1,000	0.4 U	0.4 U
TOTAL XYLENES	10,000	1.6 U	1.6 U
TRANS-1,2-DICHLOROETHENE	100	0.2 U	0.2 U
TRANS-1,3-DICHLOROPROPENE	NC	0.4 U	0.4 U
TRICHLOROETHENE	5	**6.6**	**1.1**
TRICHLOROFLUOROMETHANE	NC	0.8 U	0.8 U
VINYL CHLORIDE	2	0.8 U	0.8 U

Concentrations in µg/L.
Wells sampled on May 17, 2011.
MCL - Maximum Contaminant Level.
NC - No criterion.
U - Not detected at associated detection limit.
J - Estimated concentration.
R - Rejected.
* MCL is for for total trihalomethanes.

Detected concentrations are bolded; MCL exceedances are shaded.

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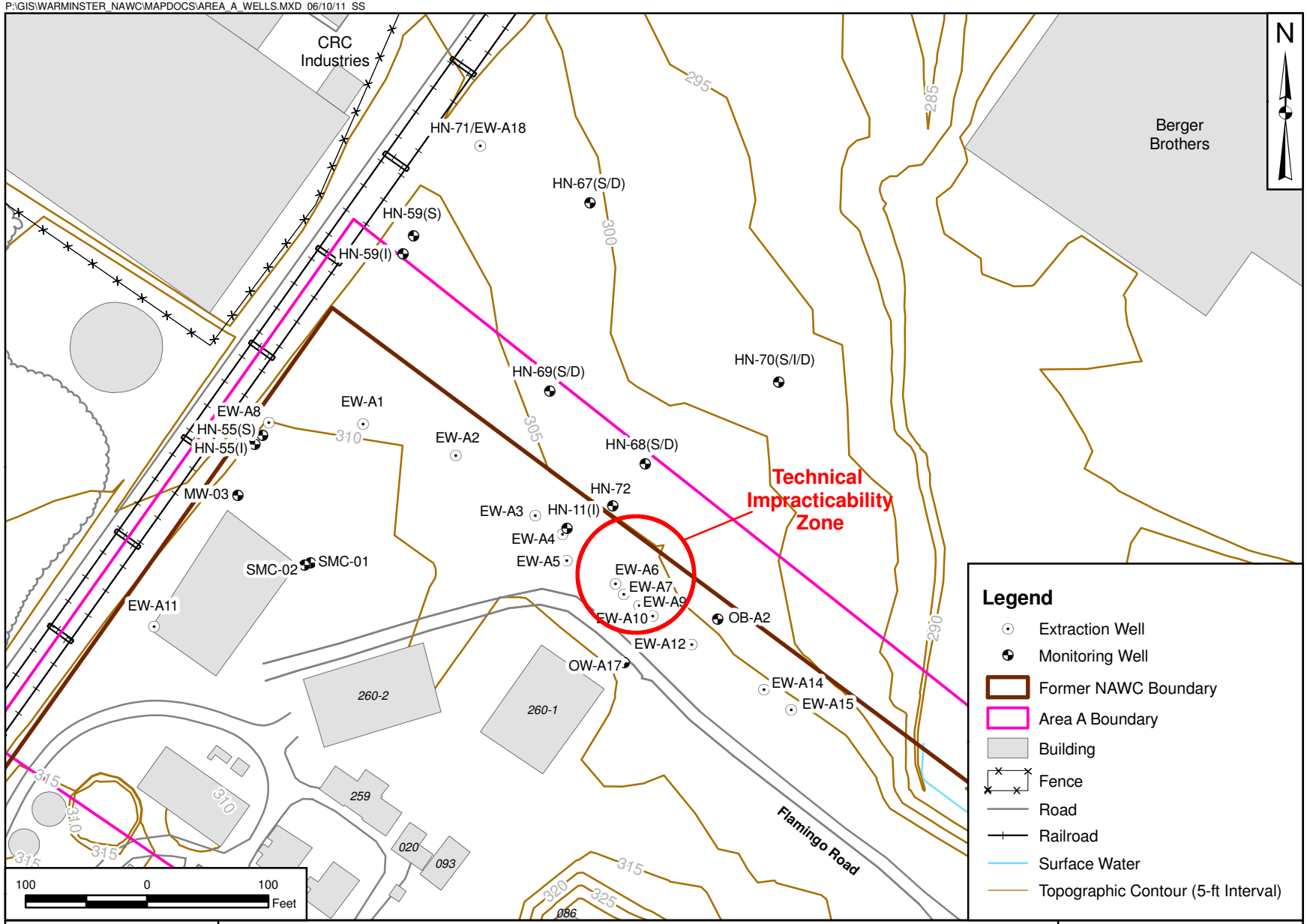

DRAWN BY S. STROZ	DATE 06/10/11	TETRA TECH	CONTRACT NUMBER CTO WE09
CHECKED BY R. MILLER	DATE 06/10/11	TECHNICAL IMPRACTICABILITY WAIVER ZONE AREA A GROUNDWATER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	APPROVED BY ___ DATE ___
REVISED BY	DATE		APPROVED BY ___ DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 3-1 REV 0

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Legend

- Monitoring Well Location
- Extraction Well
- Water Supply Well
- Potentiometric Contour (5-ft interval) (Dashed Where Inferred)
- Groundwater Flow Direction
- Environmental Site Boundary
- CRC Property Boundary
- Former NAWC Boundary
- Fence
- Building
- Railroad
- Roads
- Surface Water
- Topographic Contours (5-ft Interval)

N

WMA-26

HN-100(I)
270.09

HN-52(D)
284.22

HN-52(I)
271.52

HN-16(I)
278.78

CRC-MW-6B
277.64

CRC-MW-2B
281.21

HN-14(I)
283.28

HN-71/EW-A18
284.21

HN-67(S/D)
S: 283.64
D: 281.61

HN-68(S/D)
S: 282.28
D: 282.33

WW-1

HN-70(S/I/D)
S: 285.59
I: 285.31
D: 285.21

HN-72
284.85

HN-11(I)
279.32

HN-106(S/D)
S: 283.26
D: 283.28

HN-59(I)
282.73

HN-11(S)(C)
281.17

EW-A19
283.20

EW-A6
253.44

EW-A8
273.71

EW-A1
281.26

EW-A7
275.11

HN-55(I)
281.88

EW-A2
280.63

EW-A9
261.38

EW-A3
280.18

EW-A10
259.90

EW-A11
283.11

OB-A2
279.47

HN-19(I2)
287.09

EW-A4
260.05

EW-A5
270.99

EW-A12
268.62

EW-A13
288.17

OW-A17
281.37

E
286.90

EW-A15
299.48

D
283.57

MW-02
282.61

OW-A16
291.39

BG-04
299.38

DG-12
297.34

HN-13(S)/DG-23
301.05

AREA D

AREA A

HN-83(S)/MW-04
304.70

HN-82(S)
301.33

255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335

200 0 200 Feet

Note: The groundwater levels at HN-52(D), OW-A14, and SMC-1 were not used to generate groundwater contours.

DRAWN BY K. MOORE	DATE 09/08/10	TETRA TECH	CONTRACT NUMBER WE23
CHECKED BY S. WARINO	DATE 02/21/11	POTENTIOMETRIC SURFACE MAP HYDROGEOLOGIC UNIT B MAY 25, 2010 AREA A NAWC WARMINSTER, PENNSYLVANIA	APPROVED BY ___
REVISED BY J. ENGLISH	DATE 02/21/11		APPROVED BY ___
SCALE AS NOTED			FIGURE NO. FIGURE 3-2
			REV 0

P:\GIS\WARMINSTER_NAWC\MXD\TCE_PCE_UNIT_B_JUNE2010.MXD 09/27/10 JEE

Legend

- Monitoring Well Location
- Extraction Well Location
- Water Supply Well
- 2.6 — TCE Concentration (ug/L)
- 3.3 — PCE Concentration (ug/L)
- 3.3 — Carbon Tetrachloride Concentration (ug/L)
- J — Estimated Value
- ND (1.0) — Not Detected (Reporting Limit)
- TCE Concentration Contour (Dashed Where Inferred)
- PCE Concentration Contour (Dashed Where Inferred)
- Carbon Tetrachloride Concentration Contour (Dashed Where Inferred)
- NAWC Area
- CRC Property Boundary
- Fence
- Building
- Railroad
- Road

N

WMA-26
42 J
700
ND (25)

HN-100(I)
38
0.5 J
ND (0.84)

HN-52(I)
140
3.3
ND (3.1)

HN-16(I)
2.1
2.3
ND (1.1)

CRC-MW-6B
227
93.5
ND (1.0)

CRC-MW-2B
23
13.1
ND (1.0)

HN-67D
520
3.8 J
ND (13)

HN-106D
1500
ND (31)
ND (31)

HN-14(I)
0.93
ND (0.5)
ND (0.5)

EW-A19
33
0.21 J
ND (0.5)

HN-59(I)
67
1.6
ND (1.0)

HN-11(I)
30,000
ND (630)
ND (630)

WW-1
16
0.31 J
ND (0.5)

HN-11(S)(C)
18
0.27 J
ND (0.5)

HN-68D
1.3
1.2
1.4

EW-A1
8.5
1.7
0.28 J

EW-A8
3.1
1.6
0.14 J

HN-70D
1.8
0.72
0.31 J

HN-72
140
5.2
13

EW-A6
9500
93 J
250 J

EW-A2
19
1.4
0.4 J

HN-55(I)
20
1.9
0.23 J

EW-A7
4100
46 J
250

EW-A11
2.7
35 J
4

EW-A3
25
5.1
2

EW-A9
5300 J
57 J
83 J

EW-A10
650 J
13
67

HN-19(I2)
0.55
ND (0.5)
ND (0.5)

EW-A13
2.8
44 J
6.7

EW-A15
1.2
1.8
ND (0.5)

OB-A2
1.3
1
0.19 J

EW-A4
450
36
16

EW-A5
1400
140
62

OW-A17
7.7
11
3.4

EW-A12
34
6.4
3.5

AREA A

AREA D

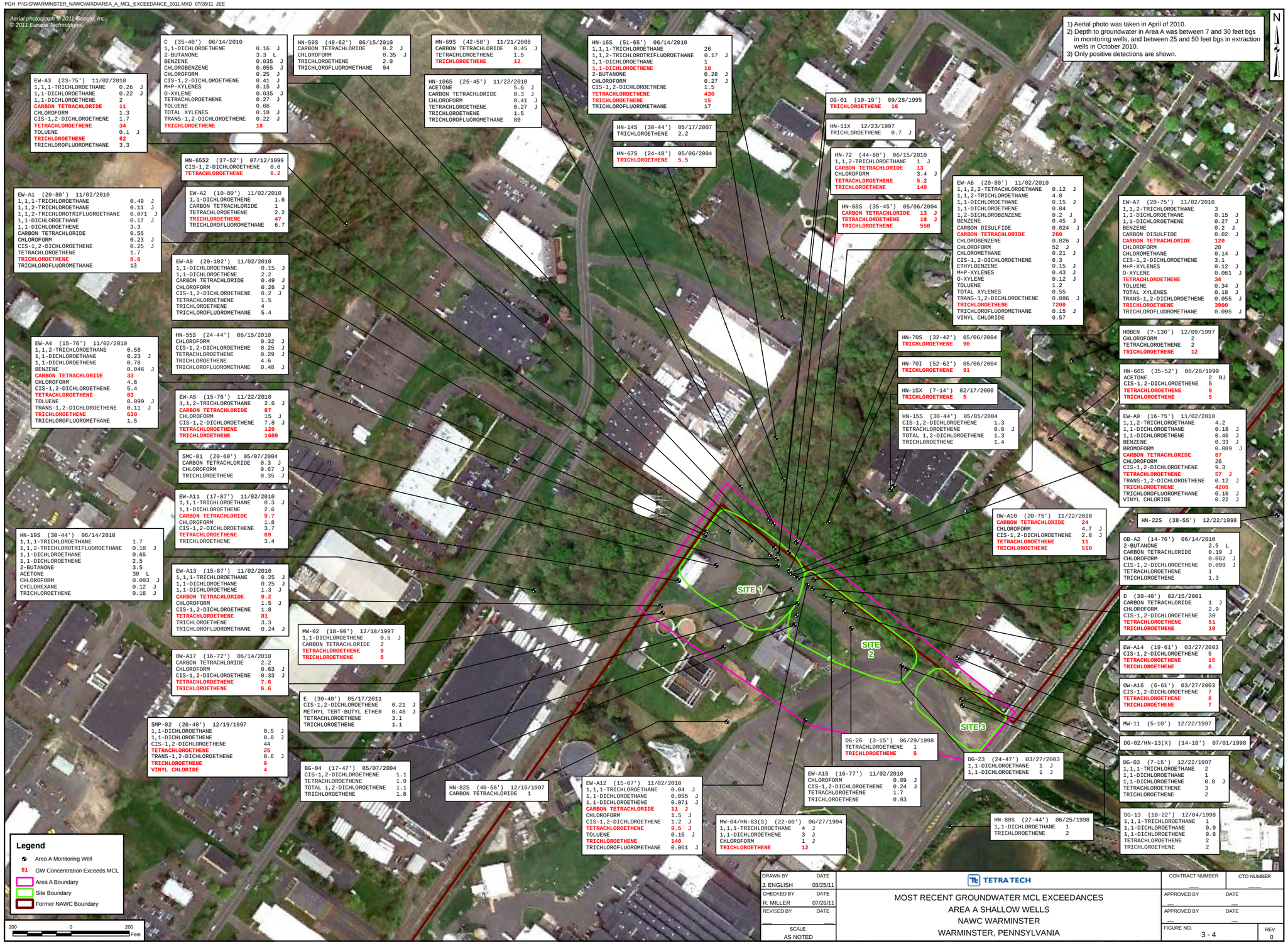
HN-17(S)
19
0.78
0.22 J

200 0 200 Feet

Note: WMA-26 PCE concentrations were assigned to Unit A, and TCE concentrations were assigned to Unit B for contouring purposes.

DRAWN BY T. WHEATON	DATE 09/14/10	TETRA TECH	CONTRACT NUMBER WE23
CHECKED BY E. GLICK	DATE 09/27/10	ISOCONCENTRATION MAP OU-1A HYDROGEOLOGIC UNIT B AREA A SPRING 2010 NAWC WARMINSTER, PENNSYLVANIA	APPROVED BY — DATE —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 3-3 / REV 0

PGH P:\GIS\WARMINSTER_NAWC\MXD\AREA_A_MCL_EXCEEDANCE_2011.MXD 07/26/11 JEE



4.0 OPERABLE UNIT 3

4.1 INTRODUCTION

Implementation of remedial actions at OU-3 began in approximately 1993 and is ongoing. This five-year review includes an evaluation of approximately 15 years of data and provides a current status update for OU-3. This review is required because contaminated groundwater remains on site at concentrations that do not allow for unlimited use and unrestricted exposure.

4.2 SITE BACKGROUND AND CHRONOLOGY

OU-3 consists of the groundwater underlying and downgradient of Area C that has been impacted by Navy-related releases of contamination. A list of important OU-3 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Basewide Phase I RI activities began
April 1991	Basewide Phase I RI activities completed
May 1992	Basewide Phase II RI and FS activities began
April 1993	Basewide Phase II RI and FS activities completed
December 28, 1993	OU-3 RI/FS began
August 1994	OU-3 RI/FS completed
January 15, 1995	OU-3 treatment system construction began
March 10, 1995	OU-3 ROD signed
March 10, 1995	OU-3 remedial design began
May 1996	OU-3 treatment system construction completed
July 1996	OU-3 remedial action (groundwater extraction and treatment) began
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
September 29, 1999	OU-3 ESD signed
September 7, 2000	OPS for OU-3 signed
October 2010	Annual Performance Monitoring Report for Fiscal Year 2010 at OUs 1A, 3, and 4 and Final SAP for LTM at OUs 1A, 3, and 4
1996 to 2011 (ongoing)	Quarterly to semi-annual performance monitoring reports for OU-1A, OU-3, and OU-4

OU-3 background information, including information about physical characteristics, land and resource use, history of contamination, and initial response and basis for taking action, is presented in Section 2.0.

4.3 REMEDIAL ACTIONS

4.3.1 Remedy Selection

The 1995 ROD established the following RAO for OU-3:

- Restore contaminated groundwater attributable to Area C to a level protective of human health and the environment.

The objective of the OU-3 remedy was to eliminate the unacceptable risk associated with exposure or potential exposure to this groundwater (PCE and thallium were identified risk drivers in the ROD). The ROD documented selection of groundwater extraction, treatment at Area A or Area C, and discharge to surface water at the Area A system outfall. The remedy included the following major components:

- Installation, operation, and maintenance of groundwater extraction wells.

- Installation, operation, and maintenance of an on-base groundwater treatment system located within Area A including precipitation, filtration, air stripping, carbon adsorption, and/or other necessary means of treatment.

- Periodic sampling of treated water to ensure the effectiveness of the treatment system.

- Discharge of treated water to the outfall of the groundwater treatment system constructed pursuant to the OU-1 ROD. The outfall is located along an unnamed tributary of Little Neshaminy Creek.

- Installation, operation, and maintenance of vapor-phase carbon adsorption (if such a unit was necessary to control air emissions).

- Off-base treatment and/or disposal of solid residuals generated during water treatment and control of air emissions (if necessary).

- Monitoring of groundwater in monitoring wells and residential wells.

- Installation and periodic sampling of observation wells to ensure the effectiveness of the groundwater extraction wells.

- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction wells.

- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations.

As stated in the ROD, the OU-3 extraction well system is to continue operation until groundwater sample results confirm that cleanup levels have been attained throughout the plume for 12 consecutive quarters. The cleanup levels established in the ROD for Area C groundwater were based on background concentrations in accordance with Pennsylvania regulations. No estimate was made regarding the length of time to achieve cleanup levels. The time required for cleanup will be dictated by actual sampling results over time.

An ESD for OU-3 was signed on September 29, 1999, to add as an additional component of the remedy institutional controls to prevent the use of groundwater that presented an unacceptable risk to human health and to protect the integrity and effectiveness of the Area C extraction well network.

The selected remedy, as documented in the ROD and modified by the ESD, was determined to be protective of human health and the environment, to attain ARARs, and to be cost effective. The remedy complies with action- and location-specific ARARs, and eventual compliance with chemical-specific ARARs will be verified by monitoring.

4.3.2 Remedy Implementation

Groundwater Extraction and Treatment System

Construction of the OU-3 remedy began in January 1995, commencing with construction of the treatment plant building for the interim remedy for OU-1. Extraction wells for Area C were installed between January and May 1995. The Navy completed construction of the groundwater treatment plant in May 1996, and the groundwater extraction system for OU-3 became operational in July 1996.

The groundwater remediation system for OU-3 currently includes a groundwater extraction system comprising six extraction wells (EW-C16 through EW-C21) designed to contain and capture PCE-contaminated groundwater associated with OU-3. The extraction wells were installed along the fence line adjacent to Kirk Road to depths ranging from 70 to 143 feet. The total current pumping rate is approximately 20 gpm. Three extraction wells, EW-C16, EW-C17, and EW-C21, are currently inactive because contaminant concentrations in these wells have decreased to less than the MCL for PCE. They are, however, operational and could be used in the future if performance monitoring data indicate that their operation would increase the effectiveness of the groundwater remedy.

In July 1999, modifications inside the treatment plant were made to treat only Area C groundwater using liquid carbon adsorption vessels. The discharges from the extraction wells are routed to the groundwater treatment plant located along the western edge of Area A for treatment via air stripping and/or carbon adsorption. The transfer line for OU-3 groundwater is configured such that the water can be routed through the entire treatment system or can bypass all but the final carbon adsorption portion of the treatment process. Due to low concentrations of PCE in the groundwater, the current operation includes bypass of the pretreatment and air stripping components of the treatment plant, with contaminant removal achieved through carbon adsorption only.

Land Use Controls

In September 2000, the Navy began the process of transferring the remaining property in the vicinity of Area C to the FLRA as part of an EDC. The associated Finding of Suitability to Transfer (FOST) was signed by the Navy on October 2, 2000. LUCs specified in the OU-3 ESD were included in the conveyance documents for this property. As described in these documents, the LUCs prohibit extraction and use of Area C groundwater by current and future landowners.

LUCs were implemented in accordance with the 1999 ESD to prevent the use of Area C groundwater as long as it presents an unacceptable risk and to protect the integrity and effectiveness of the extraction well network (U.S. Navy and USEPA, 1999a). LUCs must remain in place so long as a threat to human health and the environment is posed by Area C groundwater and include those that address previously owned Navy property and private property that was never owned by the Navy. The groundwater LUCs addressing previously owned Navy property consist of restrictions on the future installation of wells and/or the use of water from wells installed in the future. Supply wells will not be installed, and groundwater otherwise will not be withdrawn without the approval of the Navy and/or USEPA. The need for such restrictions was identified in FOSTs issued by the Navy, and these restrictions were included in the leases entered into for the transfer of property. As described for OU-1A, LUCs for affected private property within Warminster Township consist of the continued enforcement by the Township of Warminster of its Ordinance No. 32, which regulates well drilling in Warminster Township (Township of Warminster, 1955). The LUCs will remain in place as long as a threat to human health and the environment is posed by impacted groundwater attributable to Area C and as long as the Area C extraction well network remains in operation.

A LUCIP was prepared in 2009 to ensure and document compliance with LUCs and/or deed restrictions required for sites at the former NAWC Warminster, including previously transferred property and other private property impacted by Navy IR sites (ECOR Solutions, Inc., 2009). Annual LUC inspections are conducted to document continued maintenance of the required restrictions. For OU-3, this includes confirmation that Area C-impacted groundwater is not being used for any purpose. The results of annual

LUC inspections indicate that the Area C groundwater LUCs are being implemented as required (Tetra Tech, 2010b).

Long-Term Groundwater Monitoring

The OU-3 long-term groundwater monitoring program is currently being implemented in accordance with the Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Long-Term Monitoring, Operable Units 1A, 3, and 4 (Tetra Tech, 2010a), which replaces previous monitoring program documents including Long-Term Performance Monitoring Plan for Operable Units 1A, 3, and 4 (ECOR, 2005a), QAPP for Long-Term Environmental Monitoring at OUs 1A, 3, and 4 (ECOR, 2005b), SAP for Former NAWC, Warminster (ECOR, 2006c), and Final Diffusion Sampling Plan for Long-Term Environmental Monitoring at the Former NAWC Warminster (Battelle, 2002).

Performance monitoring has included the collection and analysis of groundwater samples from extraction wells and selected nearby monitoring wells, collection and mapping of periodic rounds of water levels, and evaluation of the resultant data. WTMA public water supply well WMA-13 is located downgradient of the OU-3 source area, and this well in included in the performance monitoring program. Numerous performance monitoring reports have been generated to date, including the Pre-Startup and Startup Performance Monitoring Report (EA Engineering, 2000b), Performance Monitoring Reports for quarterly events conducted from 1997 to 2008, and Performance Monitoring Reports for semi-annual events conducted in 2009 and 2010.

The results of the May/June and November 2010 long-term performance monitoring indicate that hydraulic containment of OU-3 groundwater contamination is being achieved (see Figure 4-1). The combined instantaneous pumping rate for OU-3 measured on May 27, 2010, was 28.2 gpm, and the calculated average pumping rate for the 5-month period from May 27, 2010, to November 2, 2010, was 22.97 gpm. As of November 2010, the total volume of water pumped since system startup is 174,194,826 gallons (Tetra Tech, 2011b). The 2010 Semi-Annual and Annual Performance Monitoring Reports also indicate that progress is being made to restore groundwater quality to levels protective of human health and the environment (see Figure 4-2) (Tetra Tech, 2011a and 2011b).

4.3.3 Remedy Cost

The capital cost for construction of the treatment plant was estimated in the ROD as between $1,186,852 and $1,839,690. The costs included installation of the groundwater extraction and treatment system and any necessary liquid or air discharge controls, depending on the need to meet emission standards. The actual cost for implementation of the remedy has not yet been tabulated.

4.3.4 System Operations/Operation and Maintenance

An O&M plan is in place and being implemented for the OU-3 remedy provides operating information, troubleshooting, and maintenance relative to the extraction well pumps and pump controllers, transfer sump and pump, and treatment system. A revised O&M Manual was finalized in June 2009 to incorporate changes to the system over time based on changes in contaminants and concentrations (Tetra Tech, 2009a). The treatment system was originally designed to remove organic and inorganic contaminants and initially included pH adjustment, chemical oxidation, precipitation, clarification, sand filtration, neutralization, sludge thickening, and sludge dewatering. These units were taken off line in 2006 and have not been used since. The sludge dewatering equipment was never used. To simplify the O&M Manual, references to the off-line units were deleted.

Operation, maintenance, and system monitoring activities associated with the groundwater extraction and treatment system are conducted in accordance with the current O&M Manual.

O&M Cost

An annual O&M cost ranging from $214,729 to $244,444 was estimated in the ROD. The costs included O&M of the groundwater extraction and treatment system (including water and air emission treatment wastes as necessary to meet standards) and groundwater/effluent monitoring. The Navy's O&M cost records were not available for review; however, their estimate is an average of $500,000 per year. This estimated cost includes O&M of the system addressing OU-1A, OU-3, and OU-4. The actual cost for implementation of the remedial design has not yet been tabulated because remedial actions are ongoing.

OPS Determination

In September 2000, the Navy submitted a technical demonstration document to support the determination that the OU-3 remedy was OPS based on an evaluation of remedy performance using groundwater monitoring well and extraction well data as related to the RAO and cleanup goals. The Navy demonstrated that a well-developed cone of depression has formed within the hydrologic unit with maximum concentrations of VOCs around the Area C extraction wells, which indicated that inward gradients have been achieved in the plume area along the base boundary. The capture zone analysis showed that capture of the plume exists to a point off base and that the source area has been hydraulically controlled. Analysis of data collected during six sampling events since 1997 as part of RI/FS studies, interim environmental monitoring efforts, and treatment system performance monitoring indicated that the groundwater plume was contained in the vicinity of the base boundary and that overall groundwater contaminant concentrations were remaining at steady state or decreasing. The data further indicated that natural attenuation processes (primarily dilution and dispersion) are active and are limiting the migration of contaminants from the source area within Area C.

4.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-3.

Recommendations/ Required Actions	Previous Milestone Date	Current Status
Finalize the remediation optimization report and make it available to O&M and inspection contractors.	ASAP	The Optimization Report was finalized in August 2007.
O&M manual revisions and updating (as needed) to reflect intended operating procedures.	Ongoing	A revised O&M Manual was submitted in June 2009.
Document revised cleanup goals for groundwater remediation. Issue direction to O&M contractor to bypass the ion exchange unit and consider returning or recycling the equipment.	Summer 2006	Not yet completed. The ion exchange unit cannot be bypassed because it is required for Area A groundwater and water from Areas A and C are blended prior to the unit. A pH adjustment is currently being designed to make the unit more efficient.
Abandon the identified monitoring wells along Kirk Road.	Summer 2006	This has been completed for all residences to which the Navy was allowed access.
Prepare a strategy for attainment of cleanup goals and evaluate predicted cleanup durations. Propose alternatives for decreasing cleanup durations, if appropriate.	Winter 2006	Although potential source area treatment was evaluated (chemical oxidation), it was not successful, and it is not expected that pumping and treatment of groundwater will be terminated in the near future.
Additional investigation to identify the source of higher PCE concentrations.	Winter 2006	This was completed in 2007; no residual PCE source was found.
Install air stripper on WMA 13 (optional at WTMA's discretion).	To be determined	This has not been implemented by WTMA at this time.
Obtain formal access agreements for off-site monitoring wells.	2006/2007	Not yet completed – low priority.

Although the OU-3 vapor intrusion screening assessment included in the previous Five-Year Review Report indicated that risks were acceptable for residents and occupational workers, additional evaluation is in progress. The following tasks were proposed, as needed, to assess potential current vapor intrusion impacts to Gilda's House (located on Kirk Road north of EW-C19) and residences across Kirk Road:

- Sampling and analysis of wells DG-14 and HN-23A for VOCs.

- Evaluation of the concentrations and distribution (depths of fractures) of VOCs in EW-C20 via packer

sampling, vertical profiling, and review of existing borehole logs, and evaluation of building construction in the EW-C20 area (presence of vapor barriers or sub-slab ventilation systems.

- Identification and evaluation of historical data from wells near homes across Kirk Road

Samples were collected from DG-14 and HN-23S for VOC and PFOA analyses on May 17, 2011, and results are presented in Table 4-1 and on Figure 4-1. At HN-23S, concentrations of PCE (160 and 170 µg/L in the sample and duplicate) and vinyl chloride (2.9 µg/L in sample and duplicate) exceeded their MCLs (5 and 2 µg/L, respectively). Low concentrations of VOCs, less than 1 µg/L, were detected at DG-14. Trace levels of PFOA were detected. There are no buildings located within 100 feet of HN-23S. Additional evaluation based on these results, as outlined above, will be conducted to assess potential vapor intrusion impacts in the EW-C20 area and north of Kirk Road and to assess potential vapor intrusion issues for future on-site and near-site buildings.

4.5 FIVE-YEAR REVIEW PROCESS

4.5.1 Document and Analytical Data Review

This third five-year review consisted of a review of relevant documents for OU-3 including the ROD, O&M Manual, and performance monitoring reports. Construction of the remedial action (extraction well and groundwater treatment system installation) has been completed, and O&M of the treatment system and long-term performance monitoring are ongoing.

4.5.2 Site Inspection

A site inspection was conducted in April 2011. No unusual observations were documented during the visit. The Five-Year Review Site Inspection Checklist and photographs from the April 2011 inspection are included in Appendix A.

4.6 TECHNICAL ASSESSMENT

4.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The OU-3 ROD required the restoration of groundwater in Area C. A subsequent ESD added requirements for institutional controls prohibiting the use of groundwater within the area of contamination, including the prohibition of installation of new wells within this area. The institutional controls addressing former Navy property consist of restrictions on the use of water from existing wells and restrictions on the future installation of wells and/or the use of water from wells installed in the future. These controls were included in the FOSTs for various parcels of property in the vicinity of Area C and were incorporated into

the deeds transferring the parcels. The controls for off-base property are enforced through Warminster Township Ordinance No. 32, which regulates well drilling north of Area C. Performance monitoring reports indicate that contaminants are being contained within the intended zone and are not resulting in adverse effects to groundwater quality in downgradient areas.

The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. Based on activities that have been completed (groundwater extraction and treatment system installation and operation) and activities that are ongoing (system O&M, performance monitoring, and LUCs), the intent and goals of ROD have been or will be met, and there are no deficiencies or early indicators of potential remedy failure.

4.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

No changes in exposure pathways, toxicity, contaminant characteristics, or risk assessment methods have occurred since the previous five-year review that would affect progress towards meeting RAOs. No changes to site conditions have been identified. No new receptors or potential receptors that could be affected by OU-3 contaminated groundwater have been identified.

Based on the results of the vapor intrusion assessment included in the previous Five-Year Review Report (see Section 4.4), current residential and occupational risks associated with potential vapor intrusion at OU-3 were determined to be acceptable. To further evaluate current vapor intrusion impacts, additional evaluation is in progress. Potential future vapor intrusion risks associated with construction of new buildings in the area will be addressed through completion of a vapor intrusion assessment to determine:

- Whether or not vapor intrusion issues present an unacceptable potential risk to future receptors

and if so:

- The specific area(s) where potential future vapor intrusion risks need to be addressed

The Navy will work with USEPA and PADEP to complete the vapor intrusion assessment and implement actions to address vapor intrusion risks if necessary. If additional actions (i.e., LUCs) are determined to be needed, the ROD and current LUCs will be reviewed to determine the appropriate mechanism(s) for implementing the additional actions.

4.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No additional human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

Significantly elevated PCE concentrations (up to approximately 300 µg/L) were detected in monitoring well HN-23A in Area C after its installation in 2002 (as a replacement for HN-23S). Extraction well concentrations have not increased, however, and the new monitoring well is within the capture zone of the extraction system; therefore, the remedy is still protective.

4.6.4 Technical Assessment Summary

The remedy is functioning in providing the required protection to human health as required by the ROD and ESD. Since the last 5-year review, no changes to contaminant characteristics, site conditions, or standards that could adversely affect the protectiveness of the remedy have occurred.

4.7 ISSUES

No deficiencies were identified during this five-year review of the OU-3 remedy, and no issues related to current site operations, conditions, or activities prevent the remedy from currently being protective. Although the previous vapor intrusion assessment indicated no unacceptable vapor intrusion risks for residential or occupational exposure, further evaluation of potential current risks is ongoing. Groundwater sampling was conducted in 2011, and the following additional activities are planned:

- Evaluation of EW-C20 via packer sampling, vertical profiling, and/or evaluation of building construction and historical groundwater data, with further investigation as necessary, to determine if contaminants detected in this area and across the street are present in shallow or intermediate fracture zones. In addition, existing borehole logs will be evaluated.

- Identification and evaluation of historical data for homes across Kirk Road, and further investigation if necessary based on the results of the evaluation.

Additional vapor intrusion assessment will also be conducted to determine if any additional actions are needed to address potential future vapor intrusion issues associated with future on-site or near-site buildings

These issues are summarized in the table below.

Issue	Affects Protectiveness?	
	Current	Future
Additional evaluation of potential current vapor intrusion impacts needs to be completed	No(1)	TBD(1)
Vapor intrusion assessment of future potential risks needs to be completed	No	TBD

1 Results of the vapor intrusion evaluation during the previous five-year review (Johnson and Ettinger Model) indicated acceptable residential and occupational risks.

4.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and five-year review are as follows.

Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
				Current	Future
Complete additional evaluation of potential current vapor intrusion impacts	Navy	USEPA and PADEP	2011-2012	No(1)	Yes(1)
Complete vapor intrusion assessment to determine whether there are unacceptable potential future risks; address if/as necessary	Navy	USEPA and PADEP	2012-2013	No	TBD(1)

1 Could affect future protectiveness if future vapor intrusion risks are unacceptable and if future buildings are constructed without appropriate mitigation measures over areas with unacceptable risks.

A recommendation included in the previous Five-Year Review report that does not affect the protectiveness of the OU-3 remedy includes documentation of revised cleanup goals for groundwater remediation. This issue involves the use of the MCL as the cleanup goal for PCE and the elimination of thallium as a COC for OU-3 (PCE and thallium were the only COCs in the ROD). The 1995 ROD for OU-3 did not list numerical groundwater cleanup levels but cited "background concentrations for contaminated groundwater" per 25 Pennsylvania Code Sections 264.90 through 264.100 as the chemical-specific ARARs for the remedy. It was since decided that the appropriate cleanup level for PCE is the federal MCL of 5 µg/L, and this is the criterion being used for comparisons to OU-3 performance monitoring results. However, this change in the cleanup goal (chemical-specific ARAR) has not been documented.

As stated in the First Five-Year Review Report, thallium was detected at 5.1 µg/L in only 1 of 34 samples in unfiltered Area C groundwater samples. The well with the thallium detection was a deep upgradient monitoring well located near Site 4, and thallium was not detected in filtered samples. Based on this information, it was determined prior to the beginning of performance monitoring that thallium was not an OU-3-related contaminant. Thallium was never included in the performance monitoring program, and as

of July 1999, the groundwater treatment system no longer treats extracted Area C groundwater for metals including thallium. The determination that thallium is not an OU-3 COC was also never documented.

Although these issues do not affect the protectiveness of the OU-3 remedy, it is recommended that the change in the chemical-specific ARAR for PCE be documented via an ESD and that the determination that thallium is not an OU-3-related COC be documented via a memorandum to the site file or as part of the above-mentioned ESD.

4.9 PROTECTIVENESS STATEMENT

The implemented remedy at OU-3 is protective of human health and the environment. The contaminated groundwater treatment remedy was implemented as designed and has been determined to be OPS. Contaminant migration is being adequately contained, and removal of contamination is progressing towards attainment of cleanup goals. LUCs to prevent exposure to and use of groundwater have been implemented, are being maintained and monitored, and provide a significant amount of protection until completion of the remedy is achieved to provide full protectiveness. The results of future monitoring will be used to continue to evaluate the effectiveness of the remedy. The groundwater remedial actions have been implemented as designed and include measures that prevent exposure. The remedial actions that are completed (implementation of LUCs) and ongoing (groundwater extraction and treatment and performance monitoring) are operating as designed. Future protectiveness of the remedy will be verified by continued monitoring in accordance with the SAP and by continuation of existing LUCs. In addition, a vapor intrusion assessment will be completed, and based on the results, any additional actions that may be required to ensure current and future protectiveness will be implemented. Based on the activities that are completed and ongoing, the intent and goals of the OU-3 ROD have been or will be met.

TABLE 4-1
MAY 2011 AREA C GROUNDATER RESULTS
THIRD FIVE-YEAR REVIEW REPORT
FORMER NAWC WARMINSTER, PENNSYLVANIA

PARAMETER	MCL	DG-14	HN-23A	
			Sample	Duplicate
PENTADECAFLUOROOCTANOIC ACID (µg/L)	NC	**1.5**	**1.6**	**1.6**
VOLATILE ORGANIC COMPOUNDS (µg/L)				
1,1,1-TRICHLOROETHANE	200	0.2 U	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	NC	0.4 U	0.4 U	0.4 U
1,1,2-TRICHLOROETHANE	5	0.4 U	0.4 U	0.4 U
1,1,2-TRICHLOROTRIFLUOROETHANE	NC	3 U	3 U	3 U
1,1-DICHLOROETHANE	NC	0.2 U	0.2 U	0.2 U
1,1-DICHLOROETHENE	7	0.2 U	0.2 U	0.2 U
1,2,3-TRICHLOROBENZENE	NC	0.4 U	0.4 U	0.4 U
1,2,4-TRICHLOROBENZENE	70	0.8 U	0.8 U	0.8 U
1,2-DIBROMO-3-CHLOROPROPANE	0.2	1.6 U	1.6 U	1.6 U
1,2-DIBROMOETHANE	NC	0.2 U	0.2 U	0.2 U
1,2-DICHLOROBENZENE	600	0.2 U	0.2 U	0.2 U
1,2-DICHLOROETHANE	5	0.2 U	0.2 U	0.2 U
1,2-DICHLOROPROPANE	5	0.2 U	0.2 U	0.2 U
1,3-DICHLOROBENZENE	NC	0.2 U	0.2 U	0.2 U
1,4-DICHLOROBENZENE	75	0.4 U	0.4 U	0.4 U
2-BUTANONE	NC	3.2 UR	**6.9 J**	**6.9 J**
2-HEXANONE	NC	3.2 UR	3.2 UR	3.2 UR
4-METHYL-2-PENTANONE	NC	3.2 U	3.2 U	3.2 U
ACETONE	NC	6.4 UR	**300 J**	**280 J**
BENZENE	5	0.2 U	0.2 U	0.2 U
BROMODICHLOROMETHANE	80*	**0.76 J**	0.2 U	0.2 U
BROMOFORM	80*	0.4 U	0.4 U	0.4 U
BROMOMETHANE	NC	0.4 U	0.4 U	0.4 U
CARBON DISULFIDE	NC	0.8 U	0.8 U	0.8 U
CARBON TETRACHLORIDE	5	0.4 U	0.4 U	0.4 U
CHLOROBENZENE	100	0.2 U	0.2 U	0.2 U
CHLORODIBROMOMETHANE	NC	**0.2 J**	0.4 U	0.4 U
CHLOROETHANE	NC	1.6 U	1.6 U	1.6 U
CHLOROFORM	80*	**0.43 J**	0.2 U	**0.2 J**
CHLOROMETHANE	NC	1.6 U	1.6 U	1.6 U
CIS-1,2-DICHLOROETHENE	70	0.2 U	**29**	**28**
CIS-1,3-DICHLOROPROPENE	NC	0.2 U	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE	80*	0.8 U	0.8 U	0.8 U
ETHYLBENZENE	700	0.2 U	0.2 U	0.2 U
ISOPROPYLBENZENE	NC	0.4 U	0.4 U	0.4 U
M+P-XYLENES	NC	0.8 U	0.8 U	0.8 U
METHYL TERT-BUTYL ETHER	NC	0.4 U	**0.47 J**	0.4 U
METHYLENE CHLORIDE	5	0.4 U	0.4 U	0.4 U
O-XYLENE	NC	0.4 U	0.4 U	0.4 U
STYRENE	100	0.4 U	0.4 U	0.4 U
TETRACHLOROETHENE	5	**0.3 J**	**160 J**	**170 J**
TOLUENE	1,000	0.4 U	0.4 U	0.4 U
TOTAL XYLENES	10,000	1.6 U	1.6 U	1.6 U
TRANS-1,2-DICHLOROETHENE	100	0.2 U	0.2 U	0.2 U
TRANS-1,3-DICHLOROPROPENE	NC	0.4 U	0.4 U	0.4 U
TRICHLOROETHENE	5	0.2 U	**4.3**	**4.1**
TRICHLOROFLUOROMETHANE	NC	0.8 U	0.8 U	0.8 U
VINYL CHLORIDE	2	0.8 U	**2.9**	**2.9**

Wells sampled on May 17, 2011.
MCL - Maximum Contaminant Level.
NC - No criterion.
U - Not detected at associated detection limit.
J - Estimated concentration.
R - Rejected.
* MCL is for for total trihalomethanes.

Detected concentrations are bolded; MCL exceedances are shaded.

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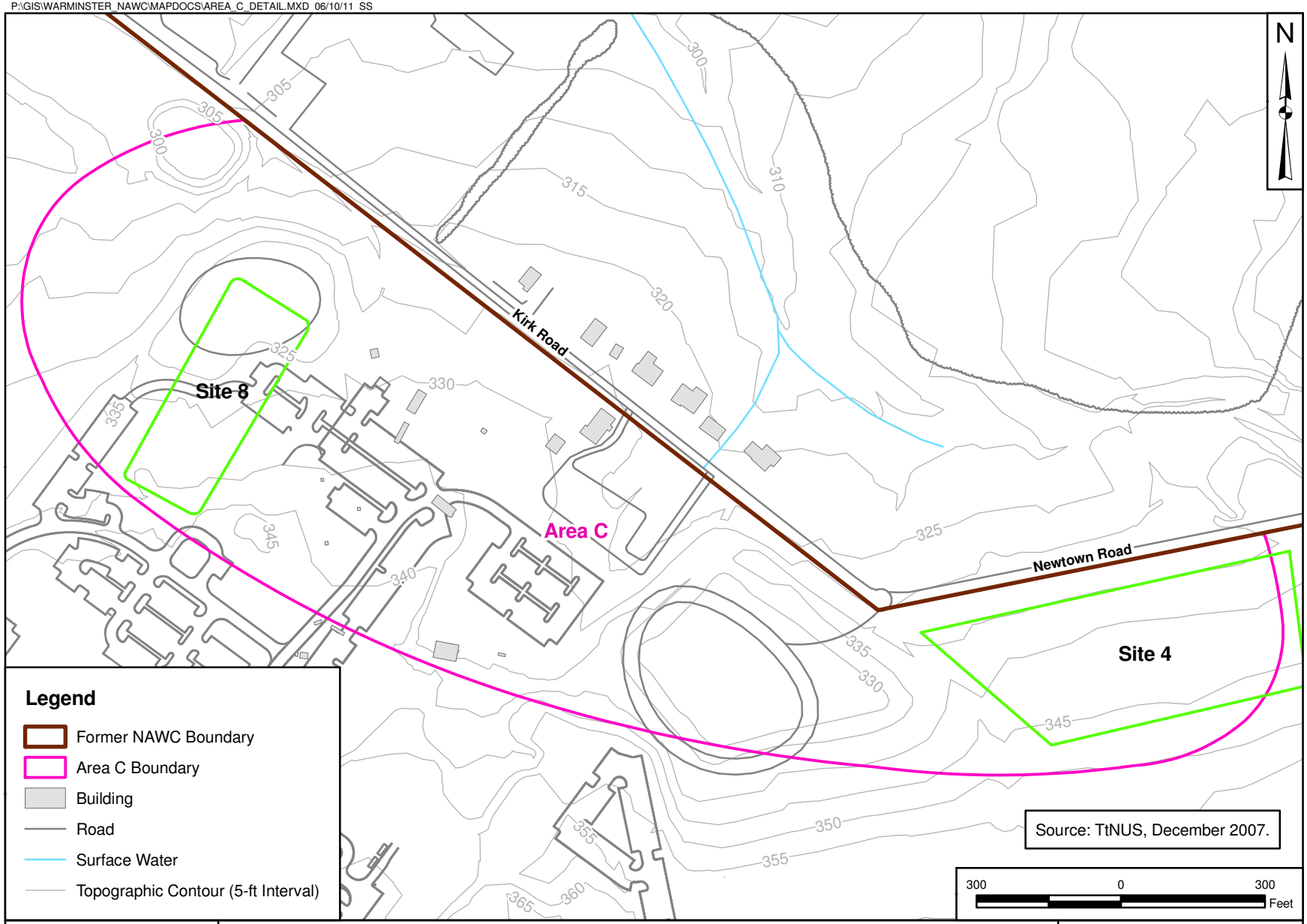

DRAWN BY J. ENGLISH	DATE 02/25/10	TETRA TECH	CONTRACT NUMBER CTO WE23
CHECKED BY R. MILLER	DATE 06/10/11	AREA C DETAIL MAP NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	APPROVED BY ___ DATE ___
REVISED BY S. STROZ	DATE 06/10/11		APPROVED BY ___ DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 4-1 / REV 0

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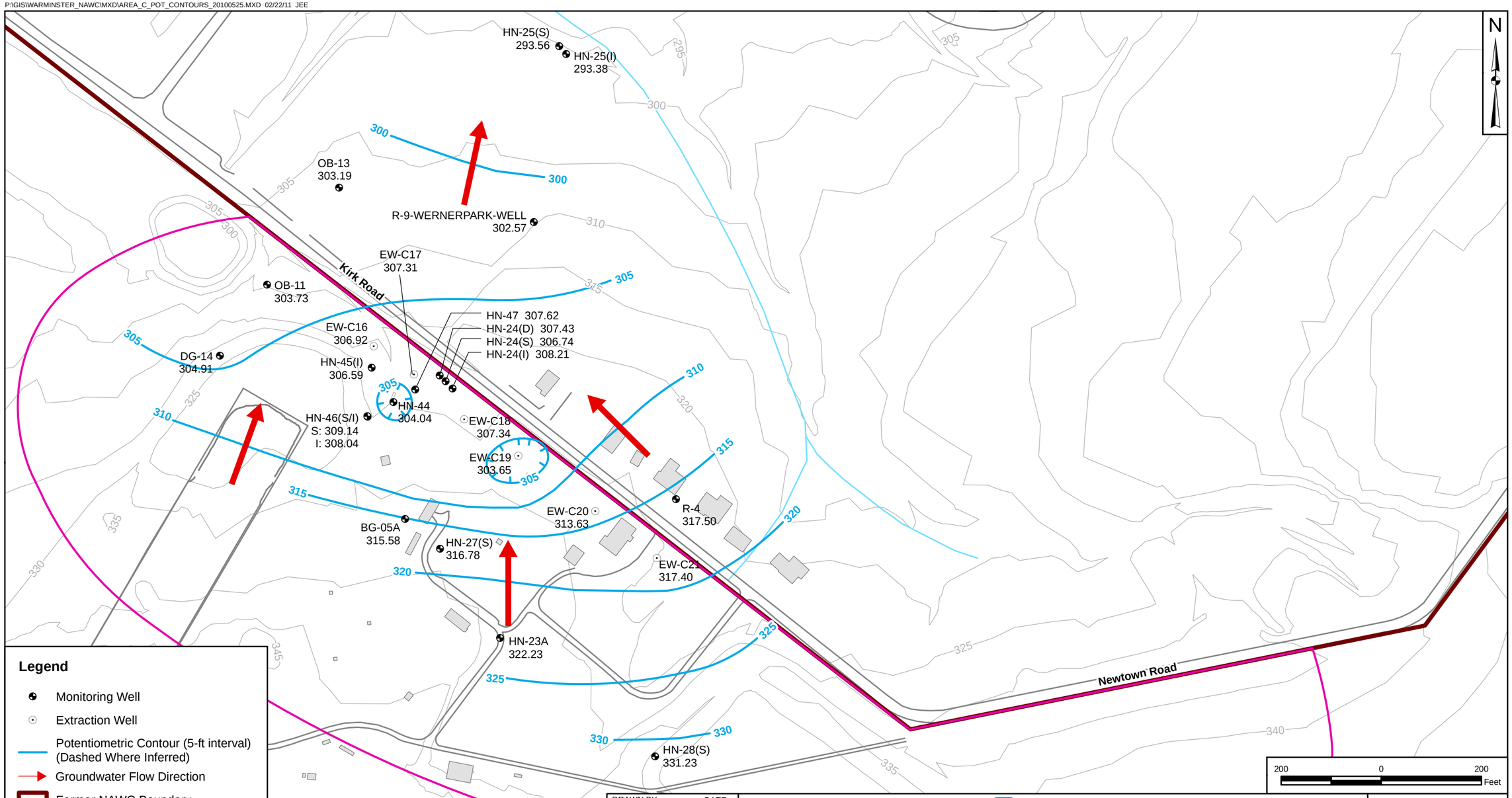

Legend

- Monitoring Well
- Extraction Well
- Potentiometric Contour (5-ft interval) (Dashed Where Inferred)
- Groundwater Flow Direction
- Former NAWC Boundary
- Area C Boundary
- Roads
- Surface Water
- Topographic Contour (5-ft Interval)

DRAWN BY	DATE
K. MOORE	09/09/10
CHECKED BY	DATE
J. ENGLISH	02/21/11
REVISED BY	DATE
J. ENGLISH	02/22/11
SCALE	
AS NOTED	

TETRA TECH

POTENTIOMETRIC SURFACE MAP
SHALLOW HYDROGEOLOGIC UNIT
MAY 25, 2010
AREA C
NAWC WARMINSTER, PENNSYLVANIA

CONTRACT NUMBER	
WE23	
APPROVED BY	DATE
___	___
APPROVED BY	DATE
___	___
FIGURE NO.	REV
FIGURE 4-2	0

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N

WMA-13
ND(0.5)

HN-25(I)
3.5

R-9-WERNER PARK-WELL
3.5

1

EW-C17
0.44 J

EW-C18/HN-48
20

EW-C19
12

EW-C20
14

BG-05A
5.3

HN-27(S)
1.7

EW-C21
2.2

HN-23A
160

100

10

5

1

HN-28(S)
ND(0.5)

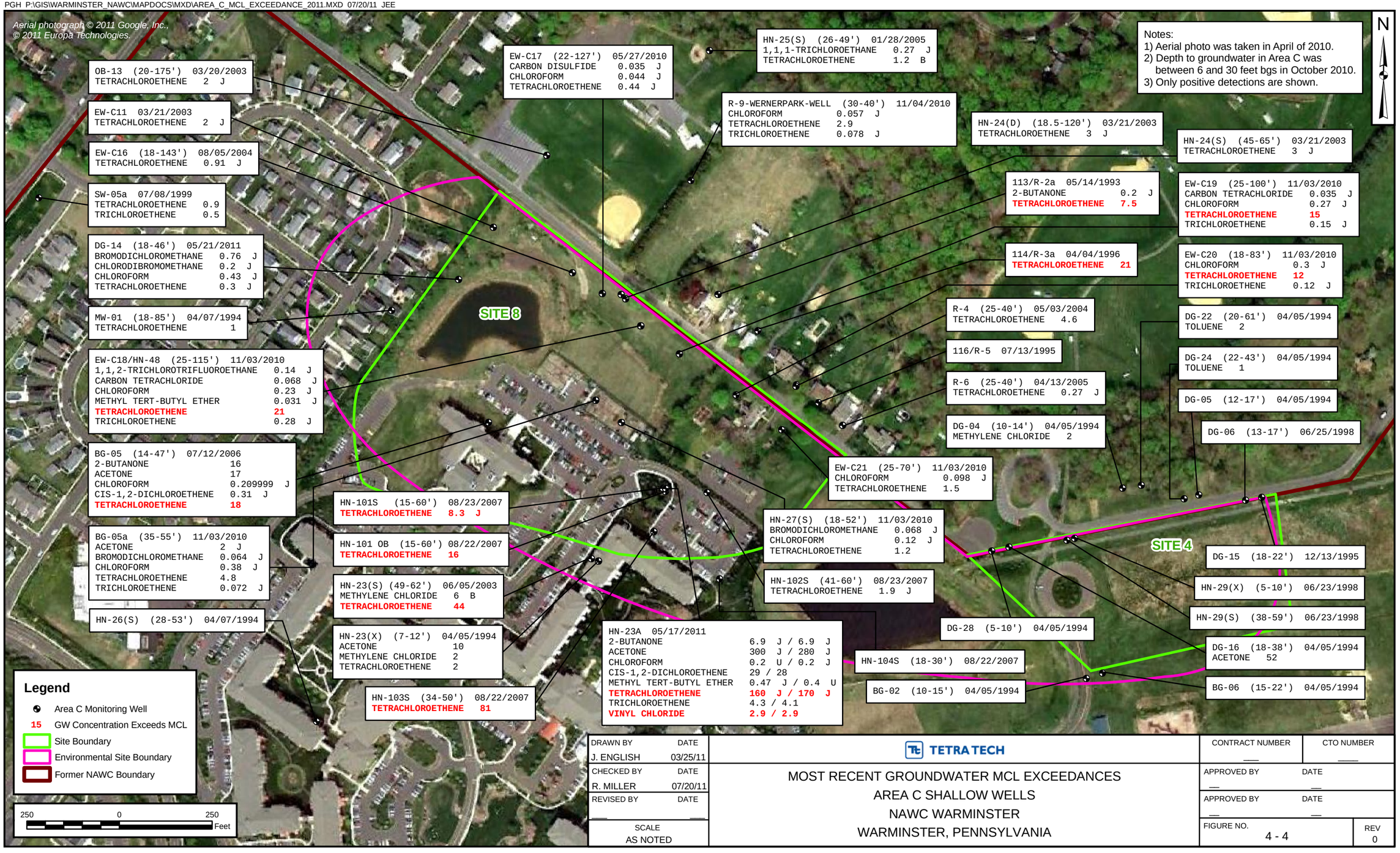
200 0 200
Feet

Legend

- Monitoring Well Location
- Extraction Well
- Water Supply Well
- 2.2 — PCE Concentration (ug/L)
- J — Estimated Value
- ND (1.0) — Not Detected (Reporting Limit)
- PCE Isoconcentration Contour (Dashed Where Inferred)
- Area C Boundary
- Former NAWC Boundary
- Building
- Road

DRAWN BY T. WHEATON	DATE 09/14/10	TETRA TECH	CONTRACT NUMBER WE23
CHECKED BY E. GLICK	DATE 09/27/10	PCE ISOCONCENTRATION MAP OU-3 SHALLOW HYDROGEOLOGIC UNIT AREA C SPRING 2010 NAWC WARMINSTER, PENNSYLVANIA	APPROVED BY ___ DATE ___
REVISED BY ___	DATE ___		APPROVED BY ___ DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 4-3 / REV 0

PGH P:\GIS\WARMINSTER_NAWC\MAPDOCS\MXD\AREA_C_MCL_EXCEEDANCE_2011.MXD 07/20/11 JEE



DRAWN BY / DATE	J. ENGLISH 03/25/11
CHECKED BY / DATE	R. MILLER 07/20/11
REVISED BY / DATE	— —
SCALE	AS NOTED

TETRA TECH

MOST RECENT GROUNDWATER MCL EXCEEDANCES
AREA C SHALLOW WELLS
NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NUMBER	CTO NUMBER
—	—
APPROVED BY / DATE	— —
APPROVED BY / DATE	— —
FIGURE NO.	REV
4 - 4	0

5.0 OPERABLE UNIT 4

5.1 INTRODUCTION

Implementation of remedial actions at OU-4 began in approximately 1994 and is ongoing. This five-year review includes an evaluation of approximately 16 years of data and provides a current status update for OU-4. This review is required because contaminated groundwater remains on site at concentrations that do not allow for unlimited use and unrestricted exposure.

5.2 SITE CHRONOLOGY AND BACKGROUND

OU-4 encompasses groundwater contamination attributable to releases within Area D of the former NAWC Warminster. A list of important OU-4 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Basewide Phase I RI activities began
April 1991	Basewide Phase I RI activities completed
May 1992	Basewide Phase II RI and FS activities began
April 1993	Basewide Phase II RI and FS activities completed
October 1, 1993	Final Focused RI/FS start for OU-1A, OU-1B, and OU-4
August 27, 1994	Interim OU-4 RI/FS began
October 1996	Interim OU-4 RI/FS completed
September 30, 1997	Interim OU-4 ROD signed
October 1, 1997	Final RI/FS for OU-4 began
August 7, 1998	Interim OU-4 remedial design began
October 9, 1998	Interim OU-4 remedial design completed
October 10, 1998	Interim OU-4 remedial action began
July 6, 1999	Interim OU-4 construction complete and pump-and-treat system began
April 2000	OU-4 Final RI/FS completed
June 22, 2000	OPS for OU-4 signed

DATE(S)	EVENT
June 26, 2000	Final OU-4 ROD signed
June 26, 2000	Final OU-4 actual remedial action began
July 28, 2000	Final OU-4 remedial action construction completed
August 20, 2000	Final RI/FS for OU-4 completed
June 2010	Groundwater extraction system taken off line
October 2010	Annual Performance Monitoring Report for Fiscal Year 2010 at OUs 1A, 3, and 4 and Final SAP for LTM at OUs 1A, 3, and 4
1999 to 2011 (ongoing)	Quarterly to semi-annual performance monitoring reports for OU-1A, OU-3, and OU-4

OU-4 background information, including information about physical characteristics, land and resource use, history of contamination, and initial response and basis for taking action, is presented in Section 2.0.

5.3 REMEDIAL ACTIONS

5.3.1 Remedy Selection

The interim ROD established the following primary RAOs for OU-4:

- Minimize the migration of contaminated groundwater
- Initiate aquifer restoration
- Obtain information about the response of the aquifer to remediation measures

In addition, a secondary RAO was to limit or eliminate unacceptable exposure to the contaminated Area D groundwater while the interim remedy was being implemented.

The interim remedy included the following major components:

- Determination of the contribution of on-base, open, water-supply wells SW-1, SW-2, SW-3, and SW-4 on the vertical distribution of contamination in groundwater.

- Reconstruction or abandonment of the open water-supply wells, as necessary, to limit further contaminant migration.

- Installation, operation, and maintenance of groundwater extraction wells.

- Pumping of contaminated groundwater and conveyance through piping to the existing on-base groundwater treatment system (constructed as part of the OU-1 interim remedy).

- If necessary, installation and monitoring of observation wells to ensure the effectiveness of groundwater extraction wells.

- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction system.

- Modification of the groundwater extraction well system as necessary based on periodic evaluations.

- O&M of the existing on-base groundwater treatment system and expansion of this system if necessary to treat extracted groundwater from Area D.

- Periodic sampling of treated water to ensure the effectiveness of the treatment system.

- Monitoring of treated water to ensure the effectiveness of the treatment system.

- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek.

- Installation and O&M of vapor-phase carbon adsorption units as necessary to control air emissions from the treatment system.

- Off-base treatment and/or disposal of solid residuals generated during water treatment.

- Monitoring of groundwater in off-base monitoring wells.

- Institutional controls to prevent the use of groundwater that presents an unacceptable health risk.

- A review of the remedy on a 5-year basis.

The OU-4 ROD did not specify groundwater cleanup concentrations for the interim remedy. No estimate was made regarding the length of time to achieve cleanup.

Treatment of groundwater extracted under the interim remedy for OU-4 was via a groundwater treatment plant that was initially constructed as part of the interim remedy for Area A and Area B groundwater (OU-1) and the final remedy for the Area C groundwater (OU-3).

After the nature and extent of contaminated groundwater underlying Area D was determined, and considering the information generated during implementation of the interim remedial action, the final remedy ROD for OU-4 was issued on June 26, 2000. The final ROD established the following RAOs for OU-4:

- Prevent the use of contaminated Area D groundwater that presents an unacceptable risk.

- Restore Area D groundwater to remedial action levels protective of human health. The remedial action level in this case was the federal MCL for TCE, which is 5 µg/L.

The major components of the final OU-4 remedy, as listed in the ROD, included the following:

- Continued operation of the existing groundwater extraction system with conveyance to the existing treatment plant via existing transfer lines.

- Continued treatment of extracted groundwater in the existing plant.

- Continued discharge of treated groundwater to the unnamed tributary of Little Neshaminy Creek and continued monitoring of treated water to ensure the effectiveness of the treatment system.

- Natural attenuation processes (e.g., dilution and dispersion) to reduce Area D groundwater contaminant concentrations of concern not captured by the extraction system.

- Groundwater monitoring to monitor the effectiveness of the groundwater extraction system and natural attenuation processes in restoring the beneficial use of the aquifer.

- Implementation of institutional controls to prevent the use of Area D groundwater as long as this groundwater presented an unacceptable risk and to protect the integrity and effectiveness of the extraction well system and natural attenuation processes.

- Proper abandonment or reconstruction of supply wells SW-1 and SW-2 to prevent potential vertical contaminant migration. (SW-1 was abandoned, and SW-2 was reconstructed and renamed HN-75S).

The final ROD for OU-4 indicated that the groundwater extraction and treatment system would require operation for at least 30 years before achieving cleanup concentrations within the capture zone of the extraction well network and that a combination of the extraction well system and natural attenuation processes would reduce Area D-related TCE concentrations outside the capture zone of the extraction

well system to the MCL of 5 µg/L in 2 to 3 years. Based on VOC results consistently less than cleanup levels in the capture zone, the Area D extraction and treatment system was taken off line in June 2010. During the November 2010 performance monitoring event, concentrations of VOCs were less than MCLs in all wells sampled (Tetra Tech, 2011b).

5.3.2 Remedy Implementation

Construction of the interim remedy began in January 1995, commencing with construction of the treatment plant building for the OU-1 interim remedy. The Navy completed construction of the groundwater treatment plant in June 1996. Drilling and installation of the extraction wells for OU-4 were performed between October 1998 and February 1999, and operation of the groundwater extraction system for OU-4 began in July 1999.

The groundwater remediation system for OU-4 included a source area groundwater extraction system including extraction wells EW-D1 through EW-D8. Wells EW-D9 and EW-D10 were also drilled for use as potential extraction wells; however, based on yield testing and/or water-quality sampling results, the wells were completed as open borehole observation and monitoring wells. The discharges from the extraction wells were routed to the groundwater treatment plant located along the western edge of Area A for treatment via air stripping and carbon adsorption. The OU-4 groundwater extraction system was designed to capture the highly contaminated portion of the volatile organics plume (primarily TCE) before it migrated beyond the former facility boundary. The low-concentration portion of the plume that may extend beyond the capture zone of the extraction system will be remediated through natural attenuation processes, primarily dispersion and dilution.

Further downgradient of the source area extraction system, WTMA Well No. 26 is pumped continuously at an average rate of approximately 200 to 250 gpm. Water from this well is routed through an air stripping unit for treatment before entering the municipal water system. It was expected that natural attenuation processes reduced Area D-related groundwater contamination outside of the capture zone of the extraction system to non-detect concentrations before it reached this well. In June 2010, the Area D extraction system was taken off line because TCE concentrations in groundwater were consistently less than the cleanup level. Extraction wells EW-D6, EW-D7, and EW-D8 were shut down on March 2, 2010, and the remaining extraction wells (EW-D1, EW-D2, and EW-D3) were shut down on June 2, 2010. Natural attenuation processes will be relied on to further remediate the low-concentration diffuse plume associated with OU-4.

Land Use Controls

In September 2000, the Navy transferred property in the vicinity of Area D to the FLRA as part of an EDC. The associated FOST was signed by the Navy on July 5, 2000. LUCs and restrictions specified in the

OU-4 ROD were included in the conveyance documents for this property. As described in these documents, the LUCs prohibit extraction and use of Area D groundwater by current and future landowners.

LUCs were implemented in accordance with the 2000 ROD to prevent the use of Area D groundwater as long as it presents an unacceptable risk. LUCs must remain in place so long as a threat to human health and the environment is posed by Area D groundwater and include those that address previously owned Navy property and private property that was never owned by the Navy. The groundwater LUCs addressing previously owned Navy property consist of restrictions on the future installation of wells and/or the use of water from wells installed in the future. Supply wells will not be installed, and groundwater otherwise will not be withdrawn without the approval of the Navy and/or USEPA. These restrictions were included in the leases entered into for the transfer of property. The need for such restrictions was identified in the FOST issued by the Navy. The LUCs for affected private property within Warminster Township consist of the continued enforcement by the Township of Warminster of its Ordinance No. 32, which regulates well drilling in Warminster Township (Township of Warminster, 1955). The LUCs will remain in place as long as a threat to human health and the environment is posed by impacted groundwater attributable to Area D.

A LUCIP was prepared in 2009 to ensure and document compliance with LUCs and/or deed restrictions required for sites at the former NAWC Warminster, including previously transferred property and other private property impacted by Navy IR sites (ECOR Solutions, Inc., 2009). Annual LUC inspections are conducted to document continued maintenance of the required restrictions. For OU-4, this includes confirmation that Area D-impacted groundwater is not being used for any purpose. The results of annual LUC inspections indicate that the Area D groundwater LUCs are being implemented as required (Tetra Tech, 2010b).

Long-Term Groundwater Monitoring

The OU-4 long-term groundwater monitoring program is currently being implemented in accordance with the Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Long-Term Monitoring, Operable Units 1A, 3, and 4 (Tetra Tech, 2010a), which replaces previous monitoring program documents including Long-Term Performance Monitoring Plan for Operable Units 1A, 3, and 4 (ECOR, 2005a), QAPP for Long-Term Environmental Monitoring at OUs 1A, 3, and 4 (ECOR, 2005b), SAP for Former NAWC, Warminster (ECOR, 2006c), and Final Diffusion Sampling Plan for Long-Term Environmental Monitoring at the Former NAWC Warminster (Battelle, 2002).

Performance monitoring has included the collection and analysis of groundwater samples from extraction wells and selected nearby monitoring wells, collection and mapping of periodic rounds of water levels, and evaluation of the resultant data. Many performance monitoring reports have been generated to date,

including the Pre-Startup and Startup Performance Monitoring Report (EA Engineering, 2000b), Performance Monitoring Reports for quarterly events conducted from 1997 to 2008, and Performance Monitoring Reports for semi-annual events conducted in 2009 and 2010.

Due to the shutdown of the extraction system in June 2010 at Area D, the potentiometric surface within hydrogeologic unit B is no longer affected by pumping (Figure 5-1). TCE concentrations in wells sampled in Area D during the fall 2010 sampling event were all less than the MCL of 5 mg/L, further supporting the decision that the extraction system is no longer needed at Area D (Figure 5-2).

5.3.3 Remedy Cost

The capital cost for construction of the treatment plant was estimated in the ROD at between $675,000 and $800,000. The costs included the installation of the groundwater extraction and treatment system, including any liquid or air discharge controls required depending on the need to meet emission standards. The actual cost for the implementation of the remedy has not yet been tabulated.

5.3.4 System Operations/Operation and Maintenance

During the period of groundwater extraction and treatment, system operation, operation, maintenance, and system monitoring activities were conducted in accordance with the O&M Manual (Tetra Tech, 2009a).

OPS Determination

In June 2000, the Navy submitted a technical demonstration document to support the determination that the OU-4 remedy was OPS based on evaluation of remedy performance using groundwater monitoring well and extraction well data as they relate to the applicable RAOs and medium-specific cleanup goals specified in the ROD.

O&M Cost

The annual O&M cost estimated in the ROD was between $82,000 and $100,000, including O&M of the groundwater extraction and treatment system (including water and air emission treatment wastes as necessary to meet standards) and groundwater/effluent monitoring. The Navy's O&M cost records were not available for review; however, their estimate is an average of $500,000 per year. This estimated cost includes O&M of the system addressing OU-1A, OU-3, and OU-4 areas of groundwater. The actual cost for the implementation of the remedial design has not yet been tabulated.

5.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-4.

Recommendations/ Required Actions	Previous Milestone Date	Current Status
Finalize the remediation optimization report and make it available to O&M and inspection contractors.	ASAP	The Optimization Report was finalized in August 2007.
O&M manual revisions and updating (as needed) to reflect intended operating procedures.	Ongoing	A revised O&M Manual was submitted in June 2009.
Issue direction to O&M contractor to bypass the ion exchange unit, and consider returning or recycling the equipment.	Summer 2006	The Area D extraction system was shut down in June 2010.
Prepare a strategy for attainment of cleanup goals and evaluate predicted cleanup durations. Propose alternatives for reducing cleanup durations, if appropriate.	Ongoing	
Obtain formal access agreements for off-site monitoring wells.	2006/2007	Not yet completed – low priority.

Although the OU-4 vapor intrusion screening assessment included in the previous Five-Year Review Report indicated that risks were acceptable for residents and occupational workers, additional evaluation, including sampling of wells HN-31S, HN-73S, and OW-D9 for VOCs, was conducted in May 2011 to assess potential current vapor intrusion impacts posed by shallow groundwater. VOCs were detected at low concentrations in all three wells (see Table 5-1 and Figure 5-1). The only MCL exceedance was minimal; the TCE concentration at OW-D9 was 5.3 µg/L, only slightly greater than the MCL of 5 µg/L. There are no buildings within 100 feet of OW-D9. Based on this information, no further vapor intrusion evaluation is recommended for Area D groundwater, and modification of LUCs to address potential future vapor intrusion issues associated with current and future on-site or near-site buildings is not warranted.

5.5 FIVE-YEAR REVIEW PROCESS

5.5.1 Document and Analytical Data Review

This third five-year review consisted of a review of relevant documents for OU-4 including the ROD, O&M Manual, and performance monitoring reports. Extraction well and groundwater treatment system installation and operation has been completed, and O&M and long-term performance monitoring are ongoing.

5.5.2 Site Inspection

A site inspection was conducted in April 2011. No unusual observations were documented during the visit. The Five-Year Review Site Inspection Checklist and photographs from the April 2011 inspection are included in Appendix A.

5.6 TECHNICAL ASSESSMENT

5.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The final OU-4 ROD required the restoration of groundwater and implementation of institutional controls to prohibit groundwater use in Area D. Based on 2010 monitoring results, significant progress has been made in restoring groundwater quality, and in June 2010, the Area D groundwater extraction and treatment system was taken off line based on consistent monitoring results less than the cleanup level. As documented in monitoring reports when the system was operating, contaminants were effectively contained within the intended zone and did not adversely affect groundwater quality in downgradient areas. During the November 2010 monitoring event, concentrations of VOCs in all Area D wells sampled were less than MCLs. The institutional controls addressing former Navy property consist of restrictions on the use of water from existing wells and restrictions on the future installation of wells and/or the use of water from wells installed in the future. These controls prevent the use of groundwater that presents unacceptable human health risks and protect the integrity and effectiveness of the Area D extraction well network. These controls were included in the FOST for property in the vicinity of Area D and have been incorporated into the deed transferring the parcel (i.e., Parcel 3). The controls are enforced through Warminster Township Ordinance No. 32 for both former and off-base Navy property.

The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. Based on activities that have been completed (groundwater extraction and treatment system installation and operation) and activities that are ongoing (performance monitoring and LUCs), the intent and goals of ROD have been or will be met, and there are no deficiencies or early indicators of potential remedy failure.

5.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

No changes in exposure pathways, toxicity, contaminant characteristics, or risk assessment methods have occurred since the previous five-year review that would affect progress toward meeting RAOs. No changes to site conditions have been identified. No new receptors or potential receptors that could be affected by contaminated groundwater have been identified.

5.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

5.6.4 Technical Assessment Summary

The remedy is functioning in providing the required protection to human health as required by the ROD. Since the last five-year review, no changes to contaminant characteristics, site conditions, or standards that could adversely affect the protectiveness of the remedy have occurred.

5.7 ISSUES

No issues related to the protectiveness of the OU-4 remedy were identified during the five-year review. As discussed in Section 5.4, the results of an additional vapor intrusion evaluation in 2011 did not indicate the need for further investigation to address potential vapor intrusion issues for current and future on-site and near-site buildings.

5.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Because no protectiveness issues were identified for OU-4, no recommendations and required actions were identified.

5.9 PROTECTIVENESS STATEMENT

The remedy at OU-4 is protective of human health and the environment and was determined to be OPS. Contaminant migration was adequately contained as required when the extraction and treatment system was operational, and downgradient natural attenuation processes are progressing toward attainment of cleanup goals. LUCs to prevent exposure to and use of groundwater have been implemented, are being maintained and monitored, and provide a significant amount of protection until completion of the remedy is achieved to provide full protectiveness. The results of future monitoring will be used to continue to evaluate the effectiveness of the remedy. The groundwater remedial actions have been implemented as designed and include measures that prevent exposure. The remedial actions that are completed (implementation of LUCs and groundwater extraction and treatment) and ongoing (performance monitoring) are operating as designed. Future protectiveness of the remedy will be verified by continued monitoring in accordance with the SAP and continuation of existing LUCs. Based on the activities that are completed and ongoing, the intent and goals of the OU-4 ROD have been or will be met.

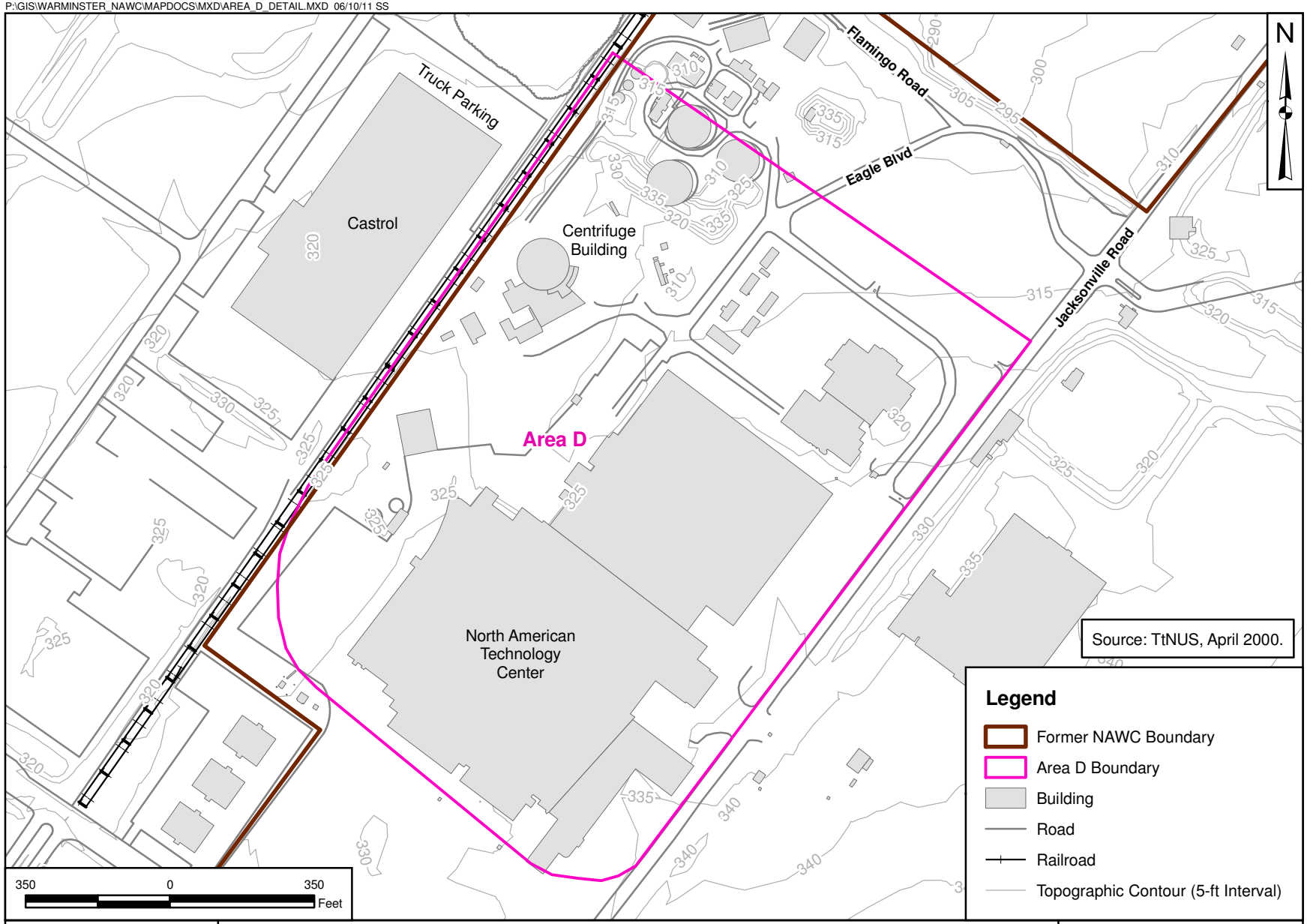
TABLE 5-1
MAY 2011 AREA D GROUNDWATER RESULTS
THIRD FIVE-YEAR REVIEW REPORT
FORMER NAWC WARMINSTER, PENNSYLVANIA

PARAMETER	MCL	HN-31S	HN-73S	OW-D9
1,1,1-TRICHLOROETHANE	200	0.2 U	**1.1**	0.2 U
1,1,2,2-TETRACHLOROETHANE	NC	0.4 U	0.4 U	0.4 U
1,1,2-TRICHLOROETHANE	5	0.4 U	0.4 U	0.4 U
1,1,2-TRICHLOROTRIFLUOROETHANE	NC	3 U	3 U	3 U
1,1-DICHLOROETHANE	NC	0.2 U	**0.48 J**	**0.54 J**
1,1-DICHLOROETHENE	7	0.2 U	**2.5**	0.2 U
1,2,3-TRICHLOROBENZENE	NC	0.4 U	0.4 U	0.4 U
1,2,4-TRICHLOROBENZENE	70	0.8 U	0.8 U	0.8 U
1,2-DIBROMO-3-CHLOROPROPANE	0.2	1.6 U	1.6 U	1.6 U
1,2-DIBROMOETHANE	NC	0.2 U	0.2 U	0.2 U
1,2-DICHLOROBENZENE	600	0.2 U	0.2 U	0.2 U
1,2-DICHLOROETHANE	5	0.2 U	0.2 U	0.2 U
1,2-DICHLOROPROPANE	5	0.2 U	0.2 U	0.2 U
1,3-DICHLOROBENZENE	NC	0.2 U	0.2 U	0.2 U
1,4-DICHLOROBENZENE	75	0.4 U	0.4 U	0.4 U
2-BUTANONE	NC	3.2 UR	3.2 UR	3.2 UR
2-HEXANONE	NC	3.2 UR	3.2 UR	3.2 UR
4-METHYL-2-PENTANONE	NC	3.2 U	3.2 U	3.2 U
ACETONE	NC	6.4 UR	6.4 UR	6.4 UR
BENZENE	5	0.2 U	0.2 U	0.2 U
BROMODICHLOROMETHANE	80*	0.2 U	0.2 U	0.2 U
BROMOFORM	80*	0.4 U	0.4 U	0.4 U
BROMOMETHANE	NC	0.4 U	0.4 U	0.4 U
CARBON DISULFIDE	NC	0.8 U	0.8 U	0.8 U
CARBON TETRACHLORIDE	5	**0.71 J**	0.4 U	0.4 U
CHLOROBENZENE	100	0.2 U	0.2 U	0.2 U
CHLORODIBROMOMETHANE	NC	0.4 U	0.4 U	0.4 U
CHLOROETHANE	NC	1.6 U	1.6 U	1.6 U
CHLOROFORM	80*	**0.26 J**	0.2 U	0.2 U
CHLOROMETHANE	NC	1.6 U	1.6 U	1.6 U
CIS-1,2-DICHLOROETHENE	70	**0.6 J**	0.2 U	**1.2**
CIS-1,3-DICHLOROPROPENE	NC	0.2 U	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE	80*	0.8 U	0.8 U	0.8 U
ETHYLBENZENE	700	0.2 U	0.2 U	0.2 U
ISOPROPYLBENZENE	NC	0.4 U	0.4 U	0.4 U
M+P-XYLENES	NC	0.8 U	0.8 U	0.8 U
METHYL TERT-BUTYL ETHER	NC	0.4 U	0.4 U	0.4 U
METHYLENE CHLORIDE	5	0.4 U	0.4 U	0.4 U
O-XYLENE	NC	0.4 U	0.4 U	0.4 U
STYRENE	100	0.4 U	0.4 U	0.4 U
TETRACHLOROETHENE	5	**2.3**	0.4 U	**0.83 J**
TOLUENE	1,000	0.4 U	0.4 U	0.4 U
TOTAL XYLENES	10,000	1.6 U	1.6 U	1.6 U
TRANS-1,2-DICHLOROETHENE	100	**0.28 J**	0.2 U	**0.42 J**
TRANS-1,3-DICHLOROPROPENE	NC	0.4 U	0.4 U	0.4 U
TRICHLOROETHENE	5	**1.7**	**0.43 J**	**5.3**
TRICHLOROFLUOROMETHANE	NC	0.8 U	0.8 U	0.8 U
VINYL CHLORIDE	2	0.8 U	0.8 U	0.8 U

Concentrations in µg/L.
Wells sampled on May 17, 2011.
MCL - Maximum Contaminant Level.
NC - No criterion.
U - Not detected at associated detection limit.
J - Estimated concentration.
R - Rejected.
* MCL is for for total trihalomethanes.

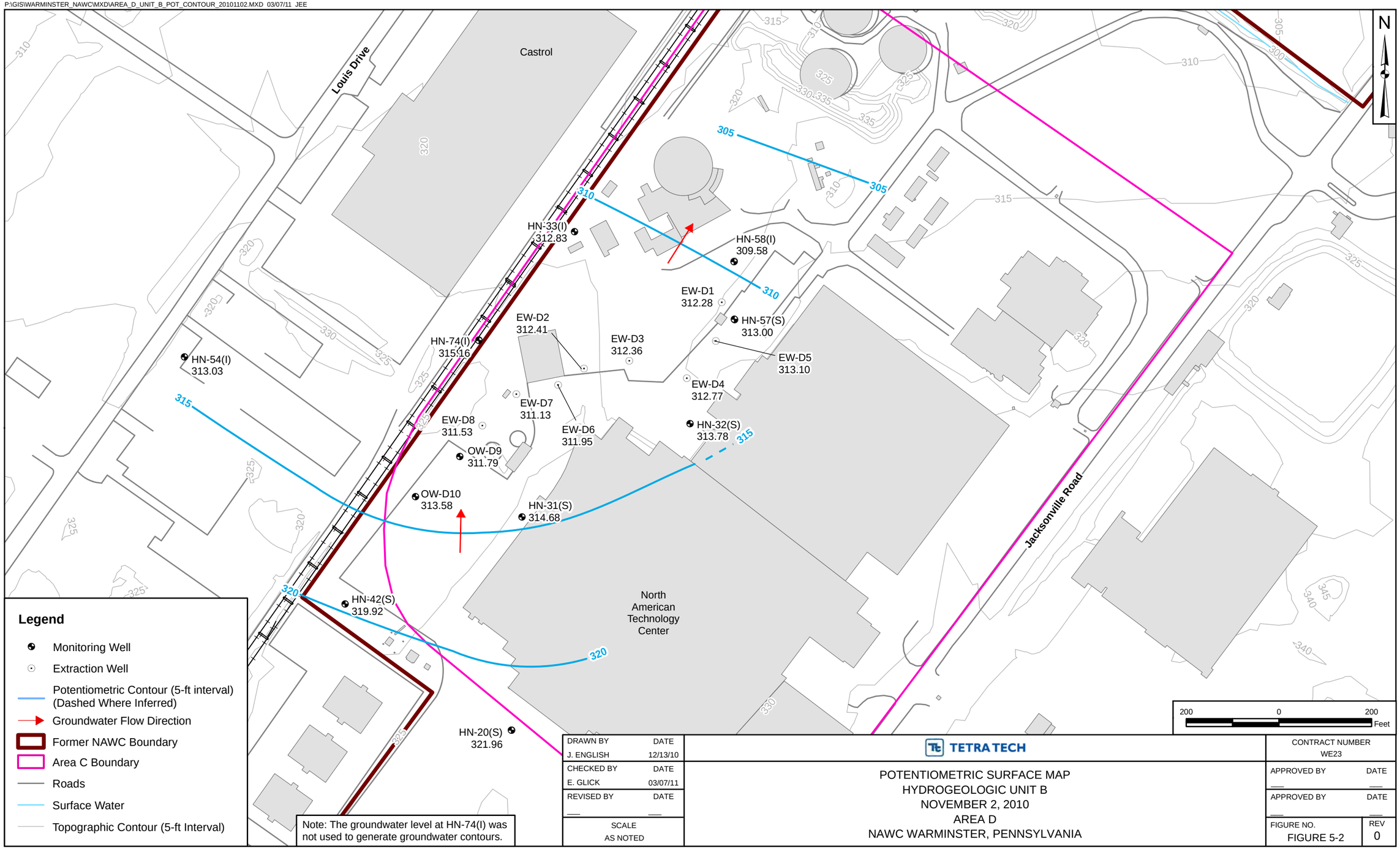
Detected concentrations are bolded; MCL exceedances are shaded.

P:\GIS\WARMINSTER_NAWC\MAPDOCS\MXD\AREA_D_DETAIL.MXD 06/10/11 SS



DRAWN BY J. ENGLISH	DATE 02/25/10	TETRA TECH	CONTRACT NUMBER CTO WE23
CHECKED BY R. MILLER	DATE 06/10/11	AREA D DETAIL MAP NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	APPROVED BY ___ DATE ___
REVISED BY S. STROZ	DATE 06/10/11		APPROVED BY ___ DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 5-1 REV 0

P:\GIS\WARMINSTER_NAWC\MXD\AREA_D_UNIT_B_POT_CONTOUR_20101102.MXD 03/07/11 JEE



Legend

- Monitoring Well
- Extraction Well
- Potentiometric Contour (5-ft interval) (Dashed Where Inferred)
- Groundwater Flow Direction
- Former NAWC Boundary
- Area C Boundary
- Roads
- Surface Water
- Topographic Contour (5-ft Interval)

Note: The groundwater level at HN-74(I) was not used to generate groundwater contours.

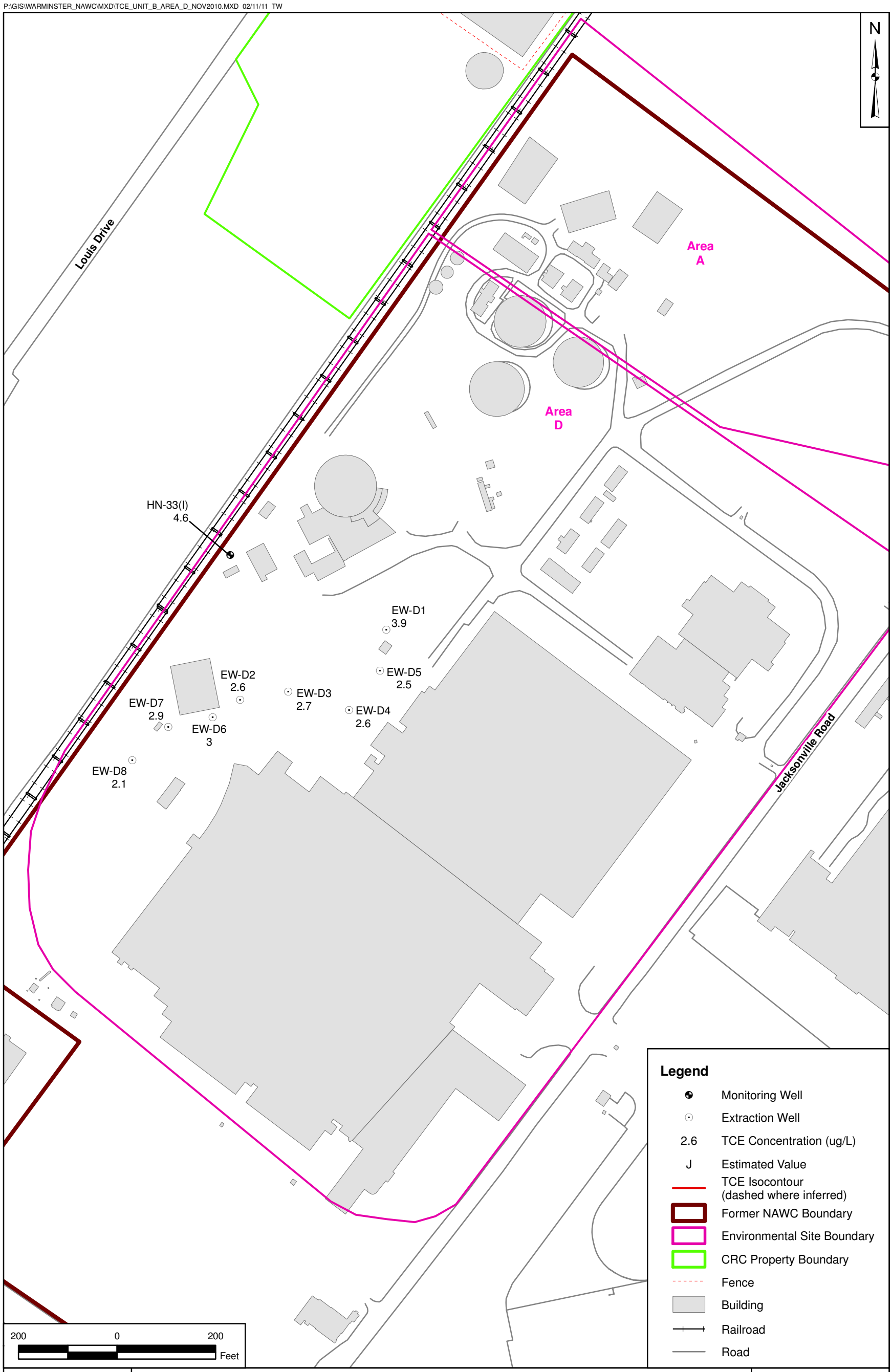
DRAWN BY	DATE
J. ENGLISH	12/13/10
CHECKED BY	DATE
E. GLICK	03/07/11
REVISED BY	DATE
___	___
SCALE	
AS NOTED	

TETRA TECH

POTENTIOMETRIC SURFACE MAP
HYDROGEOLOGIC UNIT B
NOVEMBER 2, 2010
AREA D
NAWC WARMINSTER, PENNSYLVANIA

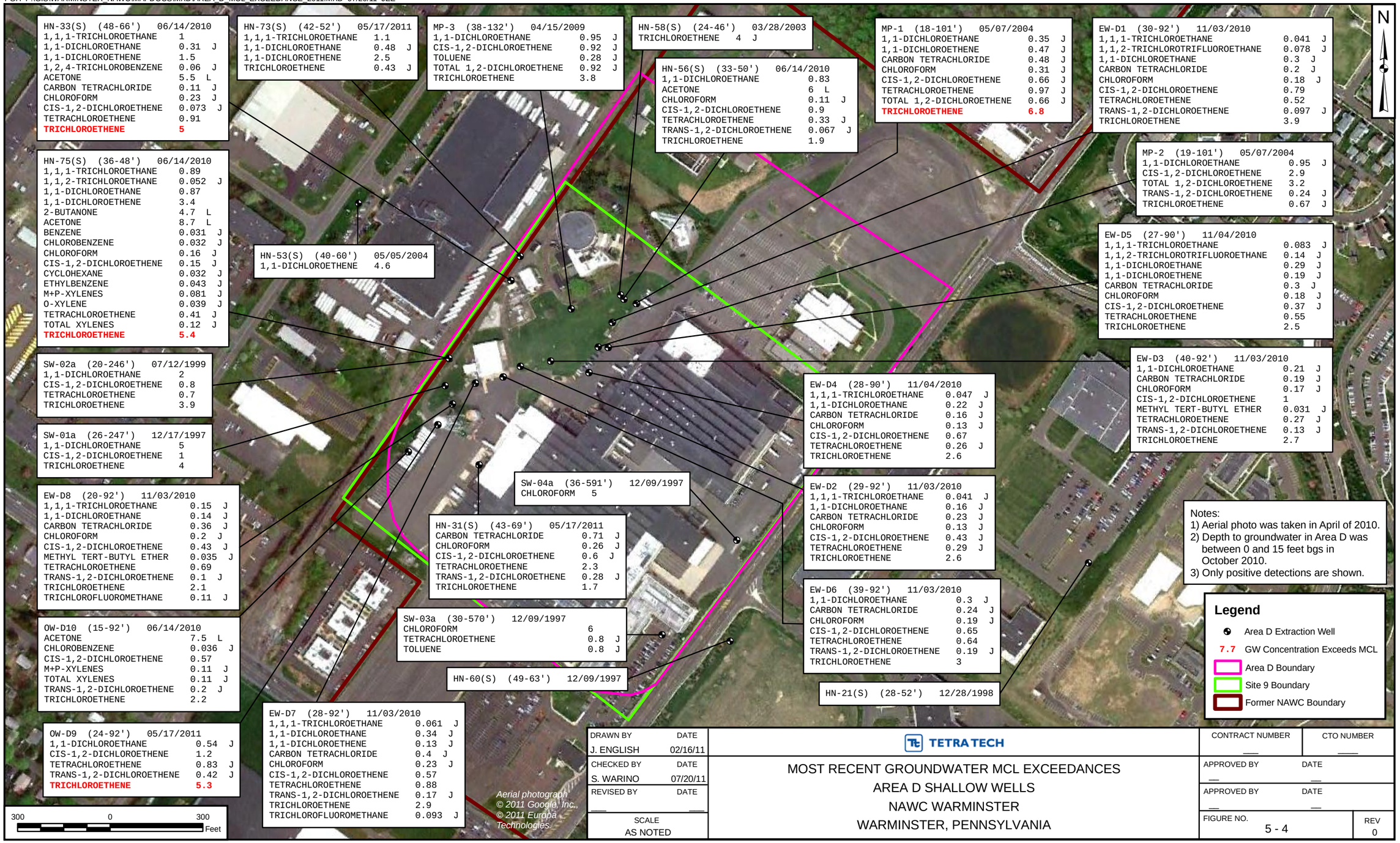
CONTRACT NUMBER	
WE23	
APPROVED BY	DATE
___	___
APPROVED BY	DATE
___	___
FIGURE NO.	REV
FIGURE 5-2	0

P:\GIS\WARMINSTER_NAWC\MXD\TCE_UNIT_B_AREA_D_NOV2010.MXD 02/11/11 TW



DRAWN BY J. ENGLISH	DATE 01/21/11	TETRA TECH	CONTRACT NUMBER WE23
CHECKED BY E. GLICK	DATE 02/11/11	TCE CONCENTRATION MAP OU-4 HYDROGEOLOGIC UNIT B AREA D NOVEMBER 2010 NAWC WARMINSTER, PENNSYLVANIA	APPROVED BY ___ DATE ___
REVISED BY T. WHEATON	DATE 02/11/11		APPROVED BY ___ DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 5-3 REV 0

PGH P:\GIS\WARMINSTER_NAWC\MAPDOCS\MXD\AREA_D_MCL_EXCEEDANCE_2011.MXD 07/20/11 JEE



Notes:
1) Aerial photo was taken in April of 2010.
2) Depth to groundwater in Area D was between 0 and 15 feet bgs in October 2010.
3) Only positive detections are shown.

Legend

- Area D Extraction Well
- 7.7 GW Concentration Exceeds MCL
- Area D Boundary
- Site 9 Boundary
- Former NAWC Boundary

DRAWN BY / DATE	J. ENGLISH 02/16/11
CHECKED BY / DATE	S. WARINO 07/20/11
REVISED BY / DATE	___ ___
SCALE	AS NOTED

TETRA TECH

MOST RECENT GROUNDWATER MCL EXCEEDANCES
AREA D SHALLOW WELLS
NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NUMBER	CTO NUMBER
___	____
APPROVED BY / DATE	___ ___
APPROVED BY / DATE	___ ___
FIGURE NO.	REV
5 - 4	0

6.0 OPERABLE UNIT 7

6.1 INTRODUCTION

Implementation of remedial actions at OU-7 began in 1997 and is ongoing. This five-year review provides a current status update for OU-7. This review is required because contaminant concentrations remain at levels that do not allow for unlimited use and unrestricted exposure. OU-7 consists of contaminated soil and waste associated with Sites 6 and 7 at Area B. These sites are grouped as OU-7 because of their close proximity in Area B and the similarity of disposal practices.

6.2 SITE BACKGROUND AND CHRONOLOGY

Site 6 was reportedly used for disposal of unknown quantities of waste paints, solvents, oil, flammable wastes, grease trap waste, and demolition debris. These materials were reportedly disposed of in pits excavated by backhoe through general dumping and backfilling throughout the area. At Site 7, sludge from the wastewater treatment plant was disposed of in trenches approximately 100 feet long by 12 feet wide and 8 feet deep. The estimated potential capacity of each trench was 356 cubic yards. The trenches were reportedly backfilled after each dumping episode. Upon site closure in 1955, the trenches were covered with 2 feet of soil, graded, and seeded. The area of Sites 6 and 7 was also used for the deposition of demolition and construction debris including large quantities of concrete and asphalt from demolished runways and parking aprons. The area of debris deposition is now partly covered by a woodlot.

A list of important OU-7 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1950 to 1955	Site 7 operated two trenches for disposal.
1960 to 1980	Site 6 operated an unknown number of trenches and pits for disposal.
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Basewide Phase I RI activities began
April 1991	Basewide Phase I RI activities completed
May 1992	Basewide Phase II RI and FS activities began
April 1993	Basewide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
May 1, 1997	OU-7, Sites 6 and 7 Action Memorandum signed
May 31, 1997	OU-7, Sites 6 and 7 removal action began

DATE(S)	EVENT
July 19, 1997	OU-7, Sites 6 and 7 removal action completed
June 20, 1998	OU-7 RI/FS began
November 1999	OU-7 RI completed
December 1999	OU-7 FS completed
June 20, 2000	OU-7 ROD signed
June 20, 2000	OU-7, Sites 6 and 7 removal action completed
June 20, 2000	OU-7 remedial design began
July 19, 2000	OU-7 remedial design completed
August 30, 2000	OU-7 remedial action began
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
October 11, 2000	FOST for Sites 6 and 7 signed
November 27, 2000	Assignment of the parcel that includes OU-7 to the National Park Service for recreational reuse
August 1, 2002	OU-7 remedial action completed
August 30, 2002	Remedial Action Close-Out Report submitted
July 2009	OU-10 sediment sampling to confirm that the OU-7 response action mitigated potential unacceptable risks.
October 2009	OU-10 Sediment Sampling Report Finalized
August 2009	Basewide LUCIP finalized

6.3 REMEDIAL ACTIONS

6.3.1 Remedy Selection

OU-7 includes the soil and wastes associated with the Site 6 and Site 7 property within Area B. Prior to selecting the final remedy and preparing the ROD, an Action Memorandum was prepared for a removal action based on the OU-7 RI. The Action Memorandum also included removal of debris and construction rubble from the surface of Sites 6 and 7 and post-removal soil sampling.

The ROD for OU-7 was signed on June 20, 2000. The primary RAOs for OU-7 were as follows:

- Prevent human exposure (via incidental ingestion and dermal contact) to subsurface soils containing hazardous substances at levels that present an unacceptable risk under the planned recreational use of the property.

- Eliminate unacceptable risk from exposure to soils by implementing institutional controls (e.g., land use restrictions) to ensure the property is not used for residential purposes.

- Prevent industrial/commercial use of the property by implementing institutional controls that require Navy and/or USEPA approval of a risk assessment for such use and additional environmental response work (if necessary).

The major components of the remedy for OU- 7 were as follows:

- Placement of a permanent 2-foot vegetated soil cover over site-wide subsurface soil, and implementation of any engineering controls necessary to establish and maintain a stable cover.

- Deed restrictions providing that the 2-foot vegetated soil cover remain in place and that the Navy and/or USEPA must approve any plans for excavation below 2 feet within the area of site-wide subsurface soil.

- A deed restriction to prohibit residential use of the parcel.

- A deed restriction to prevent industrial and commercial use, especially daycare facilities, of the area of site-wide surface soil without Navy and/or USEPA approval of a risk assessment for industrial and commercial use and additional environmental response work, if necessary.

- Periodic monitoring to identify measures necessary to maintain the 2-foot vegetated soil cover and to identify whether deed restrictions are being adhered to as required.

- Maintenance of the 2-foot vegetated soil cover based on periodic monitoring. Maintenance may include revegetation, placement of additional soil cover, engineering controls, and/or other measures.

- Enforcement of deed restrictions based on periodic monitoring.

To be protective of recreational use, the OU-7 remedy targeted prevention of human ingestion of and dermal contact with hazardous substances in subsurface soil that exceed the cleanup goals presented in the table below. Soil cleanup goals were developed for each substance determined to be a significant contributor to an unacceptable non-carcinogenic risk (corresponded to an HQ of 0.1) to ensure protectiveness. The cleanup goals were as follows for site-wide subsurface soils and for the three zones (locations) of concern at OU-7.

Substance	Cleanup Goal (in mg/kg)			
	Site-Wide	Zone 1	Zone 2	Zone 3
Chromium	54.1	54.1	54.1	54.1
Thallium	7.43	7.43	7.43	7.43
Arsenic	-	-	27.9	27.9
Cadmium	-	-	40.2	40.2
Aroclor-1254	-	-	-	1,540

6.3.2 Remedy Implementation

The removal action for OU-7 was conducted between May and July 1997 and included the excavation and removal of approximately 3,698 tons of soil and debris from three discrete locations at Sites 6 and 7 and the removal of debris and construction rubble from the surface of Sites 6 and 7. Post-removal soil sampling was performed to confirm that cleanup goals established for the removal action for protection of groundwater and human health were attained within the designated removal action areas.

The remedial design for the OU-7 vegetated soil cover was completed in July 2000, and the remedial action for OU-7 began in August 2000 and was completed on August 1, 2002. As part of construction, a 2-foot vegetated soil cover was placed over site-wide subsurface soil to ensure that subsurface soil with concentrations exceeding remediation goals were not available for human exposure. Site-wide subsurface soils were defined as soils in areas where subsurface disposal had occurred. Engineering controls were also implemented to establish and maintain the soil cover.

Two separate areas were delineated that required additional cover and grading. An 18-inch clean fill layer and 6-inch topsoil layer were placed over these two areas, as depicted in the final construction grading plan. A total of 10,760 tons for clean fill and 9,595 tons of topsoil were used during soil cover construction. Drainage swales were installed along the perimeter of Sites 6 and 7 to control stormwater flows. The soil cover was then vegetated to provide permanent erosion control, to establish surface stabilization, and to promote wildlife habitat. A seed mix was applied to the covered areas through hydroseeding, and a wildflower mix was applied to enhance the covered areas. In addition, hardwood trees were planted along the northern perimeter of one of the graded areas to control and maintain the soil cover. Immediately following completion of the soil cover, a significant rainfall event resulted in some erosion of the covered areas. A portion of the topsoil layer was washed downgradient of Sites 6 and 7. In response, additional erosion and sediment control measures were implemented. About 140 tons of topsoil were added to the soil cover, and the disturbed areas were again reseeded.

Land Use Controls

The institutional controls for OU-7 have been implemented. On October 11, 2000, the Navy signed the FOST for Sites 6 and 7. The deeds through which the property was transferred to Warminster Township as part of an EDC indicated that the vegetated soil cover present at the time of transfer will remain in place and that any plans for excavation below 2 feet within the area of site-wide subsurface soils must be approved by the Navy and/or USEPA. The deed also indicates that the property will not be used for residential purposes. The deed also prohibits industrial and commercial use, especially daycare facilities, without Navy and/or USEPA approval of a risk assessment for such use and any necessary additional environmental response work. This approval will consider the available information and will be contingent on the submission and approval of a plan that ensures that necessary measures are undertaken to protect human health and the environment. The information to be considered will include RI data regarding the nature and extent of COCs in accordance with the ROD.

6.3.3 Remedy Cost

In the Action Memorandum, the Navy estimated the cost of the removal action for Site 6 at $500,000. The capital cost for implementation of the cap alternative was estimated in the ROD at $1,220,000 for Sites 6 and 7. This estimate included costs associated with site preparation, excavation, removal, and off-site disposal of subsurface soil, backfill of the excavation, site grading, soil cover placement (2 feet), construction of erosion control and stormwater drainage system, and revegetation. The actual cost for implementation of the remedy has not yet been tabulated.

6.3.4 System Operations/Operation and Maintenance

A LUCIP was prepared in 2009 to ensure and document compliance with LUCs and/or deed restrictions required for sites at the former NAWC Warminster, including previously transferred property and other private property impacted by Navy IR sites (ECOR Solutions, Inc., 2009). Annual LUC inspections are conducted to document continued maintenance of the required restrictions. For OU-7, this includes confirmation of passive recreational use only, maintenance of excavation restrictions, and verification of the integrity of the soil cover. The results of annual LUC inspections indicate that the OU-7 LUCs are being implemented as required (Tetra Tech, 2010b).

In addition, in the ROD for OU-10, the Navy indicated that they would prepare a sediment confirmation sampling and analysis work plan and conduct additional stream monitoring to confirm that the OU-7 response actions would mitigate potential unacceptable risks presented by sediment impacted by Sites 6 and 7 in Area B. Sediment sampling was conducted in July 2007, and the associated report was finalized in October 2007 (Tetra Tech, 2007b). The conclusions based on sediment monitoring results were that Area B impacts on sediment (especially off-site sediment) were minimal and that concentrations were

generally comparable to levels at background locations. No further actions were recommended.

O&M Cost

The average annual O&M costs (includes long-term monitoring, mowing, cover repairs, etc.) are estimated at $8,000 per year for 30 years, and five-year reviews costs are estimated at $20,000 per event in the ROD. The actual costs for the implementation of periodic monitoring and maintenance have not yet been tabulated. The actual costs for the sediment sampling and analysis program for OU-10 have also not been tabulated.

6.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-7.

Recommendations/ Required Actions	Previous Milestone Date	Current Status
Complete and implement the sediment sampling and analysis work plan for OU-10 to confirm that the OU-7 response action mitigated potential unacceptable risks.	December 2006	Sampling was completed as documented in the Operable Unit 10 Sediment Sampling Report (Tetra Tech, 2007).
Conduct/continue post-closure monitoring activities.	Summer 2006	Annual LUC inspections are conducted in accordance with the 2009 LUCIP.
Review the draft remedial action close-out report for OU-7.	Summer 2006	Draft report was never revised; no longer required because property has been transferred and is now a park.
Evaluate post-ROD information and prepare a memo for an insignificant change or an Explanation of Significant Differences.	Winter 2007	None required at this time.

6.5 FIVE-YEAR REVIEW PROCESS

6.5.1 Document and Analytical Data Review

This third five-year review consisted of a review of relevant documents for OU-7 including the ROD, LUCIP, LUC Inspection Report, and related OU-10 documents. The remedial action (2-foot vegetative cover) has been completed at OU-7, and LUCs have been implemented and are being maintained in accordance with the LUCIP.

6.5.2 Site Inspection

A site inspection was conducted in April 2011. No unusual observations were documented during the visit. The cap appeared to be in good shape, and signs are posted indicating the area is a nature preserve. The Five-Year Review Site Inspection Checklist and photographs from the April 2011 inspection are included in Appendix A.

6.6 TECHNICAL ASSESSMENT

6.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-7 was focused excavation and off-site disposal, vegetated soil cover, erosion control and stormwater drainage systems, institutional controls, and monitoring. The review of documents, ARARs, and risk assumptions and the results of annual LUC inspections and the April 2011 site inspection indicate that the remedy is functioning as intended by the ROD. In addition, based on the results of 2007 sediment monitoring, the OU-7 response actions mitigated potential unacceptable risks presented by sediment impacted by Area B, and no action is necessary to directly address the sediments (OU-10 ROD requirements).

Based on the completed activities (RI and risk assessment), the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

6.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no significant changes in the physical conditions for OU-7, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. There have been no changes in the risk assessment methodologies or exposure assumptions that would impact the protectiveness of the remedy.

6.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No additional human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

6.6.4 Technical Assessment Summary

The remedy as specified in the ROD included focused excavation and off-site disposal, vegetated soil cover, erosion control and stormwater drainage systems, institutional controls, and monitoring. According to the information reviewed and the site inspections, the remedy is functioning as intended by the ROD.

There have been no significant changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

6.7 ISSUES

No issues related to the protectiveness of the OU-7 remedy were identified during the five-year review.

6.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Because no protectiveness issues were identified for OU-7, no recommendations and required actions were identified.

6.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-7 is protective of human health and the environment. The source of contamination is contained, and the exposure pathways that could result in unacceptable risks are being controlled. The cover system minimizes infiltration and subsequent contaminant migration and prevents direct contact with soil and contaminated materials. Continued implementation and inspection of LUCs will maintain the effectiveness of the remedy into the future. Based on the completed activities, the intent and goals of the ROD are being met.

7.0 OPERABLE UNIT 9

7.1 INTRODUCTION

Implementation of the remedial actions at OU-9 began in 1998 and is ongoing. This five-year review provides a current status update for OU-9. This review is required because contaminant concentrations remain on site that do not allow for unlimited use and unrestricted exposure.

7.2 SITE BACKGROUND AND CHRONOLOGY

OU-9 consists of the contaminated soils and sediment associated with Area A, which includes Sites 1, 2, and 3 and adjacent areas in Area A in the northwestern corner of the former facility (see Figure 3-1). In addition to Sites 1, 2, and 3, Area A includes the location of eight former impoundments used for storage of industrial wastewater treatment sludge.

Site 1 was reportedly a burn pit operated from 1940 to 1955 and located at the embankment of a ravine formed by erosion action. Waste materials were reportedly dumped over the bank and burned. The waste was reportedly disposed of included inorganics, solvents, acids, bases, and firing range waste. Site 2 was a 200-foot by 12-foot by 8-foot trench used for the disposal of approximately 1,400 cubic yards of industrial wastewater treatment sludge from 1965 to 1970. Site 3 is immediately southeast of Site 2 and was reportedly used from 1955 to 1965 as a burn pit for solvents, paints, acids, bases, mixed municipal waste, and other unspecified chemicals. The pit was reportedly approximately 20 feet wide by 30 feet long by 10 feet deep and was covered by a large metal screen enclosure. Residue from the pit was reportedly removed periodically and deposited at an unspecified, on-base “sanitary landfill.”

A list of important OU-9 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1940 to 1955	Site 1 operated as a burn pit for paints, oils, asphalt, unspecified chemicals, firing range waste, etc. and was closed by covering the site with excess soils generated by grading an extension of an aircraft runway.
1940 to 1973	Area A unlined impoundments or lagoons used for storage of wastewater treatment sludge generated by the industrial wastewater treatment plant that have been filled in.
1955 to 1965	Site 3 operated as a burn pit for solvents, paints, and unspecified chemicals and for closure the pit was backfilled with on-base soil and regraded.
1965 to 1970	Site 2 operated two trenches for disposal of industrial wastewater

DATE(S)	EVENT
	sludge and was closed with a cover and vegetation
September 1979	Initial discovery of contamination at NAWC Warminster
1980	Navy initially reported Site 1 as a potential location of hazardous substances disposal, Site 2 reported to be the location of a trench used for the disposal
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Basewide Phase I RI activities began
April 1991	Basewide Phase I RI activities completed
May 1992	Basewide Phase II RI and FS activities began
April 1993	Basewide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
June 1998	Action Memorandum signed – OU-9, Area A soil removal
August 25, 1998	OU-9, Area A Soils Action Memorandum signed, began removal action
January 1999	OU-9, Area A soils removal action completed
April 28, 2000	OU-9 RI/FS completed
June 26, 2000	OU-9 ROD signed
June 26, 2000	OU-9 remedial design began
August 11, 2000	OU-9 remedial design completed
August 14, 2000	OU-9 remedial action construction began
September 20, 2000	OU-9 remedial action construction completed; Close-Out Report for OU-9
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
August 2009	Basewide LUCIP finalized

7.3 REMEDIAL ACTIONS

7.3.1 Remedy Selection

Soils, surface water, and sediment associated with Area A have been defined as OU-9. Prior to selecting the final remedy and preparing the ROD, an Action Memorandum was prepared for a removal action in June 1998. The removal action in Area A was required due to the presence of hazardous substances in surface and subsurface soils and buried materials in the vicinity. The ROD for OU-9 was signed on June 26, 2000.

The RAOs for the OU-9 remedy based on the anticipated future industrial land use scenario were as follows:

- Prevent the migration of Area A soils that present a threat to ecological receptors associated with the unnamed tributary of Little Neshaminy Creek.

- Eliminate unacceptable risk to soils by implementing institutional controls (e.g., land use restrictions) to ensure the Area A parcel is not used for residential purposes.

- Mitigate potential risks associated with existing contaminants in sediment and, to a lesser extent, surface water in the unnamed tributary of Little Neshaminy Creek.

The major components of the remedy for OU-9 were as follows:

- Erosion controls to ensure that surface soils exceeding concentrations protective of sediment do not migrate to the unnamed tributary of Little Neshaminy Creek.

- Institutional controls in the form of deed restrictions to ensure permanent maintenance of the erosion controls.

- Institutional controls in the form of deed restrictions to require prior approval by the Navy and/or USEPA of any plans for excavation within specified portions of Area A where contaminant concentrations in subsurface soils exceed concentrations protective of sediment.

- Institutional controls in the form of deed restrictions prohibiting non-industrial use of the Area A parcel.

- Periodic monitoring to identify maintenance activities required for erosion controls and to ensure adherence to deed restrictions.

- Periodic stream monitoring to identify the extent of any contaminant loading to the stream, to assess the ecological effects of any such loading, and to determine the nature of any necessary actions based on these evaluations.

The Action Memorandum referenced risk-based target cleanup levels for the COCs associated with Area A soils that were developed in the draft Area A Removal Site Evaluation (U.S. Navy, 1998). No specific soil cleanup goals were established for the OU-9 remedy, but to be protective of the unnamed tributary of Little Neshaminy Creek and associated environmental receptors, the remedy was designed to prevent the migration of soils at Sites 2 and 3 that contain hazardous substances at concentrations that exceed those listed in Table 7-1. These concentrations are based on the protective sediment quality concentrations

developed in Appendix J of the OU-9 RI/FS Report (Tetra Tech, 2000o) and established in the Technical Memorandum (Tetra Tech, 2000g) supporting the selection of institutional controls for the OU-9 ROD.

7.3.2 Remedy Implementation

A removal action was conducted in 1996 to remove soil at two locations beneath the footprint of the treatment plant building and surrounding property. An additional removal action based on preliminary RI results was conducted in 1998 that included excavation, transportation, and disposal in an off-base landfill of approximately 6,700 tons of nonhazardous Area A surface and subsurface soils. A small amount (about 100 pounds) of flammable solids or corrosive liquids was also removed for disposal. Soils were excavated from two separate locations within Site 1, three locations within Site 2, and one location near Site 3. Post-removal soil sampling was performed to confirm that cleanup goals established for the protection of groundwater and human health were attained with the designated removal action areas.

In July 2000, the Navy implemented erosion and sedimentation controls in the vicinity of Area A to prevent erosion of surface soils of concern to the stream. The erosion and sedimentation controls were established on August 15, 2000, and included the following:

- Removal of the existing damaged silt fence.
- Removal of sediment between the dike and perimeter fence to grade.
- Removal of sediment within the sediment basin. The sediment was used to fill the ruts that formed south of the existing stone dike due to excessive runoff.
- Installation of 6- to 8-inch stone (approximately 160 tons) to the north of the existing stone dike.
- Increasing the height of the existing dike by at least 1 foot to create a uniform height along the dike.

The remedial action completion report for the Site 2 erosion controls was issued on September 20, 2000.

Land Use Controls

The institutional controls for OU-9 have been implemented. On October 3, 2000, the Navy signed the FOST for Sites 1 and 2 (designated as Parcels 6 and 7). Parcel 6, which includes Site 1, the Impoundment Area, and the on-base wastewater treatment plant, were transferred to WTMA as part of an EDC. Parcel 7, which includes a portion of Site 2, was transferred to Bucks County for use by the forensics unit. The deeds for these parcels included the LUCs specified in the OU-9 ROD. On July 5, 2000, the Navy signed the FOST for the Phase III EDC property. A portion of this property, which includes Site 3, was transferred and deeded to the FLRA on July 12, 2000. The deeds prepared by the Navy for transfer of the properties described above provide that the erosion controls established at the time of transfer remain in place permanently.

Institutional controls in the form of deed restrictions also provide for excavation control in areas where subsurface soil concentrations exceed those concentrations determined to be protective of sediment (see Table 7-1). The subsurface soils of concern are located within Site 2 and Site 3. Prior approval by the Navy and/or USEPA is required for excavation plans within Sites 2 and 3. Such approval will consider the available information and will be contingent on the submission and approval of a plan that ensures that necessary measures are undertaken to prevent migration of the subject soils to the unnamed tributary of Little Neshaminy Creek and to otherwise protect human health and the environment. The information to be considered will include data regarding the nature and extent of subsurface soils exceeding the soil concentrations protective of sediment quality. The deeds also provide that Area A will not be used for non-industrial purposes such as residential, recreational, and child daycare uses.

7.3.3 Remedy Cost

In the Action Memorandum, the Navy estimated the capital cost of the removal action for OU-9 at $1,069,000. The capital cost for implementation of the selected remedy was estimated in the ROD at $46,483 for Sites 1, 2, and 3. This estimate included costs associated with institutional controls and environmental monitoring. The actual cost for the implementation of the remedy has not yet been tabulated.

7.3.4 System Operations/Operation and Maintenance

A LUCIP was prepared in 2009 to ensure and document compliance with LUCs and/or deed restrictions required for sites at the former NAWC Warminster, including previously transferred property and other private property impacted by Navy IR sites (ECOR Solutions, Inc., 2009). Annual LUC inspections are conducted to document continued maintenance of the required restrictions. For OU-9, this includes maintenance of excavation restrictions at Sites 2 and 3 and verification of the integrity of erosion controls at Site 2. The annual LUC inspections indicate that the OU-9 LUCs are being implemented as required (Tetra Tech, 2010b).

In addition, the unnamed tributary of Little Neshaminy Creek was periodically monitored to identify the extent of contaminant loading to the stream, to assess the ecological effects of contaminant loading, and to determine the nature of necessary actions based on these assessments. Eight rounds of stream monitoring were conducted between September 1999 and November 2001. Based on surface water sample results indicating that no COCs were detected in excess of laboratory detection limits, the stream monitoring program was suspended. However, during annual LUC inspections, the stream banks are inspected, and if excessive erosion is observed, the need for additional monitoring will be assessed (ECOR, 2009).

O&M Cost

The costs for periodic O&M (every 5 years for 30 years) were estimated as $20,000 in the Action Memorandum. The present worth of the O&M costs (includes long-term monitoring, erosion and sedimentation control, five-year reviews, etc.) are estimated at $249,000 for the first 5 years based on the ROD. The average annual O&M costs are estimated at $31,749 per year for 5 years, and five-year reviews costs are estimated at $12,000. The actual costs for the implementation of maintenance and periodic monitoring have not yet been tabulated.

7.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-9.

Previous Recommendation/ Required Action	Current Status
Conduct sediment sampling and analysis as necessary	Stream monitoring program suspended in 2001 but may be restarted if required based on erosion control inspection results.
Conduct/continue post-closure monitoring activities	Annual LUC inspections are conducted in accordance with the 2009 LUCIP.
Evaluate post-ROD information and prepare a memo for an insignificant change or an Explanation of Significant Differences	None required at this time.

7.5 FIVE-YEAR REVIEW PROCESS

7.5.1 Document and Analytical Data Review

This third five-year review consisted of a review of relevant documents for OU-9 including the ROD, remedial design, O&M plan, and O&M reports. The remedial action (erosion controls) has been completed at OU-9, and LUCs have been implemented and are being maintained in accordance with the LUCIP.

7.5.2 Site Inspection

A site inspection was conducted in April 2011. No unusual observations were documented during the visit. Access to Site 3 is restricted by fencing, and visual observations at Site 2 revealed no problems with regard to sediment accumulation, subsidence, erosion, ponding, and obstructions to flow. The storm drainage system at Site 2 appeared to be in good condition. Only Site 2 has off-site discharge within

Area A. The Five-Year Review Site Inspection Checklist and photographs from the April 2011 inspection are included in Appendix A.

7.6 TECHNICAL ASSESSMENT

7.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-9 was erosion controls, institutional controls, monitoring of the erosion and institutional controls, and environmental monitoring of the stream. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD.

Based on the completed activities, the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

7.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no significant changes in the physical conditions for OU-9, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. There have been no changes in the risk assessment methodologies or exposure assumptions that would impact the protectiveness of the remedy.

7.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No additional human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

7.6.4 Technical Assessment Summary

The remedy as specified in the ROD includes erosion controls, institutional controls, monitoring of erosion and institutional controls, and environmental monitoring of the stream. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD.

There have been no significant changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

7.7 ISSUES

No issues related to the protectiveness of the OU-9 remedy were identified during the five-year review.

7.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Because no protectiveness issues were identified for OU-9, no recommendations and required actions were identified.

7.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-9 is protective of human health and the environment. The source of contamination is contained, and the exposure pathways that could result in unacceptable risks are being controlled. Continued implementation and inspection of LUCs will maintain the effectiveness of the remedy into the future. Based on the completed activities, the intent and goals of the ROD are being met.

TABLE 7-1

SURFACE SOIL CONCENTRATIONS PROTECTIVE OF SEDIMENT/ECOLOGICAL RECEPTORS
THIRD FIVE-YEAR REVIEW REPORT
FORMER NAWC WARMINSTER, PENNSYLVANIA

Parameter	Soil Concentration Protective of Sediment		Site 2 Maximum Concentration		Site 3 Maximum Concentration	
	Site 2	Site 3	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil
Inorganics (mg/kg)						
Cadmium	7.69	9.08	20.3	293	--	67.1
Chromium	531	531	133	3,840	36.8	83.4
Copper	202	238	1,140	7,980	42.3	3,760
Lead	365	365	994	2,060	30.4	4,570
Mercury	2.32	2.32	1.1	0.98	--	9.7
Nickel	143	143	47	143	21.5	230
Selenium	3.32	3.32	1.6	7.3	--	2.9
Silver	3.32	3.92	58.4	317	--	368
Zinc	895	895	4,800	5,640	167	9,100
Organics (µg/kg)						
2-Methylnapthalene	129	153	21,000	360	--	690
4,4'-DDD	25.9	25.9	19	45	--	150
4,4'-DDE	49.4	58.4	8	82	--	42
Acenaphthene	164	194	180	1,400	--	4,400
Acenaphthylene	239	283	440	--	120	1,200
Anthracene	458	541	640	2,200	220	21,000
Benzo(a)anthracene	2,290	2,290	3,300	5,200	1,200	53,000
Benzo(a)pyrene	2,520	2,520	3,400	3,800	1,400	44,000
Benzo(b)fluoranthene	5,860	1,060	5,300	4,900	1,300	45,000
Benzo(g,h,i)perylene	1,230	2,220	4,400	2,100	320	26,000
Benzo(k)fluoranthene	5,860	1,060	1,800	2,200	1,000	34,000
Chrysene	2,820	2,820	3,300	4,900	1,200	51,000
Dibenzo(a,h)anthracene	464	464	470	450	99	9,400
Fluoranthene	4,970	4,970	6,200	13,000	3,300	120,000
Fluorene	464	464	250	1,000	41	4,500
Indeno(1,2,3-cd)pyrene	1,100	1,990	5,000	2,500	380	29,000
Naphthalene	0.73	0.86	52	250	--	450
Pyrene	4,640	4,640	4,600	9,800	1,800	97,000

Shaded soil concentrations exceed protection-of-sediment concentrations.

8.0 OPERABLE UNIT 10

8.1 INTRODUCTION

Implementation of the remedial actions at OU-10 began in 2000. This five-year review provides a current status update for OU-10. OU-10 consists of Site 5 soils and waste and surface water and sediment associated with Area B.

8.2 SITE BACKGROUND AND CHRONOLOGY

OU-10, Site 5, consists of up to eight trenches used for the disposal of demolition wastes, paint, solvents, scrap metal, aircraft paints, cans, and asphalt and is located within the enlisted personnel housing area maintained by the Navy as part of NAS Willow Grove. The trenches were approximately 12 feet by 70 feet by 8 feet in dimension and were covered with 2 feet of fill, graded, and seeded. Historical aerial photographs indicate that the housing units were constructed within the apparent disposal area after disposal occurred.

A list of important OU-10 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1955 to 1970	Site 5 operated trenches for disposal.
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Basewide Phase I RI activities began
April 1991	Basewide Phase I RI activities completed
May 1992	Basewide Phase II RI and FS activities began
April 1993	Basewide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
September 30, 1998	OU-10 RI began
September 28, 2000	OU-10 NFA ROD signature; RI completed
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
February 22, 2007	Final Letter Work Plan for Post-ROD Monitoring at OU 10
July 2009	OU-10 sediment sampling
October 2009	OU-10 Sediment Sampling Report finalized

8.3 REMEDIAL ACTIONS

8.3.1 Remedy Selection

OU-10 includes soils and waste at Site 5 and surface water and sediment potentially impacted by Area B. The results of the risk assessment and RI indicated that, based on available information, OU-10 soils and sediment did not present an unacceptable risk to human health and the environment, and no action was the selected remedy for OU-10. The ROD also indicated that the Navy would conduct stream monitoring to confirm that potential impacts to stream sediment by Area B [which includes OU-10 (Site 5) and OU-7 (Sites 6 and 7)] are mitigated by response actions for Area B and OU-7.

8.3.2 Remedy Implementation

No remedial action was required in the OU-10 ROD for Site 5 soils and sediment and surface water associated with Area B; however, the ROD indicated that the Navy would prepare a sediment confirmation sampling and analysis work plan and conduct additional stream monitoring. As part of post-ROD activities, a work plan for OU-10 was finalized in 2007 (Tetra Tech, 2007a), sediment sampling was conducted in July 2007, and the associated report was finalized in October 2007 (Tetra Tech, 2007b). The conclusions based on sediment monitoring results were that Area B impacts on sediment (especially off-site sediment) were minimal and that concentrations were generally comparable to levels at background locations. No further actions were recommended.

8.3.3 Remedy Cost

No remedial action costs were required for OU-10 other than the costs for the sediment sampling and analysis program. The actual costs for the sediment sampling and analysis program for OU-10 have not been tabulated.

8.3.4 System Operations/Operation and Maintenance

A long-term monitoring program is not required for OU-10.

8.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-9.

Previous Recommendation/ Required Action	Current Status
Complete review of sediment sampling and analysis work plan	The Final Letter Work Plan for Post-ROD Monitoring at OU 10 was finalized in February 2007, sampling was conducted in July 2007, and the Sediment Monitoring Report was finalized in October 2007.
Conduct/implement sediment sampling and analysis	
Evaluate post-ROD information and prepare a memo for an insignificant change or an Explanation of Significant Differences	None required at this time.

8.5 FIVE-YEAR REVIEW PROCESS

8.5.1 Document and Analytical Data Review

This third five-year review consisted of a review of relevant documents for OU-10 including the ROD and sediment monitoring work plan and report. No remedial action was required at OU-10, and post-ROD sediment monitoring has been completed. No further action is required for OU-10.

8.5.2 Site Inspection

A site inspection was conducted in April 2011. No unusual observations were documented during the visit. The Five-Year Review Site Inspection Checklist and photographs from the April 2011 inspection are included in Appendix A.

8.6 TECHNICAL ASSESSMENT

8.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-10 was no action with sediment confirmation sampling and analysis. The post-ROD sediment sampling and analysis was completed in 2007, and results indicated that the OU-7 response actions mitigated potential unacceptable risks presented by sediment impacted by Area B and that no action was necessary to directly address the sediments (Tetra Tech 2007b). Therefore, all requirements of the OU-10 ROD have been met.

8.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no changes in the physical conditions for OU-10, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy.

8.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

8.6.4 Technical Assessment Summary

The remedy as specified in the ROD is no action with sediment confirmation sampling and analysis. According to the information reviewed and the site inspection, all ROD requirements have been met. There have been no changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

8.7 ISSUES

No issues related to the protectiveness of the OU-10 remedy were identified during the five-year review.

8.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Because no protectiveness issues were identified for OU-10, no recommendations and required actions were identified.

8.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-10 is protective of human health and the environment. Based on the activities completed, all requirements of the ROD have been met. Because all requirements of the ROD have been completed and because contaminant concentrations at OU-10 are at or less than levels that allow for unlimited use and unrestricted exposure, no further five-year reviews are required for OU-10.

9.0 BASEWIDE PROTECTIVENESS STATEMENT

The basewide conclusions and recommendations of the third five-year review for the former NAWC Warminster are presented below. These conclusions and recommendations are presented in the form of a basewide protectiveness statement and recommendations for the next five-year review.

9.1 PROTECTIVENESS STATEMENT

The remedial actions that have been implemented and that are ongoing at OU-1A, OU-3, OU-4, OU-7, OU-9, and OU-10 are expected to be protective of human health and the environment, and at all of these sites, LUCs have been implemented to ensure short-term protection by preventing exposure to soil or groundwater that could result in unacceptable risks until completion of the remedies provide long-term protectiveness. In addition, the results of performance monitoring at OU-1A, OU-3, and OU-4 and LUC inspections at all sites are used to evaluate remedy effectiveness and to evaluation potential migration of contamination.

At OU-1A, OU-3, and OU-4, the remedial actions that are completed (groundwater extraction and treatment system construction and operation and LUC implementation and maintenance) and performance monitoring are operating as designed and include measures that prevent potentially unacceptable exposure. At OU-4, groundwater extraction and treatment has been discontinued based on monitoring results consistently less than cleanup levels, although performance monitoring and LUCs continue. Based on vapor intrusion evaluations included in the previous Five-Year Review Report, vapor intrusion is not a current concern at any of the sites; however, further evaluation of current vapor intrusion impacts was conducted for OU-1A and OU-4, and is ongoing at OU-3. To evaluate whether further actions are needed to address potential future vapor intrusion risks for new buildings, additional vapor intrusion assessment will be conducted for the OU-1A and OU-3 areas. The results of the OU-4 vapor intrusion evaluation did not indicate the need for further action to address current or potential future vapor intrusion.

At OU-7 and OU-9, the remedial actions that are completed (soil cover and erosion controls, respectively, and LUC implementation and maintenance at both sites) are operating as designed and include measures that prevent potentially unacceptable exposure. Based on the results of 2007 OU-10 post-ROD sediment sampling to confirm that the OU-7 remedial action mitigated potential unacceptable risks, no action is necessary to directly address the sediments. Stream monitoring was suspended at OU-9 in 2001 but may be restarted if necessary based on the results of LUC (erosion control) inspections.

For OU-10, upon completion of the 2007 post-ROD sediment sampling event, and subsequent determination that no action is necessary to address the sediments, all requirements of the ROD have been met.

The results of this five-year review show that the Navy is meeting or exceeding the requirements of the RODs for the OUs at the former NAWC Warminster and is constantly re-evaluating to utilize permanent remedies and alternative treatment technologies and to optimize monitoring programs to the maximum extent practical for each OU.

9.6 NEXT REVIEW

This report presents the results of the third five-year review of IR Program sites at the former NAWC Warminster. The next five-year review is required within 5 years of the signature date of this review, November 2016. Included in the next five-year review will be evaluations of the ongoing protectiveness of the remedies at OU-1A, OU-3, OU-4, OU-7, and OU-9. Unless there are unforeseen changes in site conditions or other issues affecting remedy protectiveness, OU-10 will not be included in the next five-year review because all of the ROD requirements have been fulfilled, and no ongoing activities are required.

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U.S. Navy and USEPA, 2000h. CERCLA Record of Decision for OU-10 (Site 5 Soils and Area B Surface Water and Sediment) at NAWC Warminster, Pennsylvania. September 28.

APPENDIX A

FIVE-YEAR REVIEW SITE INSPECTION CHECKLISTS

- OU-1
- OU-3
- OU-4
- OU-7
- OU-9

FIVE-YEAR REVIEW QUESTIONNAIRES

PHOTOGRAPHS

FIVE-YEAR REVIEW INSPECTION CHECKLIST

I. SITE INFORMATION

Site name: OU-1: Area A Groundwater	**Date of inspection: 4/5 - 4/6/11**
Location and Region: Warminster, PA/Region 3	**EPA ID: PA6170024545**
Agency, office, or company leading the five-year review: Tetra Tech for BRAC PMO	**Weather/temperature: Overcast 50°**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Land use controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Fred Mattison (Name) Project Superintendent (Title) 4/6/11 (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. 484.432.1188
   Problems, suggestions; ☐ Report attached Lawn maintenance equipment needs to be replaced.

2. **O&M staff** Bill LeBard (Name) Treatment Plant Operator (Title) _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. 484.354.8987
   Problems, suggestions; ☐ Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.
   Problems; suggestions; ☐ Report attached _____

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.
   Problems; suggestions; ☐ Report attached _____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

III. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks_____

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Self-reporting, visual inspection, annual LUC inspec.
Frequency Periodically/annually
Responsible party/agency US Navy
Contact Jeff Dale (Name) RPM (Title) 4/6/11 (Date) 215.897.4914 (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

_____

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks_____

2. **Land use changes on site** ☐ N/A

Remarks None

3. **Land use changes off site** ☐ N/A

Remarks None

FIVE-YEAR REVIEW INSPECTION CHECKLIST

IV. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
   Remarks_____

B. Other Site Conditions

Remarks Generally in good condition

X. GROUNDWATER REMEDY ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A

   Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ Good condition ☐ Needs Maintenance

   Remarks_____

3. **Spare Parts and Equipment**
   ☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

   Remarks Limited supply

B. Treatment System ☐ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
   ☒ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☒ Air stripping ☒ Carbon adsorbers
   ☒ Filters Bag filters
   ☐ Additive (*e.g.*, chelation agent, flocculent) No
   ☐ Others_____
   ☒ Good condition ☐ Needs Maintenance
   ☒ Sampling ports properly marked and functional
   ☒ Sampling/maintenance log displayed and up to date
   ☒ Equipment properly identified
   ☐ Quantity of groundwater treated annually_____
   ☐ Quantity of surface water treated annually_____

   Remarks Resin for chromium removal, no other metals treatment. O&M manual updated 2010 (draft).

FIVE-YEAR REVIEW INSPECTION CHECKLIST

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks_____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

Remarks_____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks_____

5. **Treatment Building(s)**
☐ N/A ☐ Good condition (esp. roof and doorways) ☒ Needs repair
☐ Chemicals and equipment properly stored

Remarks Roof leaks a little.

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks_____

C. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A

Remarks_____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

I. SITE INFORMATION

Site name: OU-3: Area C Groundwater	**Date of inspection: 4/5/11**
Location and Region: Warminster, PA/Region 3	**EPA ID: PA6170024545**
Agency, office, or company leading the five-year review: Tetra Tech for BRAC PMO	**Weather/temperature: Overcast 50°**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Land use controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☒ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Fred Mattison (Name) Project Superintendent (Title) 4/6/11 (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. 484.432.1188
   Problems, suggestions; ☐ Report attached None offered up r.e. Area C

2. **O&M staff** Bill LeBard (Name) Treatment Plant Operator (Title) _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. 484.354.8987
   Problems, suggestions; ☐ Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

III. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks Fencing was in good shape

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Self-reporting, visual inspection
Frequency Annual, also periodic checks
Responsible party/agency Navy
Contact Jeff Dale RPM 215.887.4914
Name Title Date Phone no.
Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks

2. **Land use changes on site** ☒ N/A

Remarks

3. **Land use changes off site** ☒ N/A

Remarks

FIVE-YEAR REVIEW INSPECTION CHECKLIST

IV. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A
Remarks_____

B. Other Site Conditions

Remarks _____

X. GROUNDWATER REMEDY ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A

Remarks__Telemetry operation system installed in 2010_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance

Remarks_____

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks_____

B. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☒ Carbon adsorbers
☒ Filters__Bag filters_____
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☐ Others_____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually_____
☐ Quantity of surface water treated annually_____

Remarks__Shared treatment system with OU-1A, OU-4. At OU-3, only VOC removal required___

FIVE-YEAR REVIEW INSPECTION CHECKLIST

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks_____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

Remarks_____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks_____

5. **Treatment Building(s)**
☐ N/A ☐ Good condition (esp. roof and doorways) ☒ Needs repair
☐ Chemicals and equipment properly stored

Remarks Roof leaks a little

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks_____

C. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A

Remarks_____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

I. SITE INFORMATION

Site name: OU-4: Area D Groundwater	**Date of inspection: 4/5/11**
Location and Region: Warminster, PA/Region 3	**EPA ID: PA6170024545**
Agency, office, or company leading the five-year review: Tetra Tech for BRAC PMO	**Weather/temperature: Overcast 50°**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Land use controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment *(Inactive)*
- ☐ Other_____
- ☒ Monitored natural attenuation
- ☒ Groundwater containment *(Inactive)*
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Fred Mattison (Name) Project Superintendent (Title) 4/6/11 (Date)
   Interviewed ☐ at site ☒ at office ☐ by phone Phone no. 484.432.1188
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** Bill LeBard (Name) Treatment Plant Operator (Title) _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. 484.354.8987
   Problems, suggestions; ☐ Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

III. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks Fencing was in good shape; however, it does not limit access and is not supposed to.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Self-reporting, visual inspection
Frequency Annual, also periodic checks
Responsible party/agency Navy
Contact Jeff Dale (Name) RPM (Title) _____ (Date) 215.897.4914 (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks

2. **Land use changes on site** ☒N/A

Remarks

3. **Land use changes off site** ☒ N/A

Remarks

FIVE-YEAR REVIEW INSPECTION CHECKLIST

IV. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A
Remarks_____

B. Other Site Conditions

Remarks _____

X. GROUNDWATER REMEDY ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☒ N/A

Remarks Extraction wells were all shut down in 2010.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance

Remarks_____

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks_____

B. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☒ Carbon adsorbers
☒ Filters Bag filters
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☐ Others_____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☐ Quantity of groundwater treated annually_____
☐ Quantity of surface water treated annually_____

Remarks Shared treatment system with OU-1A, OU-3. At OU-4 only VOC removal was required.

FIVE-YEAR REVIEW INSPECTION CHECKLIST

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks_____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

Remarks_____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks_____

5. **Treatment Building(s)**
☐ N/A ☐ Good condition (esp. roof and doorways) ☒ Needs repair
☐ Chemicals and equipment properly stored

Remarks Roof leaks a little

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks_____

C. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A

Remarks_____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

I. SITE INFORMATION

Site name: OU-7: Sites 6/7 Soil and Wastes	**Date of inspection: 4/5/11**
Location and Region: Warminster, PA/Region 3	**EPA ID: PA6170024545**
Agency, office, or company leading the five-year review: Tetra Tech for BRAC PMO	**Weather/temperature: Overcast 50°**

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment (soil cover)
- ☐ Access controls
- ☒ Land use controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other – Sedimentation controls
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____
   _____

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____
   _____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

III. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks__Signs posted in Park (see photos), clearly visible._____

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) __Inspections_____
Frequency _Annual_____
Responsible party/agency ___Navy_____
Contact ___Jeff Dale_____ _____RPM_____ _____ 215.897.4914
Name Title Date Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks_____

2. **Land use changes on site** ☒ N/A

Remarks_____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

3. **Land use changes off site** ☒ N/A
Remarks_____
_____

IV. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A

Remarks__Walking path through park passes by the site._____
_____

B. Other Site Conditions

Remarks _____
_____
_____

V. LANDFILL COVER X Applicable ☐ N/A

A. Landfill Surface

1. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_____ Depth_____

Remarks___See photos_____
_____

2. **Differential Settling** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____
_____

3. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
☒ Trees/Shrubs (indicate size and locations on a diagram)

Remarks___See photos_____
_____

4. **Evidence of Burrowing Animals** ☐ Location shown on site map ☒ Not evident

Remarks_____
_____

5. **Cracks** ☐ Location shown on site map ☒ Cracking not evident

Lengths_____ Widths_____ Depths_____
Remarks_____
_____

6. **Holes** ☐ Location shown on site map ☒ Holes not evident

Areal extent_____ Depth_____
Remarks_____
_____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident

Areal extent_____ Height_____
Remarks_____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_____
☐ Ponding ☐ Location shown on site map Areal extent_____
☐ Seeps ☐ Location shown on site map Areal extent_____
☐ Soft subgrade ☐ Location shown on site map Areal extent_____

Remarks_____

VI. SEDIMENTATION CONTROLS

1. **Sediment Accumulation** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____
☐ Sediment does not impede flow

Remarks_____

2. **Subsidence** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____

3. **Ponding** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____

4. **Flow Obstructions** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____

5. **Erosion** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____

6. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent_____ Type_____

Remarks Site overgrown with natural vegetation, no maintenance required.

FIVE-YEAR REVIEW INSPECTION CHECKLIST

I. SITE INFORMATION	
Site name: OU-9: Area A Soil - Sites 1, 2, and 3	**Date of inspection: 4/5/11**
Location and Region: Warminster, PA/Region 3	**EPA ID: PA6170024545**
Agency, office, or company leading the five-year review: Tetra Tech for BRAC PMO	**Weather/temperature: Overcast 50°**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Land use controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- ☒ Other – Erosion and sedimentation controls, periodic stream monitoring

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____
   _____

   Agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Problems; suggestions; ☐ Report attached _____
   _____

FIVE-YEAR REVIEW INSPECTION CHECKLIST

III. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks Fencing in good shape

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Inspections
Frequency Annual
Responsible party/agency Navy
Contact Jeff Dale (Name) RPM (Title) _____ (Date) 215.897.4914 (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks

2. **Land use changes on site** ☒ N/A

Remarks

FIVE-YEAR REVIEW INSPECTION CHECKLIST

3. **Land use changes off site** ☒ N/A

Remarks_____

_____

IV. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks Road borders site area. Paved, good condition._____

_____

B. Other Site Conditions

Remarks _____

_____

_____

V. EROSION AND SEDIMENTATION CONTROLS

A. Erosion Controls

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent_____ Depth_____

Remarks_____

_____

2. **Holes** ☐ Location shown on site map ☒ Holes not evident
Areal extent_____ Depth_____

Remarks_____

_____

3. **Vegetative Cover** ☐ Grass ☒ Cover properly established ☒ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)

Remarks Rip rap placed on slopes to stabilize bank areas._____

_____

4. **Evidence of Burrowing Animals** ☐ Location shown on site map ☒ Not evident

Remarks_____

_____

A. Sedimentation Controls

1. **Sediment Accumulation** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____
☐ Sediment does not impede flow

Remarks_____

_____

2. **Subsidence** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____
_____

3. **Ponding** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____
_____

4. **Flow Obstructions** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____

Remarks_____
_____

5. **Erosion** ☐ Location shown on site map ☒ Not evident
Areal extent_____ Depth_____
Remarks_____
_____

6. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent_____ Type_____

Remarks_____
_____

VI. SEDIMENT MONITORING

1. **Sediment Monitoring** Type of monitoring None
Frequency_____

Remarks_____
_____

FORMER NAWC WARMINSTER
FIVE-YEAR REVIEW QUESTIONNAIRE
APRIL 2011

Date/Time: 04/06/11, 9:40
Location: Warminster Authority Building
Phone: 215.345.4330
Interviewee: Toby Kessler, PG
Position: Representative for Township Engineer
Interviewer:

1. **Do you have any past or present knowledge of the Site? If you are aware of the Site, what is your overall impression of the Site?**

   Yes, I have attended RAB meetings and reviewed reports prepared by the Navy and others since 2008.

2. **What effects do you think the Site operations may have had on the surrounding community?**

   Currently, the site operations include operation of groundwater treatment and maintaining engineered caps (primarily). These current operations have a positive effect, as they protect the public and allow for reuse of the property

3. **Are you aware of any community concerns regarding the Site or its operation and administration?**

   There is some concern for future use of Shenandoah Woods area.

4. **Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing or emergency responses from local authorities?**

   No

5. **Do you feel well informed about the Site's activities and progress?**

   Yes

6. **Do you have any comments, suggestions or recommendations regarding the Site's management or operation?**

   No

7. **Additional Comments?**

   Vapor intrusion needs to be evaluated. Status of Shenandoah Woods area will need to be communicated as part of reuse planning.

FORMER NAWC WARMINSTER
FIVE-YEAR REVIEW QUESTIONNAIRE
APRIL 2011

Date/Time: 04/06/11
Location: Warminster RAB Meeting
Phone: 215.814.3361
Interviewee: Dennis Orenshaw, USEPA
Position: Project Manager
Interviewer:

1. **Do you have any past or present knowledge of the Site? If you are aware of the Site, what is your overall impression of the Site?**

   Yes, investigated and cleaned up in accordance with CERCLA standards. Reused in a manner beneficial to the community and protective of human health and the environment.

2. **What effects do you think the Site operations may have had on the surrounding community?**

   Efficient reuse created jobs, open space, and housing opportunities. Clean-up resulted in reduced risk to community members.

3. **Are you aware of any community concerns regarding the Site or its operation and administration?**

   Groundwater contamination still exists and requires contaminated remediation and monitoring.

4. **Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing or emergency responses from local authorities?**

   No

5. **Do you feel well informed about the Site's activities and progress?**

   Yes

6. **Do you have any comments, suggestions or recommendations regarding the Site's management or operation?**

   No

7. **Additional Comments?**

   Navy seems committed to doing good job of site management resulting in reduced risk and reuse.

FORMER NAWC WARMINSTER
FIVE-YEAR REVIEW QUESTIONNAIRE
APRIL 2011

Date/Time: 04/06/11
Location: WMA Boardroom
Phone: NA
Interviewee: Norm Kelly
Position: RAB Co-chair
Interviewer: JPO

1. **Do you have any past or present knowledge of the Site? If you are aware of the Site, what is your overall impression of the Site?**

   Yes, RAB Co-chair. Navy is doing everything they can but process is slow.

2. **What effects do you think the Site operations may have had on the surrounding community?**

   Not much, most of community not even aware of things going on now.

3. **Are you aware of any community concerns regarding the Site or its operation and administration?**

   None that I am aware of.

4. **Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing or emergency responses from local authorities?**

   None that I am aware of.

5. **Do you feel well informed about the Site's activities and progress?**

   Yes, regular RABs and info provided.

6. **Do you have any comments, suggestions or recommendations regarding the Site's management or operation?**

   No

7. **Additional Comments?**

OU-4/Area D

Layout

Well Vaults

Monitoring Well

OU-1A/Area A

Groundwater Treatment Plant

Fencing

Extraction Wells

Monitoring Wells

Well Vaults

OU-9/Sites 1, 2, and 3

Fencing/Rip-Rap

OU-7/Sites 6 and 7

General Layout

Vegetation

Vegetation/Walking Path

Signs


NATURE AREA
SECTIONS OF THIS PARK HAVE BEEN SET ASIDE AS NATURAL AREAS TO PROTECT AND/OR STUDY WILDLIFE AND PLANT SPECIES.
NO HUNTING, TRAPPING, SHOOTING FIREARMS OR BOWS PERMITTED IN THIS PARK.
HARMING OR DISTURBING WILDLIFE MAY RESULT IN A FINE OF UP TO $1000.00.
NO DOGS ALLOWED IN NATURE AREAS DOGS MUST BE LEASHED.
VISITORS TO THIS AREA ARE TO REMAIN ON THE PATHWAYS.


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VISITORS TO THIS AREA ARE TO REMAIN ON THE PATHWAYS.
THESE RULES STRICTLY ENFORCED BY THE WARMINSTER TOWNSHIP POLICE DEPARTMENT TO REPORT VIOLATIONS CALL 215-672-1000 FOR EMERGENCIES DIAL 911
WARMINSTER TWP ORDINANCES 321 & 604

OU-3/Area C

Drainage Swale

Fencing

Well Vaults

Monitoring Wells

Electrical Panels/Telemetry

Transfer Sumps


NAWCA
GWTS

OU-1A/Area A

Well Vault

Transfer Sump

Electrical Panel

GAC Tanks

Stripper

Resin Stock

Resin Filter

Equalization Tank