Department of the Navy

Record of Decision for OU-7

Naval Air Warfare Center

June 2000

DECLARATION

SITE NAME AND LOCATION

Naval Air Development Center

Soil and Waste at Sites 6 and 7 (Operable Unit 7)

Warminster, Pennsylvania

CERCLIS ID # PA6170024545

STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for Soil and Waste at Sites 6 and 7 (Operable Unit 7 or OU-7), at the Naval Air Development Center (NADC) ("the Site") in Warminster, Pennsylvania. This determination has been made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In 1993, the Site was renamed the Naval Air Warfare Center (NAWC) Aircraft Division. This decision is based on the Administrative Record file for the Site.

The Commonwealth of Pennsylvania concurs with the Selected Remedy.

ASSESSMENT OF THE SITE

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

DESCRIPTION OF THE SELECTED REMEDY

Soil and waste associated with Site 6 and Site 7 has been defined as Operable Unit 7 (OU-7) at the Site.

Groundwater underlying and downgradient of Site 6 and Site 7 has been designated as Area B groundwater and is being addressed separately under Operable Unit 1 (OU-1). An interim remedy ROD addressing OU-1 was issued in 1993. A ROD addressing the final remedy for Area B groundwater will be issued in the future. Surface water and sediment associated with Sites 6 and 7 are being addressed under the RI/FS for Site 5, located adjacent to Sites 6 and 7.

Soil and wast associated with Site 6 and Site 7 (OU-7) do not includ any source materials constituting a principal threat as defined by the NCP. Therefore, the Selected Remedy does not address such a threat.

The major components of the Selected Remedy for OU- 7 are:

1. Placement of a permanent two foot vegetated soil cover over sitewide subsurface soils and implementation of any engineering controls necessary to establish and maintain a stable cover;
2. Deed restrictions which provide that the two foot vegetated soil cover remain in place and that any plans for excavation below two feet within the area of sitewide subsurface soils be approved by the Navy and/or EPA*;
3. A deed restriction to prohibit residential use of the parcel*;
4. A deed restriction to prevent industrial/commercial use, especially day care facilities, of the area of sitewide surface soils without Navy and/or EPA approval of a risk assessment for industrial/commercial use and additional environmental response work, if necessary*;
5. Periodic monitoring to identify measures necessary to maintain the two foot vegetated soil cover and to identify whether deed restrictions are being adhered to as required;
6. Maintenance of the two foot vegetated soil cover based on periodic monitoring. Maintenance may include revegetation, placement of additional soil cover, engineering controls and/or other measures; and
7. Enforcement of deed restrictions based on periodic monitoring.

* Deed restrictions are to be included in the deed entered into for transfer of property from the Navy to the next property owner.

STATUTORY DETERMINATIONS

The Selected Remedy for OU-7 is protective of human health and the environment, complies with Federal and Commonwealth of Pennsylvania requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy for OU-7 does not satisfy the statutory preference for treatment as a principal element of the remedy. Based on the remedial investigation and feasibility study, the soil and/or waste of concern at OU-7 is not amenable to treatment. OU-7 does not include a principal threat waste as defined by the NCP.

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for the Site.

- Chemicals of concern (COCs) and their respective concentrations.
- Baseline risk represented by the COCs.
- Remediation levels established for COCs and the basis for the levels.
- Current and reasonably anticipated future land use assumptions used in the baseline risk assessment

- Remediation levels established for COCs and the basis for the levels.
- Current and reasonably anticipated future land use assumptions used in the baseline risk assessment and ROD.
- Potential land use that will be available at the site as a result of the selected remedy.
- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.
- Key factors that led to selecting the remedy (i.e., how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria).

Thomas C. Ames

Thomas C. Ames
BRAC Environmental Coordinator
Naval Air Warfare Center
Warminster, Pennsylvania

6.14.00
Date

Abraham Ferdas

Abraham Ferdas, Director
Hazardous Site Cleanup Division
U.S. EPA - Region III

6/20/00
Date

DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The former Naval Air Development Center is located in Warminster Township and Ivyland Borough, Bucks County, Pennsylvania. The National Superfund electronic database identification number for the Naval Air Development Center is PA6170024545. The Naval Air Development Center was renamed the Naval Air Warfare Center (NAWC) Aircraft Division in January 1993 and was disestablished on September 30, 1996, in response to the requirements of the Base Realignment and Closure Act (BRAC). The Department of the Navy is the lead agency and EPA the support agency for CERCLA activities at NAWC. The Department of Defense is the source of cleanup monies for NAWC. Soils and wastes associated with Site 6 and Site 7 at NAWC have been identified as Operable Unit 7 at NAWC and are addressed by this ROD. Site 6 and Site 7 are two of eight sites reported by the Navy in 1980 to have been used for disposal of wastes which may contain CERCLA hazardous substances. Site 6 was reported to be a series of pits used for disposal of miscellaneous waste and Site 7 was reported to be two trenches used for the disposal of sludge.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Site History

NAWC is a 824-acre facility located in Warminster Township, Northampton Township, and Ivyland Borough, Bucks County, Pennsylvania (see Figure 1 for a site location map). As a result of the Base Realignment and Closure Act (BRAC), NAWC ceased operations on September 30, 1996. The majority of NAWC, including Sites 6 and 7, is being transferred to the private sector.

The facility lies in a populated suburban area surrounded by private homes, various commercial and industrial activities, and a golf course. On-site areas include various buildings and other complexes connected by paved roads, the runway and ramp areas, mowed fields, and a small wooded area.

Commissioned in 1944, the facility's main function was research, development, testing, and evaluation for naval aircraft systems. NAWC also conducted studies in anti-submarine warfare systems and software development. Historically, wastes were generated during aircraft maintenance and repair, pest control, fire-fighting 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 in several pits, trenches, and landfills throughout the facility property.

NAWC was listed on the Superfund National Priorities List (NPL) in 1989. This list 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 eight locations covering more than 7 acres. These locations include the following:

- Three waste disposal pits (sites 1, 3, and 6).
- Two sludge disposal pit areas (sites 2 and 7).
- Two landfills (sites 4 and 5).
- One fire-fighting training area (site 8).

Site 6 was reportedly used for disposal activities from 1960 to 1980 for the disposal of unknown quantities of waste paints, solvents, oil, flammable wastes, grease trap waste, and demolition debris. These materials were reportedly disposed in pits and through general dumping and backfilling throughout the area.

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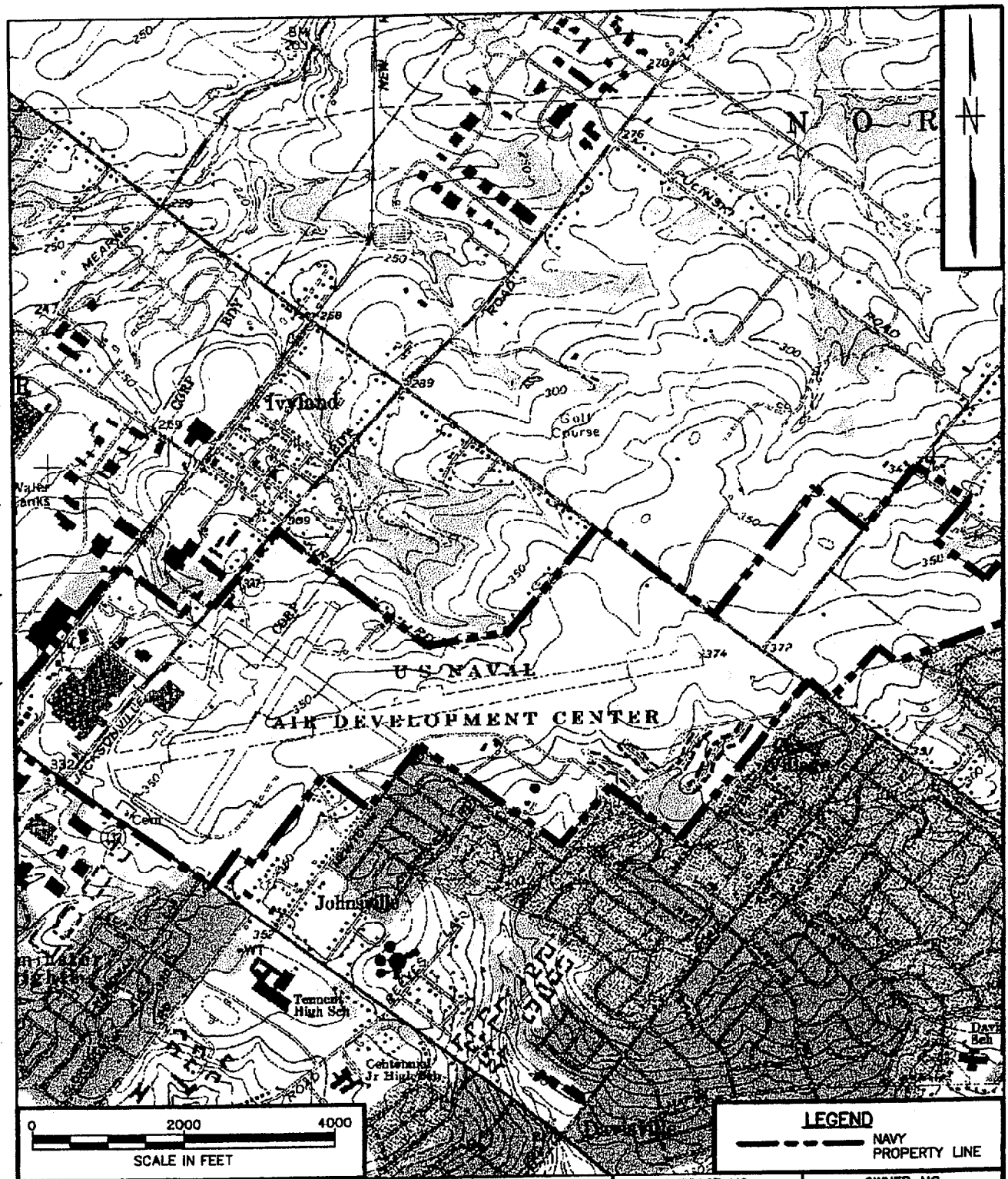

DRAWN BY A.S.M. DATE 11/24/1998	Tetra Tech NUS Inc.	CONTRACT NO. N62472-90-D-1298	OWNER NO. CTØ 0252
CHECKED BY DATE	SITE LOCATION MAP	APPROVED BY	DATE 6/29/99
COST/SCHED-AREA	FORMER NAWC WARMINSTER	APPROVED BY	DATE
SCALE 1 in.=2000 ft.	WARMINSTER, PENNSYLVANIA	DRAWING NO. FIGURE 1	REV. 0

FORM L:\AUTOCAD\BLOCKS\BORDERS\TETRA TECH\ TTNUS_AV3.DWG – REV 0 – 11/18/1998

Site 7 reportedly consisted of two trenches used from 1950 to 1955 for disposal of industrial wastewater treatment sludge generated by NAWC. The trenches were reported to be 100 feet long by 12 feet wide and 8 feet deep. The estimated potential capacity of each trench is 356 cubic yards. The trenches were reportedly backfilled with fill after each dumping episode and, upon closure in 1955, covered with 2 feet of soil, regraded, and reseeded. (See Figure 2 for the location of Sites 6 and 7).

Site 6 and Site 7 were reported to be in close proximity to one another. Remedial investigations (described below) have confirmed this and determined that pits and trenches reported as Sites 6 and 7 are both within an area of approximately five acres. This area is undeveloped and consists of open fields and a wood lot. Site 5 and a Navy housing area being retained by the Navy is located immediately east southeast of Sites 6 and 7.

The area of Sites 6 and 7 was used for the deposition 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.

B. Enforcement Actions

No enforcement actions have been taken at Sites 6 and 7. The Navy has owned the property since the mid-1900s and is the lead agency for CERCLA work at NAWC.

III. SITE INVESTIGATIONS

No significant environmental investigations of Site 6 and Site 7 were performed prior to the initiation of CERCLA remedial investigation (RI) work in 1991. RI work at Sites 6 and 7 has been conducted in several phases.

The Phase I RI (SMC Martin, 1991) included cursory soil gas and geophysical surveys and several exploratory test pits, while the Phase II RI (HNUS, 1992) was limited to sampling of soil from four borings.

Based primarily on the findings of the Aerial Photo Site Analysis for NAWC Warminster (EPIC, 1994), comprehensive RI work addressing Sites 6 and 7 was performed under the Phase III RI. Phase III geophysical and soil gas survey results and soil sample results for Sites 6 and 7 were reported in letter reports submitted in 1995 (Halliburton NUS Preliminary Geophysical Survey Results, April 19, 1995; Halliburton NUS Additional Geophysical Results for Site 6, May 22, 1995; and Halliburton NUS Proposed Subsurface Soil Investigation for Area B, July 26, 1995) and in a draft Phase III RI issued in 1996 (HNUS, 1996). The balance of Phase III RI results for Sites 6 and 7 were reported in a Draft Site 6 Removal Evaluation Report (B&R Environmental, 1996), which recommended a removal action be performed at Sites 6 and 7. Based on findings of the Phase III RI work, a supplemental RI was performed at Sites 6 and 7 in 1997, with the findings included in a Preliminary Data and Risk Evaluation Report (B&R Environmental, 1997).

Based on the RI work referenced above, a removal action was performed at Sites 6 and 7 in May through July 1997. The action included the excavation and removal of approximately 3,698 tons of soil and debris from three discrete locations at Sites 6 and 7 along with the removal of debris and construction rubble from the surface of Sites 6 and 7. Post-removal soil sampling was performed to confirm that clean-up goals established for removal action for the protection of groundwater and human health were attained within the designated removal action areas. The results of post-removal action sampling and a preliminary evaluation of the residual risk presented by soils and wastes at Sites 6 and 7 were presented in a Draft Site 6 Summary Report issued in January 1998 (B&R Environmental, 1998).

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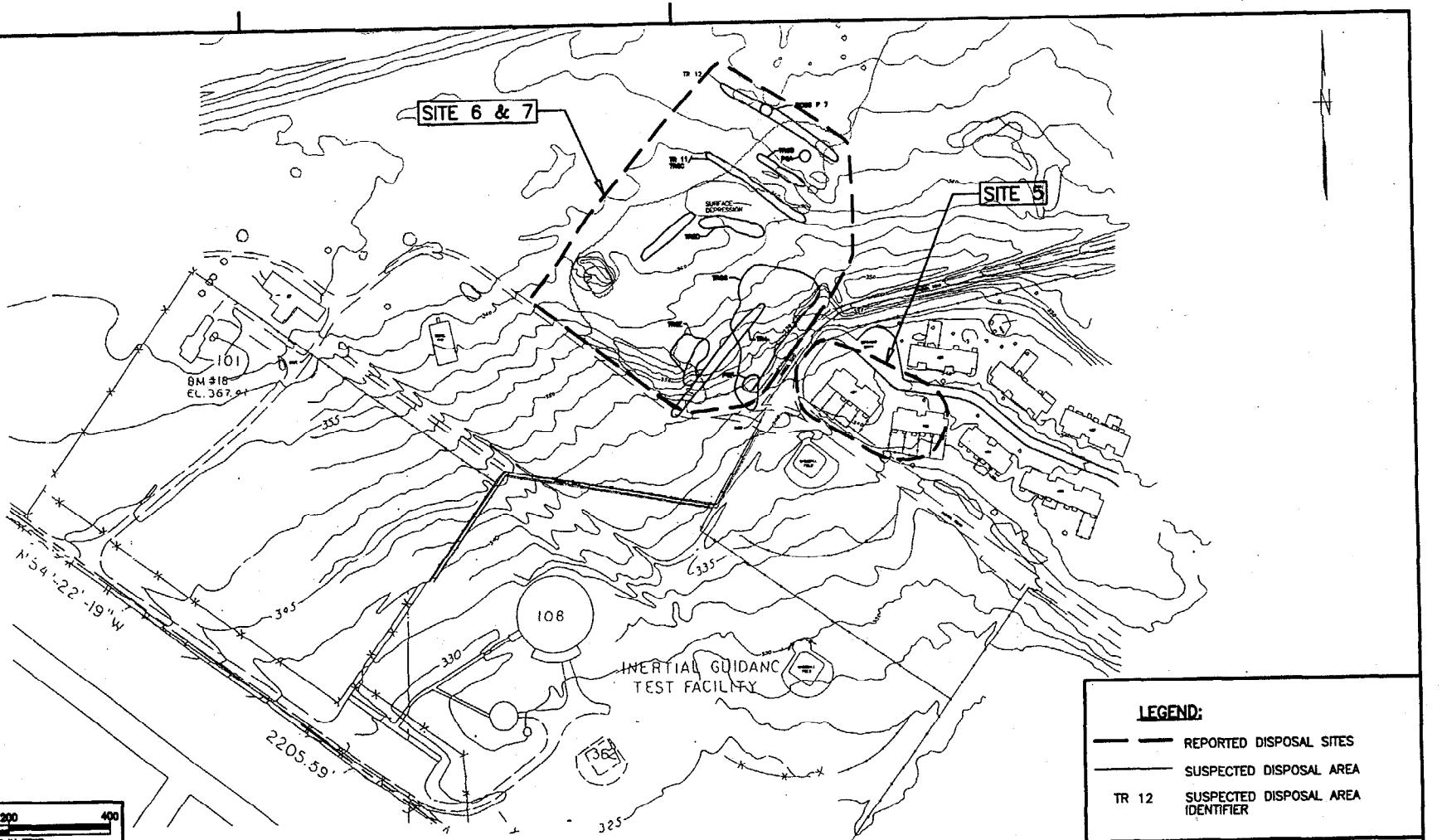

LEGEND:

- REPORTED DISPOSAL SITES
- SUSPECTED DISPOSAL AREA
- TR 12 SUSPECTED DISPOSAL AREA IDENTIFIER

0 200 400
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD
1	8/8/99	TITLE & DISPOSAL AREAS UPDATED	LDL		

REFERENCES

DRAWN BY A.S.M. DATE 11/23/1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 200 in.

Tetra Tech NUS, Inc.

AREA B – SITES 5, 6 and 7
FORMER NAWC, WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. STO 0252
APPROVED BY DATE 8/10/99
APPROVED BY DATE
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In November 1999, a final RI report was issued for soils and waste at Sites 6 and 7 (Tetra Tech NUS, 1999). The subject report considered all previous RI work and characterized conditions at Sites 6 and 7 after the removal.

While the RI report of November 1999 assesses the potential impact of soils and waste at Sites 6 and 7 on groundwater quality, the report does not address underlying and downgradient groundwater, which has been identified as Area B groundwater. Area B groundwater is being addressed under Operable Unit 1 (OU-1). RI and FS reports for Area B groundwater were issued in April 1993 (Halliburton NUS, 1993). In response to these reports, an interim remedy Record of Decision was issued for Area B groundwater on September 29, 1993. This ROD concluded that Area B groundwater presented an unacceptable risk and selected an interim remedy of pumping and treatment of groundwater to control contaminant migration while additional investigations were completed. Based on an evaluation of data generated during the construction of the planned extraction well network for Area B groundwater, the pumping and treatment of Area B groundwater has been deferred and the nature of necessary remedial actions for Area B groundwater is being further evaluated. This evaluation will be included in a final RI to be issued for Area B groundwater. A final decision regarding actions necessary for Area B groundwater will be made in a final remedy ROD for OU-1.

The RI report of November 1999 also does not assess surface water and sediment downgradient of Sites 6 and 7. The final remedy ROD for Site 5 will address these media.

IV. HIGHLIGHTS OF COMMUNITY PARTICIPATION

In accordance with Section 113 and 117 of CERCLA, the Navy issued a Proposed Remedial Action Plan (PRAP) for OU-7 on February 17, 2000. The PRAP identified a preferred remedial alternative for OU-7 and provided a public comment period for the PRAP from February 17, 2000 through March 17, 2000. The PRAP for OU-7 and the Administrative Record file which supports the PRAP were (and continue to be) available to the public in the Administrative Record and information repositories maintained at the Navy Caretaker Site Office located at 860 Flamingo Alley, Warminster, Pennsylvania and at the Bucks County Library located at 150 South Pine Street, Doylestown, Pennsylvania. Public notice was provided in the *Bucks County Courier Times, Philadelphia Inquirer,* and *Intelligencer* and a public meeting was held on March 1, 2000 at the North American Technology Center located at 626 Jacksonville Road in Warminster, Pennsylvania. Comments received during the public comment period are presented in Appendix B. Additional community involvement, including Restoration Advisory Board (RAB) activities, are detailed in Sections XII and XV.

V. SCOPE AND ROLE OF RESPONSE ACTION

VI.

Section 300.430 (a) (1) (ii) (A) of the NCP, 40 C.F.R. Section 300.340 (a) (1) (A) provides that CERCLA 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 has organized work to date into eight operable units (OUs). These OUs are as follows:

- OU-1: Area A and Area B groundwater.
- OU-2: Off-base private wells.
- OU-3: Area C groundwater.
- OU-4: Area D groundwater.
- OU-5: Soil, sediment and surface water at Site 8.
- OU-6: Soil, sediment and surface water at Site 4.
- OU-7: Soil and waste at Site 7.

- OU-8: Soil and sources other than groundwater in Area D.

The Navy and EPA selected an interim remedy for OU-1 in a ROD issued on September 23, 1993 and the removal action for OU-2 was selected by EPA in a Removal Action Memorandum signed on July 14, 1993. The Navy and EPA selected a final remedy for OU-3 in a ROD signed March 10, 1995. In September 1999, the Navy and EPA determined that institutional controls were necessary to prevent the use of Area C groundwater presenting an unacceptable human health risk and to protect the long-term effectiveness of the OU-3 remedy. An Explanation of Significant Differences (ESD) was signed to make changes to the OU-3 ROD. The institutional controls address portions of Area C (including Sites 4 and 8) on both current Navy and private property, and consist of restrictions on the use of water from existing wells, restrictions on the future installation of wells, and restrictions on the use of wells installed in the future.

An interim remedy for OU-4 was selected in a ROD signed by the Navy and EPA on September 30, 1997. A no further action ROD for OU-5 was signed by the Navy and EPA on September 30, 1999, while a no further action ROD for OU-6 is under review. The selected remedies for OU-1, OU-3, and OU-4 are all operational at this time, and the removal action addressing OU-2 has been completed. This ROD documents the selected remedy for OU-7.

OU-7consists of soil and waste at Sites 6 and 7. This ROD determines that potential ingestion and dermal contact with soil/waste at Sites 6 and 7 pose potential unacceptable risks to human health. This ROD presents a remedial action to address these unacceptable risks.

Groundwater underlying and downgradient of Sites 6 and Site 7 is being addressed under OU-1. Surface water and sediment downgradient of Sites 6 and 7 are being addressed with Site 5.

VI. SITE CHARACTERISTICS

Remedial investigations have determined that Sites 6 and 7 are both located in an approximately 5-acre area of open fields and woodlot in the eastern portion of the former NAWC. There are no streams or wetlands within this 5-acre area. Surface water runoff from Sites 6 and 7 drains south and southeast to property being retained by the Navy. This area contains surface water collection drains and culverts that flow to a concrete stormwater drainage channel approximately 600 feet from Sites 6 and 7. This channel carries water another 1,000 feet south before it passes under a roadway and empties into an unnamed tributary to Southampton Creek.

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 below ground surface, where a transition to weathered bedrock begins. Competent bedrock begins at a depth of 10 to 20 feet. Bedrock consists of alternating sequences of fine- and course-grained, gently dipping lithologic units which vary in thickness from less than a foot to 60 feet. The fine-grained units consist of siltstones and shales, while the course-grained units are sandstones. The water table or overburden aquifer is not consistently present within the area. Where it is present, water is encountered at about 20 feet. The bedrock aquifer occurs at a depth of 75 to 120 feet at Sites 6 and 7.

The RI has confirmed that waste was disposed in a series of trenches and pits in the area of Sites 6 and 7. Many of the trenches and pits were initially identified by the interpretation of available aerial photographs and visual observations of depressions in the ground surface. Geophysical surveys, soil borings and test pits further determined the location of the trenches and pits. Pits/trenches identified during this process and subsequently determined to contain buried wastes include trenches which the RI has designated as TR4, TR6D, TR6E, TR11, TR12, an unnamed trench immediately southwest of trench TR6D, and pits designated as P6A and pit P6F (see Figure 2).

Trenches TR4, TR6E and pit P6F were found below a layer of demolition debris and soil which was deposited over part of the area of Sites 6 and 7. The debris includes a substantial quantity of concrete apparently generated during the demolition of an aircraft runway and varies between 1 foot and 7 feet in thickness.

Much of the debris was found to be covered with at least two feet of soil and vegetation during the RI. While the majority of identified buried waste within the area of debris deposition was greater than 6 feet below ground surface, buried waste on the outer edges of the debris layer in several locations was noted as close as 2 feet from the ground surface.

Outside of the area of the deposited debris, the waste in trenches/pits was generally covered with several feet of soil and located between 2 and 8 feet below ground surface. In certain cases, the cover material over the trenches had subsided, creating depressions which could be observed at the surface.

Waste observed in the trenches/pits included construction debris, large concrete slabs, trash, charred debris, asphalt, metal and general refuse. A sludge-like waste material was observed in trenches TR4, TR11, TR12 and the unnamed trench southwest of trench TR6D. Crushed and deteriorated drums, portions of drums and/or metal containers were encountered in 8 different test pits conducted during the RI. The total number of drums did not appear to exceed 10. With the exception of two drums, the subject drums/containers did not contain a substantial quantity of waste material. The drums of concern contained solid material. All of the drums encountered during the test pitting were removed from the site and disposed of in accordance with federal and state requirements.

Soil gas surveys were conducted to determine where volatile organic compounds (VOCs) may have been disposed and whether waste disposed at Sites 6 and 7 may be a source of chlorinated VOCs present in Area B groundwater. TCE and PCE, which are both present in Area B groundwater, were detected in soil gas at a number of soil gas stations in the vicinity of pit 6F. This was the only area where soil gas surveys detected VOCs at levels of 50 ug/l or higher at multiple sample locations.

VII. NATURE AND EXTENT OF CONTAMINATION

The locations of soil borings and test pits conducted to characterize the nature and extent of contamination associated with soil and waste at Sites 6 and 7 were based primarily on the interpretation of aerial photos, visual observations of the ground surface, geophysical survey results and soil gas survey results.

Sampling of soils in the vicinity of pit P6F confirmed the presence of both TCE and PCE in soils at concentrations above contaminant-specific soil screening levels developed by EPA for the protection of groundwater quality. TCE and PCE are both relatively mobile in soils and may migrate to groundwater. In response, in 1997, the Navy performed a removal action in the area of pit P6F. During the excavation of soils from pit P6F, soils with elevated levels of polychlorinated biphenyls (PCBs) lead, chromium, benzo(a)anthracene, and benzo(a)pyrene were also detected and removed. In addition, as part of the same removal action, the Navy excavated soils in the area of trench TR6E and pit 6A. In the case of each excavation, soils were removed until contaminant levels were below the cleanup levels identified in a Verification Sampling Plan (B&R Environmental, August 1996). This was verified by analytical data in a series of letter reports issued by Brown and Root Environmental in 1997 (see References section of the RI report of November 1999). This data confirmed that all soils within the excavation areas with contaminant levels above the identified cleanup levels were removed. These cleanup levels were as follows:

Removal Action Cleanup Goals

Contaminant	Cleanup Goal (mg/kg)
Antimony	500
Barium	88,000
Chromium	6,300
Copper	50,000
Lead	500
Manganese	29,000
Nickel	25,000
PCBs	1.6
Banzo(a)anthracene	17
Benzo(a)pyrene	1.7
1,2-DCE	4.8
TCE	0.34
PCE	0.34

During the removal actions samples were collected and analyzed for full scan organics and inorganics and the results were compared to human health risk-based screening levels and groundwater protection screening levels established for groundwater contaminants of concern. If any contaminant was present at levels that exceeded the screening concentration, a site-specific cleanup goal was established for that compound and compared to the analytical result. If the site sample result exceeded the cleanup goal, additional excavations and follow-up sampling were conducted until all levels were below the cleanup goals. VOCs, the potential groundwater contaminants of concern for the area, were not identified in any of the samples collected from the excavations. The Final RI provides data regarding the quality of soils / wastes left in place after the removal action and still in place at this time. The balance of this section summarizes this data.

Figure 3 indicates the location of all subsurface soil/waste samples collected outside of the areas addressed by the removal action as well as the areas addressed by the removal action. Table 1 tabulates the data from sample locations outside of the removal areas and provides the occurrence and distribution of organics and inorganics in sitewide subsurface soils at Sites 6 and 7. A total of 86 subsurface locations were sampled. The contaminants of concern (COCs) in sitewide subsurface soils for the anticipated recreational use of the property have been determined to be chromium and thallium, which were detected at levels ranging up to 46,800 mg/kg and 89 mg/kg, respectively. (Note: The basis for the identification of these substances as COCs as well other COCs identified in this section is discussed under the Current and Potential Future Uses and Summary of Site Risks sections of this ROD). While residential use is not reasonably anticipated, COCs in sitewide subsurface soils under potential residential use include arsenic, cadmium, chromium, manganese, mercury, silver, thallium, Aroclor-1254, Aroclor-1260, benzo(a)pyrene, and dibenzo(a,h)anthracene.

The RI also tabulated analytical results for subsurface soil samples collected within three specific zones at Sites 6 and 7- Zone 1, Zone 2 and Zone 3 (see Figure 4). Each of these zones contained discrete disposal

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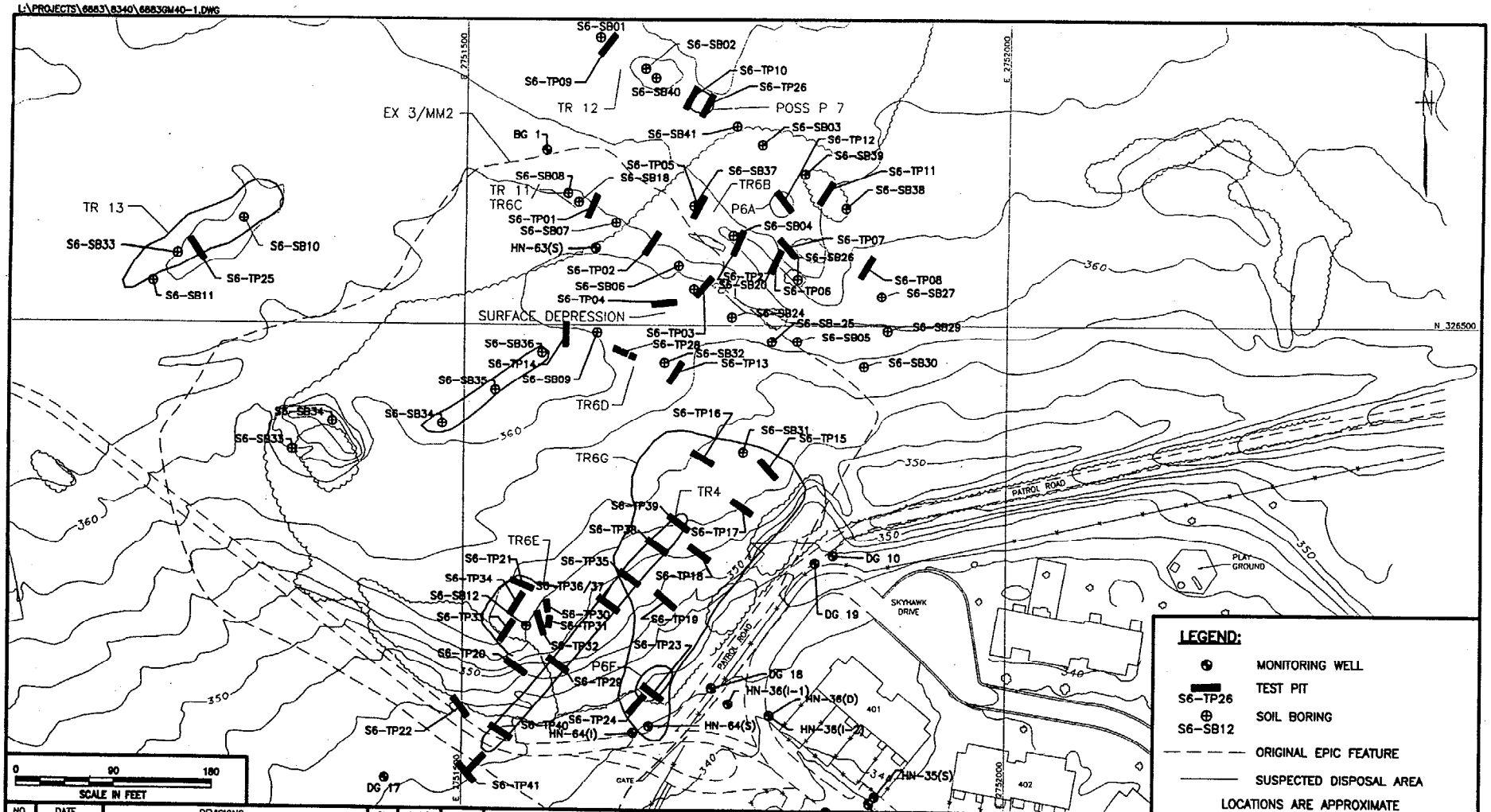


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12/2/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

TEST PIT AND BORING LOCATION MAP
AREA B-SITES 6 AND 7
NAWC, WARMINSTER

CONTRACT NO. 6883
OWNER NO.
APPROVED BY
DATE 11/26/99
APPROVED BY
DATE
DRAWING NO. FIGURE 3
REV. 1

FORM CADD NO. SOUTH_FRAME - REV 0 - 08/11/91

TABLE 1
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN SITEWIDE SUBSURFACE SOILS, SITE 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA

Substance	Background Data					Site-Related Data						
	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	*Range of Positive Detection* Min.	*Range of Positive Detection* Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration	Recreational Risk-Based Concentration
aluminum	*31/31*	*4780*	*18100*	*13400*	*BG-12*	*86/86*	*1970*	*251000*	*15000*	*S6-TP-COMP*	*15600*	*1388520.8*
antimony	1/22	13.6	13.6	3.75	BG-16	22/86	2.6	164	7.26	S6-TP08-01	7.16	50.5
arsenic	27/31	0.28	12.1	3.88	BG-11	83/86	0.86	80.7	10.9	S6-TP02-01	12.6	8.4
barium	27/29	34.1	225	61.6	BG-28	83/86	12.6	922	113	S6-TP02-01	130	8836
beryllium	27/31	0.31	1.7	0.806	BG-31	81/86	0.23	4.6	0.898	S6-SB-4005	0.99	2.9
cadmium	0/31	0	0	0	NA	31/85	0.41	152	13.2	S6-TP-29-07	23.5	63.1
calcium	25/29	240	1910	664	BG-24	83/86	340	145000	17200	S6-TP-33-W1	27400	0
chromium	31/31	7.9	35.3	19.4	BG-12	85/86	4.4	46800	1650	S6-TP-29-W3	2280	631.1
cobalt	27/30	1.6	22.1	8.9	BG-31	83/86	1.8	146	16.7	S6-TP-29-W3	18.3	7573.8
copper	29/31	3.6	30.6	11.8	BG-29	83/86	2.9	14300	330	S6-TP-COMP	230	5049.2
iron	31/31	6980	410500	33100	BG-30	86/86	4130	264000	46800	S6-TP-35-07	51000	37868.8
lead	31/31	1.6	96.5	11.7	BG-13	85/86	3.1	39300	595	S6-TP02-01	130	400
magnesium	27/31	518	4960	1980	BG-24	84/86	456	77000	3930	S6-TP-33-W1	3650	0
manganese	31/31	30.9	2010	424	BG-28	86/86	65	1320	517	S6-SB-1805	592	2903.3
mercury	1/28	0.37	0.37	0.0436	BG-23	32/86	0.06	5.6	0.624	S6-SB-2104	0.818	37.9
nickel	20/27	4.1	21.7	10.5	BG-31	86/86	2.9	345	25.8	S6-TP02-01	27.1	2524.6
potassium	27/29	89.1	3050	706	BG-24	80/86	138	8740	722	S6-TP-29-W3	808	0
selenium	0/20	0	0	0	NA	4/86	0.83	5	2.17	S6-TP02-01	2.84	631.1
silver	0/17	0	0	0	NA	62/86	0.63	368	45.8	S6-TP-36-09	111	631.1
sodium	5/20	55.2	86.7	102	BG-25	73/85	44.6	740	117	S6-TP02-01	130	0
thallium	3/31	0.37	0.42	0.378	BG-31	40/86	3.7	89.1	10.9	S6-SB-3804	19.6	10.1
vanadium	31/31	15.4	45	29.7	BG-12	82/86	6.3	73	26.2	S6-SB12-02	40.8	883.6
zinc	27/29	9	60	27.7	BG-13	83/86	9.1	78600	1150	S6-TP-29-W3	370	37868.8
4,4'-DDE	1/21	820	820	41	BG-12	1/11	3.725	3.725	2.27	S6-TP14-02	2.61	37000
4,4'-DDT	1/21	1440	1440	70.5	BG-12	2/11	4.8	10.2	3.11	S6-TP14-02	4.42	37000
alpha-chlordane	0/21	0	0	0	NA	1/11	8.4	8.4	1.7	S6-TP02-01	2.46	7600
Aroclor-1242	0/21	0	0	0	NA	1/72	21	21	37.2	S6-TP18-02	21	6300

TABLE 1
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN SITEWIDE SUBSURFACE SOILS, SITE 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA
PAGE 2 OF 3

Substance	Background Data					Site-Related Data					
	Freq. of Detection	Range of Positive Detection Min	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration	Recreational Risk-Based Concentration
Aroclor-1248	0/21	0	0	0	NA	2/73	75	710	47.1	S6-TP-36-09	44.6	6300
Aroclor-1254	1/21	51	51	38.6	BG-13	25/72	7.2	4200	180	S6-TP-29-W3	146	2500
Aroclor-1260	0/21	0	0	0	NA	27/73	9	5100	221	S6-TP-29-W3	190	6300
dieldrin	0/21	0	0	0	NA	1/10	6.1	6.1	2.41	S6-TP02-01	3.05	800
gamma-chlordane	0/21	0	0	0	NA	1/11	9.2	9.2	1.77	S6-TP02-01	2.6	6300
methoxychlor	0/21	0	0	0	NA	1/11	14	14	11.2	S6-TP14-02	12.4	631100
1,2,4-trimethylbenzene	0/0	0	0	0		1/62	170	170	6.62	S6-TP-29-W3	5.07	2524600
1,3,5-trimethylbenzene	0/0	0	0	0		1/62	120	120	5.81	S6-TP-29-W3	4.89	2524600
1,3-dichlorobenzene	0/11	0	0	0	NA	1/72	8	8	31.7	S6-TP-38-W1	8	7000000
2,4-dimethylphenol	0/11	0	0	0	NA	1/72	1100	1100	234	S6-TP-29-W3	243	2524600
2-methylnaphthalene	0/11	0	0	0	NA	1/72	50	50	237	S6-TP18-02	50	0
4-methylphenol	0/11	0	0	0	NA	1/72	6300	6300	307	S6-TP-29-W3	276	631100
acenaphthene	0/11	0	0	0	NA	2/72	45	49	235	S6-SB-4002	49	7573800
acenaphthylene	0/11	0	0	0	NA	3/72	48	89	233	S6-SB-4104	89	0
anthracene	0/11	0	0	0	NA	5/72	79	340	239	S6-SB-4104	250	37868800
benz(a)anthracene	0/11	0	0	0	NA	25/72	33	1500	245	S6-SB-4002	282	17200
benzo(a)pyrene	0/11	0	0	0	NA	25/72	42	2800	268	S6-SB-4002	291	1700
benzo(b)fluoranthene	1/11	58	58	185	BG-13	16/72	82	4100	336	S6-SB-4002	340	17200
benzo(g,h,i)perylene	0/11	0	0	0	NA	16/72	43	330	222	S6-TP-33-W1	245	0
benzo(k)fluoranthene	1/11	46	46	184	BG-13	13/72	87	1600	282	S6-SB-4002	300	172400
bis(2-ethylhexyl)phthalate	1/11	50	50	154	BG-16	17/55	39	5400	372	S6-SB-3904	395	898800
butylbenzylphthalate	0/11	0	0	0	NA	3/72	55	70	231	S6-SB-3804	70	25245800
chrysene	1/11	51	51	185	BG-13	27/72	33	1600	237	S6-SB-4002	271	1723800
di-n-butylphthalate	0/11	0	0	0	NA	13/72	29	16000	413	S6-TP-29-W3	295	12622900
dibenz(a,h)anthracene	0/11	0	0	0	NA	4/72	63	220	234	S6-SB-4002	220	1700
fluoranthene	1/11	92	92	188	BG-13	29/72	35	1800	263	S6-SB-4002	298	5049200
fluorene	0/11	0	0	0	NA	1/72	50	50	237	S6-TP-33-W1	50	5049200

TABLE 1
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN SITEWIDE SUBSURFACE SOILS, SITE 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA

Substance	Background Data					Site-Related Data					
	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration	Recreational Risk-Based Concentration
indeno(1,2,3-cd)pyrene	0/11	0	0	0	NA	14/72	46	1200	239	S6-SB-4002	259	17200
phenanthrene	1/11	51	51	185	BG-13	17/72	43	620	225	S6-TP-33-W1	254	0
phenol	0/11	0	0	0	NA	1/72	5300	5300	291	S6-TP-29-W3	270	75737500
pyrene	1/11	100	100	189	BG-13	28/72	35	2000	303	S6-SB-4002	339	3786900
2-butanone	0/20	0	0	0	NA	3/85	18	52	32.5	S6-TP-36-09	38.2	7537500
acetone	4/19	8	12	46	BG-24	17/84	22	330	39.6	S6-TP-36-09	70.9	1262300
carbon disulfide	0/20	0	0	0	NA	2/85	2	3	4.73	S6-TP-36-09	3	12622900
ethylbenzene	0/20	0	0	0	NA	1/85	36	36	4.96	S6-TP-29-W3	5.07	12622900
n-butylbenzene	0/0	0	0	0		1/62	1	1	4.2	S6-TP-31-05	1	1262300
p-isopropyltoluene	0/0	0	0	0		1/62	3	3	4.23	S6-SB-1807	3	0
sec-butylbenzene	0/0	0	0	0		1/62	0.9	0.9	4.2	S6-SB-1807	0.9	1262300
tetrachloroethene	0/20	0	0	0	NA	2/85	4	28	4.58	S6-SB-1805	4.81	242000
toluene	3/20	2	2	42.7	BG-17	3/85	1	3	4.72	S6-TP-36-09	3	25245800
trichloroethene	0/20	0	0	0	NA	1/85	56	56	5.19	S6-TP-29-W3	5.19	757400
xylene (total)	0/20	0	0	0	NA	3/85	2	620	11.8	S6-TP-29-W3	6.14	252458300

Notes:
Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are consolidated into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
The determination of representative concentrations is based on comparison of maximum to the 95 % UCL, which is presented in a separate table.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.
RBCs represent concentrations associated with a 10-6 cancer risk level or a non-cancer hazard index of 0.1.
Residential RBCs originate from EPA Region 3 RBCs for residential exposure, incidental soil ingestion, with non-cancer risk adjusted to 0.1 hazard index.
An RBC for lead based on cancer risk or hazard index is not available. The 400 mg/kg OSWER residential soil guideline is used as an RBC for soil ingestion.

trenches. Representative concentrations of certain hazardous substances in subsurface soils within these zones were significantly higher than representative sitewide subsurface soil concentrations.

Table 2 tabulates analytical data for subsurface soil samples collected within Zone 1, which includes trench TR12. The COCs for Zone 1 have been determined to be chromium and thallium.

Table 3 tabulates subsurface soil data for Zone 2, which includes trench TR11. The COCs for Zone 2 have been determined to be chromium, thallium, arsenic and cadmium.

Table 4 tabulates data for Zone 3, which includes trench TR4. The COCs for Zone 3 have been determined to be chromium, thallium, arsenic, cadmium and Aroclor-1254.

While not highlighted in the RI, hazardous substance levels were also significantly higher in subsurface soil samples collected from the unnamed trench immediately southwest of trench TR6D. The contents of this unnamed trench were characterized by soil borings SB34, SB35, and SB36. COCs for this trench include chromium, thallium and arsenic.

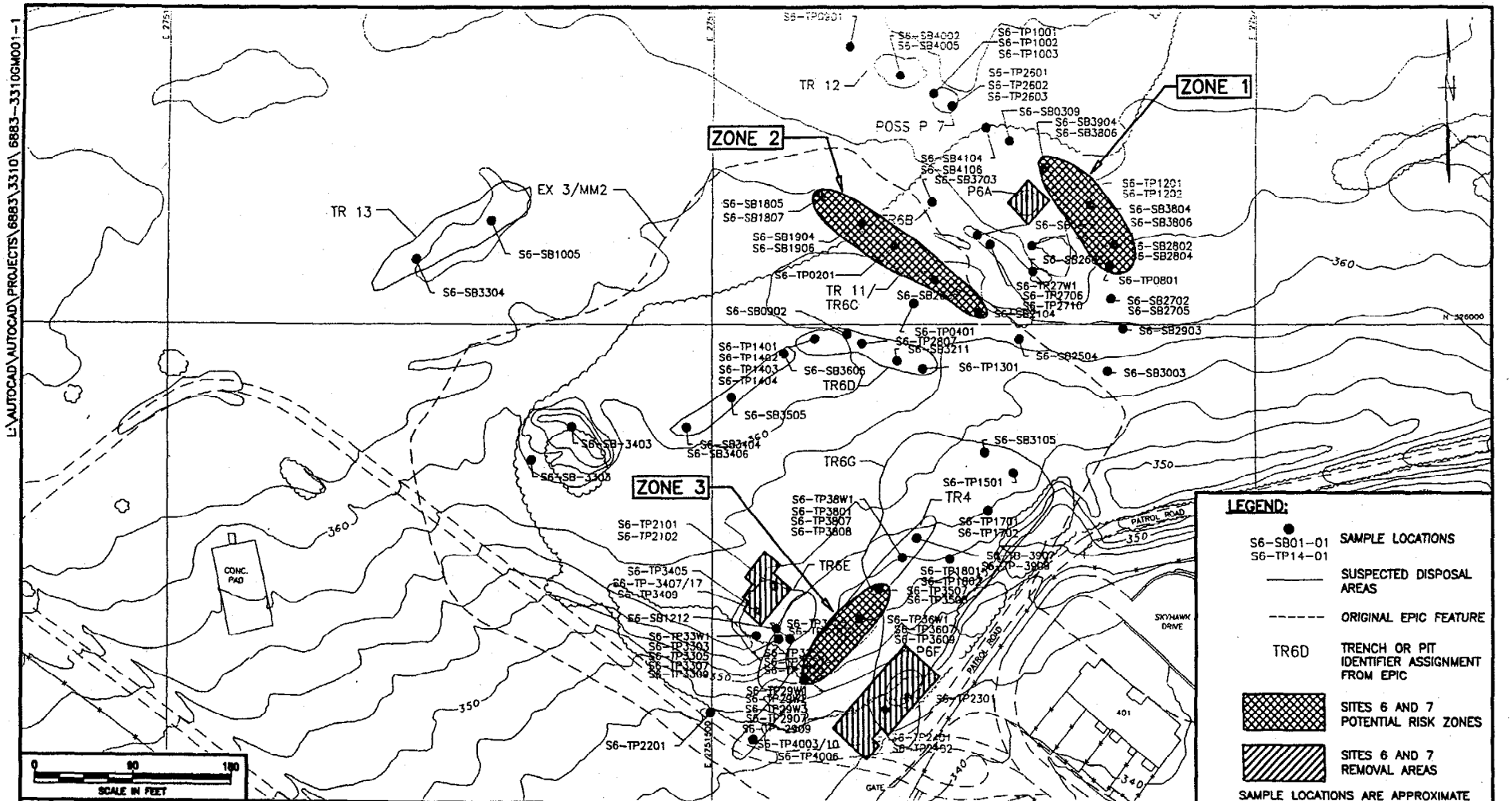
Industrial wastewater treatment sludges reportedly disposed in the area appear to be a source of several of the COCs in subsurface soils, including chromium, thallium and cadmium. Samples of apparent sludge-like material identified in Zone 1 (trench TR12), Zone 2 (trench TR11), Zone 3 (trench TR4) and the unnamed trench southwest of trench TR6D all had elevated levels of chromium and thallium, while elevated cadmium was detected in Zones 2 and 3. The largest volume of the sludge-like material appeared to be in trench TR4, where the thickness of the sludge-like material averaged about two feet and the width and length may be estimated at 15 feet by 225 feet. The volume of sludge in trench TR4 therefore can be estimated to be 250 cubic yards. While the depth of the majority of this layer is greater than 6 feet beneath ground surface, the southern portion of the layer may be within two feet of ground surface. The apparent sludge observed in the other three trenches did not appear to be continuous over a substantial length of these trenches and was not readily quantifiable. In each case, the volume appeared to be substantially less than that in trench TR4 and the depth of the material appeared to be primarily between 4 and 6 below ground surface.

All of the identified COCs are relatively immobile in soil. Soil sampling results indicate the COCs had not migrated within the soil column. All soil analytical results (including surface soils, to be discussed below) were compared to PADEP groundwater screening criteria protective of groundwater quality. Only 8 out 141 soil samples contained any substances exceeding the screening criteria. The substances identified were cadmium, lead and silver. None of these substances nor any other metals have been identified as contaminants of concern in Area B groundwater (RI for Area B Groundwater, TtNUS 2000). Given the low frequency of detection of substances at levels that exceed the subject ground water protection screening criteria and the lack of groundwater contamination by the contaminants identified, these substances are not considered to be a threat to groundwater quality. As noted earlier, all previously detected TCE and PCE levels in soils exceeding criteria protective of groundwater quality have been removed. In addition, no soils with TCE or PCE levels above the subject screening criteria are known to remain in Sites 6 and 7 soils. Based on the above, soil/waste at Sites 6 and 7 does not present a threat to groundwater quality.

A total of 33 surface soil locations at Sites 6 and 7 were sampled during the RI. Figure 5 indicates the location of these samples, while Table 5 provides the occurrence and distribution of organics and inorganics in sitewide surface soils, which include areas where there is some evidence of residuals associated with disposal activities at Sites 6 and 7. Under the anticipated recreational use, no COCs were identified in surface soil. While residential use is not reasonably anticipated, the COCs in surface soils for potential residential use were determined to include arsenic, cadmium, chromium, manganese, mercury, silver, thallium, Aroclor-1254, Aroclor-1260, benzo(a)pyrene and dibenzo(a,h) anthracene. Many of these same substances were also detected at levels above background in subsurface soils.

VIII. CURRENT AND POTENTIAL FUTURE LAND USES

The area of Sites 6 and 7 is currently undeveloped and consists of open space covered with grass, shrubs and trees. The property is located within Warminster Township. There are no structures in the area of Sites 6 and 7 at this time. The reuse plan for the former NAWC developed by the Federal Lands Reuse Authority



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12-2-1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

POTENTIAL RISK ZONES
AREA B – SITES 6 AND 7
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. CTO 0252
APPROVED BY
DATE 11/30/99
APPROVED BY
DATE
DRAWING NO. FIGURE 4
REV. 1

FORM CADD NO. L:\ACAD14\BLOCKS\BORDERS\TINUS_BH3.DWG

L:\AUTOCAD\AUTOCAD\PROJECTS\6883\3310\6883-3310GM001-1

TABLE 2

OCCURRENCE AND DISTIRBUTION OF ORGANICS AND INORGANICS IN ZONE 1 SUBSURFACE SOILS, SITES 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA

	Background Data					Site-Related Data				
Substance	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration
aluminum	31/31	4780	18100	13400	BG-12	7/7	3300	13600	7970	S6-SB-2802	10900
antimony	1/22	13.6	13.6	3.75	BG-16	3/7	6.4	164	26	S6-TP08-01	164
arsenic	27/31	0.28	12.1	3.88	BG-11	7/7	3.4	24.5	11.2	S6-SB-3904	17.3
barium	27/29	34.1	225	61.6	BG-28	7/7	24.8	384	154	S6-TP08-01	384
beryllium	27/31	0.31	1.7	0.806	BG-31	6/7	0.3	1.2	0.651	S6-SB-3909	1.2
cadmium	0/31	-			NA	3/7	32.5	42.4	16.3	S6-SB-3804	42.4
calcium	25/29	240	1910	664	BG-24	7/7	465	121000	50000	S6-SB-3904	121000
chromium	31/31	7.9	35.3	19.4	BG-12	7/7	8	7140	2890	S6-TP08-01	7140
cobalt	27/30	1.6	22.1	8.9	BG-31	7/7	8	52.4	26.8	S6-SB-3804	52.4
copper	29/31	3.6	30.6	11.8	BG-29	7/7	2.9	534	192	S6-TP08-01	534
iron	31/31	6980	410500	33100	BG-30	7/7	8310	232000	108000	S6-SB-3804	232000
lead	31/31	1.6	96.5	11.7	BG-13	7/7	3.3	128	49.2	S6-SB-3904	128
magnesium	27/31	518	4960	1980	BG-24	7/7	646	5770	2950	S6-SB-3904	4210
manganese	31/31	30.9	2010	424	BG-28	7/7	250	899	551	S6-SB-3904	899
mercury	1/28	0.37	0.37	0.0436	BG-23	3/7	2.1	5.2	1.52	S6-TP08-01	5.2
nickel	20/27	4.1	21.7	10.5	BG-31	7/7	8	113	44.6	S6-SB-3804	113
potassium	27/29	89.1	3050	706	BG-24	5/7	207	778	383	S6-SB-3909	778
silver	0/17	-			NA	6/7	0.79	330	138	S6-TP08-01	330
sodium	5/20	55.2	86.7	102	BG-25	6/7	89.8	198	118	S6-SB-3904	158
thallium	3/31	0.37	0.42	0.378	BG-31	4/7	3.7	89.1	27.6	S6-SB-3804	89.1
vanadium	31/31	15.4	45	29.7	BG-12	6/7	11.3	38.8	18.3	S6-SB-3806	28.8
zinc	27/29	9	60	27.7	BG-13	7/7	13.1	377	160	S6-SB-3804	377
Aroclor-1260	0/21	-			NA	3/6	13	1400	429	S6-SB-3904	1400
benz(a)anthracene	0/11	-			NA	2/6	91	180	178	S6-SB-3804	180
benzo(a)pyrene	0/11	-			NA	2/6	110	210	186	S6-SB-3804	210
benzo(g,h,i)perylen	0/11	-			NA	1/6	300	300	238	S6-SB-3804	300

TABLE 2

OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN ZONE 1 SUBSURFACE SOILS, SITES 6 AND 7

NAWC WARMINSTER, PENNSYLVANIA

	Background Data					Site-Related Data					
Substance	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration
bis(2-ethylhexyl)ph	1/11	50	50	154	BG-16	2/6	1500	5400	1280	S6-SB-3904	5400
butylbenzylphthalat	0/11	-			NA	1/6	70	70	200	S6-SB-3804	70
chrysene	1/11	51	51	185	BG-13	2/6	170	190	193	S6-SB-3804	190
fluoranthene	1/11	92	92	188	BG-13	2/6	79	120	166	S6-SB-3804	120
indeno(1,2,3-cd)py	0/11	-			NA	1/6	110	110	207	S6-SB-3804	110
pyrene	1/11	100	100	189	BG-13	2/6	130	290	203	S6-SB-3804	261
acetone	4/19	8	12	46	BG-24	1/7	22	22	28.6	S6-SB-3904	22

Notes:

Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are consolidated into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
The determination of representative concentrations is based on comparison of maximum to the 95 % UCL, which is presented in a separate table.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.

TABLE 3
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN ZONE 2 SUBSURFACE SOILS, SITES 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA

	Background Data					Site-Related Data				
Substance	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration
aluminum	31/31	4780	18100	13400	BG-12	7/7	4100	41400	13400	S6-TP02-01	38600
antimony	1/22	13.6	13.6	3.75	BG-16	3/7	8.4	68	14.5	S6-SB-1805	68
arsenic	27/31	0.28	12.1	3.88	BG-11	7/7	5.2	80.7	24.6	S6-TP02-01	80.7
barium	27/29	34.1	225	61.6	BG-28	7/7	27.4	922	240	S6-TP02-01	922
beryllium	27/31	0.31	1.7	0.806	BG-31	7/7	0.38	1.1	0.729	S6-SB-1807	0.946
cadmium	0/31	-			NA	4/7	48.5	135	45.4	S6-SB-2104	82.5
calcium	25/29	240	1910	664	BG-24	7/7	675	123000	43300	S6-SB-1805	80600
chromium	31/31	7.9	35.3	19.4	BG-12	7/7	9.2	22900	4910	S6-SB-1805	22900
cobalt	27/30	1.6	22.1	8.9	BG-31	7/7	8	63.4	27.7	S6-SB-2104	63.4
copper	29/31	3.6	30.6	11.8	BG-29	7/7	10.4	1880	458	S6-TP02-01	1880
iron	31/31	6980	410500	33100	BG-30	7/7	11700	261000	104000	S6-SB-1805	261000
lead	31/31	1.6	96.5	11.7	BG-13	7/7	3.8	39300	5670	S6-TP02-01	39300
magnesium	27/31	518	4960	1980	BG-24	7/7	723	4060	2650	S6-TP02-01	3530
manganese	31/31	30.9	2010	424	BG-28	7/7	227	1320	747	S6-SB-1805	1010
mercury	1/28	0.37	0.37	0.0436	BG-23	4/7	1.4	5.6	2	S6-SB-2104	3.62
nickel	20/27	4.1	21.7	10.5	BG-31	7/7	9.1	345	89.4	S6-TP02-01	345
potassium	27/29	89.1	3050	706	BG-24	6/7	324	1550	642	S6-TP02-01	1340
selenium	0/20	-			NA	1/7	5	5	3.76	S6-TP02-01	5
silver	0/17	-			NA	7/7	0.65	308	127	S6-SB-2104	220
sodium	5/20	55.2	86.7	102	BG-25	7/7	98.4	740	228	S6-TP02-01	532
thallium	3/31	0.37	0.42	0.378	BG-31	4/7	6.7	74.9	26.9	S6-SB-2104	74.9
vanadium	31/31	15.4	45	29.7	BG-12	6/7	16.6	36.8	21	S6-SB-1807	29.1
zinc	27/29	9	60	27.7	BG-13	7/7	18.7	3800	766	S6-TP02-01	3800
alpha-chlordane	0/21	-			NA	1/1	8.4	8.4	8.4	S6-TP02-01	8.4
Aroclor-1254	1/21	51	51	38.6	BG-13	3/7	61	750	220	S6-SB-1805	750
Aroclor-1260	0/21	-			NA	2/7	440	760	193	S6-SB-2104	760
dieldrin	0/21	-			NA	1/1	6.1	6.1	6.1	S6-TP02-01	6.1

TABLE 3
OCCURRENCE AND DISTRIBUTION OF ORGANICS AN INORGANICS IN ZONE 2 SUBSURFACE SOILS, SITES 6 AND 7
NAWC WARMINSTER, PENNSYLANIVA

	Background Data					Site-Related Data					
Substance	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration
gamma-chlordane	0/21	-			NA	1/1	9.2	9.2	9.2	S6-TP02-01	9.2
benz(a)anthracene	0/11	-			NA	1/6	120	120	272	S6-SB-2104	120
benzo(a)pyrene	0/11	-			NA	2/6	140	150	200	S6-SB-2104	150
benzo(b)fluoranthene	1/11	58	58	185	BG-13	1/6	140	140	275	S6-SB-2104	140
benzo(g,h,i)perylene	0/11	-			NA	1/6	90	90	267	S6-SB-2104	90
benzo(k)fluoranthene	1/11	46	46	184	BG-13	1/6	480	480	332	S6-SB-2104	480
bis(2-ethylhexyl)phthalate	1/11	50	50	154	BG-16	3/6	60	870	273	S6-SB-1805	870
chrysene	1/11	51	51	185	BG-13	1/6	120	120	272	S6-SB-2104	120
di-n-butylphthalate	0/11	-			NA	4/6	42	370	182	S6-SB-1805	370
fluoranthene	1/11	92	92	188	BG-13	1/6	210	210	287	S6-SB-2104	210
indeno(1,2,3-cd)pyrene	0/11	-			NA	1/6	82	82	265	S6-SB-2104	82
phenanthrene	1/11	51	51	185	BG-13	1/6	98	98	268	S6-SB-2104	98
pyrene	1/11	100	100	189	BG-13	1/6	210	210	287	S6-SB-2104	210
acetone	4/19	8	12	46	BG-24	1/7	98	98	96.6	S6-SB-1904	98
p-isopropyltoluene	0/0	-				1/6	3	3	10.2	S6-SB-1807	3
sec-butylbenzene	0/0	-				1/6	0.9	0.9	9.82	S6-SB-1807	0.9
tetrachloroethene	0/20	-			NA	1/7	28	28	7.86	S6-SB-1805	23.1
toluene	3/20	2	2	42.7	BG-17	1/7	2	2	9.79	S6-SB-2104	2

Notes:

Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are consolidated into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
The determination of representative concentrations is based on comparison of maximum to the 95 % UCL, which is presented in a separate table.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.

TABLE 4
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN ZONE 3 SUBSURFACE SOILS, SITES 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA

	Background Data					Site-Related Data					
Substance	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration
aluminum	31/31	4780	18100	13400	BG-12	9/9	3360	28400	9460	S6-TP-29-W2	17600
antimony	1/22	13.6	13.6	3.75	BG-16	4/9	9.6	48.3	11.9	S6-TP-29-W3	48.3
arsenic	27/31	0.28	12.1	3.88	BG-11	9/9	5.9	35.5	18	S6-TP-29-W3	31.9
barium	27/29	34.1	225	61.6	BG-28	9/9	41.3	536	218	S6-TP-36-09	536
beryllium	27/31	0.31	1.7	0.806	BG-31	9/9	0.35	1.2	0.71	S6-TP-35-08	0.885
cadmium	0/31	-			NA	8/9	0.64	152	48.5	S6-TP-29-07	152
calcium	25/29	240	1910	664	BG-24	9/9	1490	79600	26400	S6-TP-36-09	79600
chromium	31/31	7.9	35.3	19.4	BG-12	9/9	15.8	46800	8050	S6-TP-29-W3	46800
cobalt	27/30	1.6	22.1	8.9	BG-31	9/9	6.6	146	41.7	S6-TP-29-W3	146
copper	29/31	3.6	30.6	11.8	BG-29	9/9	8.3	920	211	S6-TP-29-W2	920
iron	31/31	6980	410500	33100	BG-30	9/9	15000	264000	100000	S6-TP-35-07	264000
lead	31/31	1.6	96.5	11.7	BG-13	9/9	9.8	7700	926	S6-TP-29-W3	7700
magnesium	27/31	518	4960	1980	BG-24	9/9	1100	4970	2300	S6-TP-36-07	3340
manganese	31/31	30.9	2010	424	BG-28	9/9	259	1160	722	S6-TP-35-07	1120
mercury	1/28	0.37	0.37	0.0436	BG-23	7/9	0.2	3.4	1.22	S6-TP-36-09	3.4
nickel	20/27	4.1	21.7	10.5	BG-31	9/9	8.3	66.2	29.9	S6-TP-29-07	66.2
potassium	27/29	89.1	3050	706	BG-24	8/9	197	8740	1350	S6-TP-29-W3	4910
silver	0/17	-			NA	9/9	1.1	368	132	S6-TP-36-09	368
sodium	5/20	55.2	86.7	102	BG-25	9/9	96.8	405	144	S6-TP-29-W3	203
thallium	3/31	0.37	0.42	0.378	BG-31	6/9	4.7	62.4	23	S6-TP-36-09	62.4
vanadium	31/31	15.4	45	29.7	BG-12	7/9	18.6	32.3	19	S6-TP-29-W1	26.2
zinc	27/29	9	60	27.7	BG-13	9/9	35.2	78600	9020	S6-TP-29-W3	78600
Aroclor-1248	0/21	-			NA	2/9	75	710	164	S6-TP-36-09	710
Aroclor-1254	1/21	51	51	38.6	BG-13	4/8	91	4200	797	S6-TP-29-W3	4200
Aroclor-1260	0/21	-			NA	5/9	13	5100	808	S6-TP-29-W3	5100
1,2,4-trimethylbenzene	0/0	-				1/9	170	170	22.1	S6-TP-29-W3	79.8
1,3,5-trimethylbenzene	0/0	-				1/9	120	120	16.5	S6-TP-29-W3	50.4

TABLE 4
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN ZONE 3 SUBSURFACE SOILS, SITES 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA

	Background Data					Site-Related Data					
Substance	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration
2,4-dimethylphenol	0/11	-			NA	1/9	1100	1100	333	S6-TP-29-W3	508
4-methylphenol	0/11	-			NA	1/9	6300	6300	911	S6-TP-29-W3	2480
benz(a)anthracene	0/11	-			NA	4/9	42	120	293	S6-TP-35-07	120
benzo(a)pyrene	0/11	-			NA	5/9	42	140	269	S6-TP-35-07	140
benzo(b)fluoranthene	1/11	58	58	185	BG-13	1/9	150	150	359	S6-TP-35-07	150
benzo(g,h,i)perylene	0/11	-			NA	1/9	89	89	353	S6-TP-35-07	89
benzo(k)fluoranthene	1/11	46	46	184	BG-13	1/9	470	470	395	S6-TP-35-07	470
bis(2-ethylhexyl)phthalate	1/11	50	50	154	BG-16	4/5	39	310	389	S6-TP-36-09	310
chrysene	1/11	51	51	185	BG-13	6/9	51	320	147	S6-TP-29-W3	276
di-n-butylphthalate	0/11	-			NA	4/9	48	16000	1920	S6-TP-29-W3	16000
fluoranthene	1/11	92	92	188	BG-13	7/9	46	360	164	S6-TP-29-W3	295
indeno(1,2,3-cd)pyrene	0/11	-			NA	1/9	87	87	352	S6-TP-35-07	87
phenanthrene	1/11	51	51	185	BG-13	4/9	62	540	227	S6-TP-29-W3	429
phenol	0/11	-			NA	1/9	5300	5300	800	S6-TP-29-W3	2030
pyrene	1/11	100	100	189	BG-13	6/9	38	230	282	S6-TP-35-07	230
2-butanone	0/20	-			NA	3/9	18	52	53	S6-TP-36-09	52
acetone	4/19	8	12	46	BG-24	4/9	36	330	107	S6-TP-36-09	307
carbon disulfide	0/20	-			NA	1/9	3	3	5.39	S6-TP-36-09	3
ethylbenzene	0/20	-			NA	1/9	36	36	7.17	S6-TP-29-W3	13.9
toluene	3/20	2	2	42.7	BG-17	2/9	1	3	5.17	S6-TP-36-09	3
trichloroethene	0/20	-			NA	1/9	56	56	9.39	S6-TP-29-W3	21.2
xylene (total)	0/20	-			NA	2/9	2	620	71.7	S6-TP-29-W3	620

TABLE 4
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN ZONE 3 SUBSURFACE SOILS, SITES 6 AND 7
NAWC WARMINSTER, PENNSYLVANIA
PAGE 3 OF 3

Notes:

Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are consolidated into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
The determination of representative concentrations is based on comparison of maximum to the 95 % UCL, which is presented in a separate table.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.

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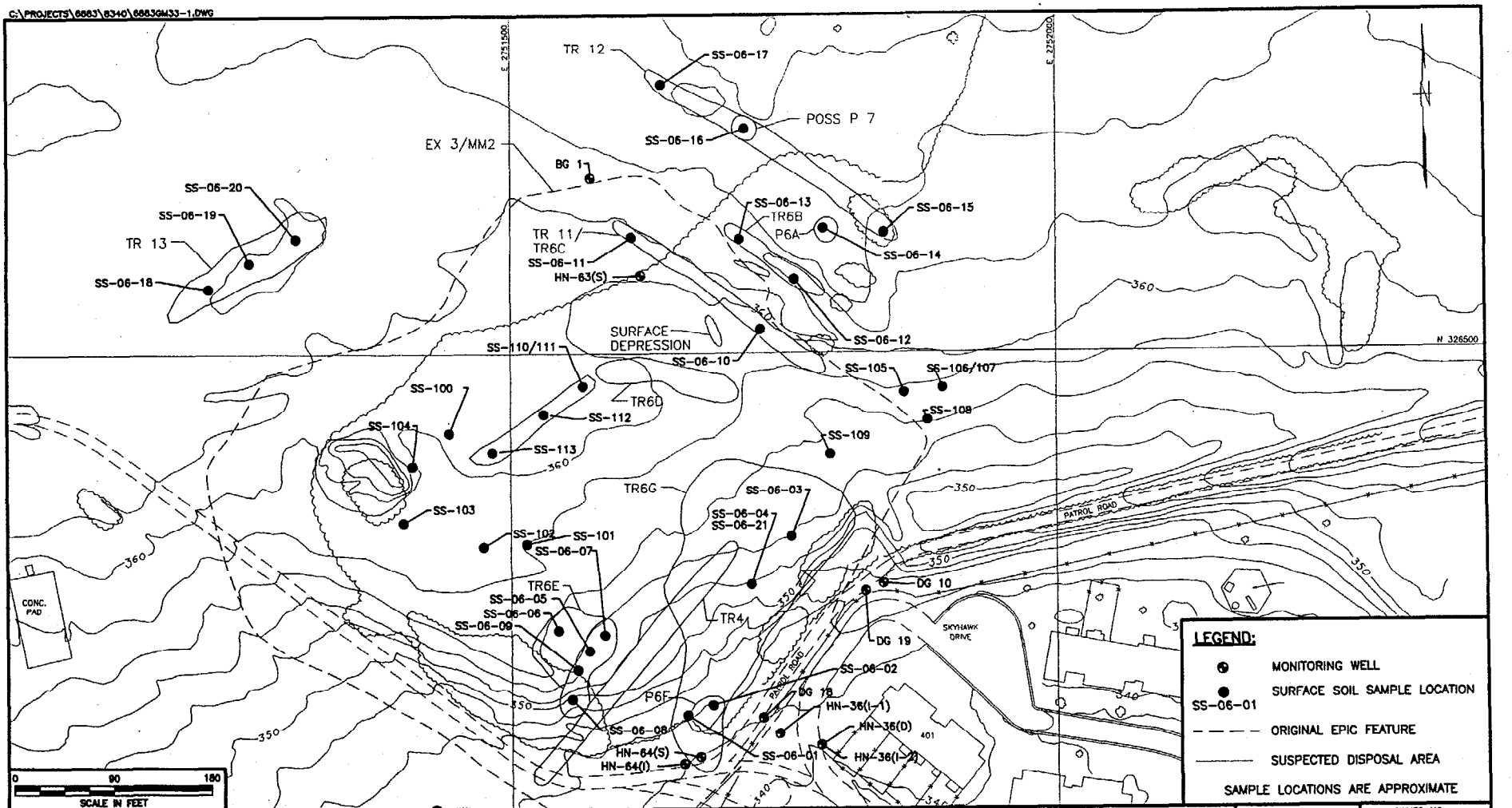


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12/2/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

SURFACE SOIL
SAMPLE LOCATIONS
AREA B-SITES 6 AND 7
NAWC, WARMINSTER

CONTRACT NO. 6883
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. Figure 5
REV. 1

FORM CADD NO. SOUTH_BHAIGH - REV 0 - 08/01/97

TABLE 5

Occurrence and Distribution of Organics and Inorganics in Sitewide Surface Soils, Site 6 and 7
NAWC WARMINSTER, PENNSYLVANIA

Substance	Background Data					Site-Related Data					
	Freq. of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Freq. Of Detection	Range of Positive Detection Min.	Range of Positive Detection Max.	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration	Recreational Risk-Based Concentration
aluminum	31/31	4780	18100	13400	BG-12	29/29	5940	22100	13500	S6-SS-06-19	14500	1388520.8
antimony	1/22	13.6	13.6	3.75	BG-16	2/10	5.1	5.1	2.63	S6-SS-112	4.38	50.5
arsenic	27/31	0.28	12.1	3.88	BG-11	29/29	4.6	15.1	8.47	S6-SS-100	9.88	8.4
barium	27/29	34.1	225	61.6	BG-28	29/29	30.2	1030	101	S6-SS-112	111	8836
beryllium	27/31	0.31	1.7	0.806	BG-31	29/29	0.39	1.9	0.89	S6-SS-06-19	1.01	2.9
cadmium	0/31	0	0	0	NA	5/29	3.3	18.9	2.11	S6-SS-112	2.98	63.1
calcium	25/29	240	1910	664	BG-24	29/29	506	40000	4760	S6-SS-112	6170	0
chromium	31/31	7.9	35.3	19.4	BG-12	29/29	13.2	2760	188	S6-SS-100	239	631.1
cobalt	27/30	1.6	22.1	8.9	BG-31	29/29	5.1	20.9	9.81	S6-SS-06-21	10.8	7573.8
copper	29/31	3.6	30.6	11.8	BG-29	29/29	7.3	867	63.9	S6-SS-112	76	5049.2
cyanide	0/21	0	0	0	NA	1/17	3.9	3.9	0.776	S6-SS-06-10	0.912	2524.6
iron	31/31	6980	410500	33100	BG-30	29/29	13200	56300	22500	S6-SS-100	24600	37868.8
lead	31/31	1.6	96.5	11.7	BG-13	29/29	8.3	278	38.3	S6-SS-06-03	46.6	400
magnesium	27/31	518	4960	1980	BG-24	29/29	1390	14400	2640	S6-SS-100	2950	0
manganese	31/31	30.9	2010	424	BG-28	29/29	123	3040	558	S6-SS-06-19	702	2903.3
mercury	1/28	0.37	0.37	0.0436	BG-23	11/29	0.05	25.6	1	S6-SS-112	0.497	37.9
nickel	20/27	4.1	21.7	10.5	BG-31	19/29	9.7	29.9	11.4	S6-SS-112	14.6	2524.6
potassium	27/29	89.1	3050	706	BG-24	28/29	363	973	601	S6-SS-06-03	660	0
silver	0/17	0	0	0	NA	14/29	0.77	123	9.12	S6-SS-112	19.2	631.1
sodium	5/20	55.2	86.7	102	BG-25	12/29	49.1	130	54.6	S6-SS-112	65.9	0
thallium	3/31	0.37	0.42	0.378	BG-31	9/29	5.1	15.1	2.91	S6-SS-100	5.84	10.1
vanadium	31/31	15.4	45	29.7	BG-12	29/29	13.4	41.7	30.3	S6-SS-06-17	32.3	883.6
zinc	27/29	9	60	27.7	BG-13	29/29	24.9	1840	122	S6-SS-112	122	37868.8
4,4'-DDD	1/21	16	16	2.66	BG-12	1/16	7.7	7.7	2.38	S6-SS-06-11	2.74	52400
4,4'-DDT	1/21	1440	1440	70.5	BG-12	2/16	5.5	6.5	2.52	S6-SS-06-11	2.99	37000
alpha-chlordane	0/21	0	0	0	NA	1/17	8.2	8.2	1.46	S6-SS-06-03	1.71	7600
Aroclor-1254	1/21	51	51	38.6	BG-13	3/29	180	490	59.7	S6-SS-06-03	67.5	2500

TABLE 5
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN SITEWIDE SURFACE SOILS, SITE 6 and 7
NAWC WARMINSTER, PENNSYLVANIA

Substance	Background Data				Site-Related Data					
	Freq. of Detection	Range of Positive Detection	Mean of All Data	Sampling Round and Location of Maximum	Freq. of Detection	Range of Positive Detection	Mean of All Data	Sampling Round and Location of Maximum	Representative Concentration	Recreational Risk-Based Concentration
		Min. - Max.				Min. - Max.				
Aroclor-1260	0/21			NA	6/29	13 - 1000	60.4	S6-SS-112	53.2	6300
endrin	0/21	0 - 0	0	NA	1/17	14 - 14	2.72	S6-SS-06-03	3.19	37900
2-methylnaphthalene	0/11	0 - 0	0	NA	1/29	1100 - 1100	235	S6-SS-112	253	0
acenaphthene	0/11	0 - 0	0	NA	1/29	4100 - 4100	338	S6-SS-112	326	7573800
anthracene	0/11	0 - 0	0	NA	2/29	100 - 6000	400	S6-SS-112	354	37868800
benz(a)anthracene	0/11	0 - 0	0	NA	5/29	42 - 13000	645	S6-SS-112	468	17200
benzo(a)pyrene	0/11	0 - 0	0	NA	5/29	45 - 11000	585	S6-SS-112	462	1700
benzo(b)fluoranthene	1/11	58 - 58	185	BG-13	6/29	54 - 13000	647	S6-SS-112	480	17200
benzo(g,h,i)perylene	0/11	0 - 0	0	NA	6/29	41 - 3700	308	S6-SS-112	336	0
benzo(k)fluoranthene	1/11	46 - 46	184	BG-13	4/29	360 - 7900	489	S6-SS-112	418	172400
benzoic acid	0/0	0 - 0	0		3/12	220 - 240	316	S6-SS-100	240	504916700
bis(2-ethylhexyl)phthalate	1/11	50 - 50	154	BG-16	1/26	2700 - 2700	285	S6-SS-112	372	898800
butylbenzylphthalate	0/11	0 - 0	0	NA	2/29	49 - 700	216	S6-SS-112	245	25245800
chrysene	1/11	51 - 51	185	BG-13	5/29	53 - 14000	681	S6-SS-112	474	1723800
dibenz(a,h)anthracene	0/11	0 - 0	0	NA	3/29	44 - 1200	227	S6-SS-112	265	1700
dibenzofuran	0/11	0 - 0	0	NA	1/29	2100 - 2100	269	S6-SS-112	284	504900
fluoranthene	1/11	92 - 92	188	BG-13	7/29	36 - 28000	1170	S6-SS-112	665	5049200
fluorene	0/11	0 - 0	0	NA	1/29	2800 - 2800	294	S6-SS-112	300	5049200
indeno(1,2,3-cd)pyrene	0/11	0 - 0	0	NA	5/29	49 - 4600	345	S6-SS-112	344	17200
phenanthrene	1/11	51 - 51	185	BG-13	4/29	53 - 28000	1160	S6-SS-112	582	0
pyrene	1/11	100 - 100	189	BG-13	5/29	73 - 25000	1080	S6-SS-112	594	3786900
bromomethane	0/16	0 - 0	0	NA	1/29	3 - 3	6.17	S6-SS-06-17	3	176700
methylene chloride	1/14	4 - 4	58.9	BG-17	2/25	4 - 6	4.8	S6-SS-108	6	1677800
toluene	3/20	2 - 2	42.7	BG-17	11/29	1 - 15	4.21	S6-SS-06-03	5.32	25245800
trichloroethene	0/20	0 - 0	0	NA	9/29	1 - 4	3.57	S6-SS-06-16	4	757400

Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are consolidated into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
The determination of representative concentrations is based on comparison of maximum to the 95 % UCL, which is presented in a separate table.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.
RBCs represent concentrations associated with a 10-6 cancer risk level or a non-cancer hazard index of 0.1.
Residential RBCs originate from EPA Region 3 RBCs for residential exposure, incidental soil ingestion, with non-cancer risk adjusted to 0.1 hazard index.
An RBC for lead based on cancer risk or hazard index is not available. The 400 mg/kg OSWER residential soil guideline is used as an RBC for soil ingestion.

(FLRA) of Bucks County and approved by representatives of Warminster Township and other municipalities identifies the future use of the area of Sites 6 and 7 as recreational. As noted previously, available information suggests that residential use of the property is not reasonably anticipated. Based primarily on the reuse plan, the Proposed Remedial Action Plan (PRAP) and supporting administrative record identified recreational use as the reasonably anticipated land use for Sites 6 and 7. Since the issuance of the PRAP, it has been suggested that limited industrial/commercial use of Sites 6 and 7 may also be possible.

IX. SUMMARY OF SITE RISKS

The human health risks associated with potential exposure to soils/waste at Sites 6 and 7 have been evaluated as part of the RI for Sites 6 and 7. (Evaluation of risks posed by Sites 6 and 7 to surface water and sediment will be addressed in the final RI report for Site 5).

A. Summary of Human Health Risk Assessment

The baseline human health risk assessment estimates the risks posed to human health by soils and wastes at Sites 6 and 7 if no action is taken and identifies the contaminants and exposure pathways of concern. This section of the ROD summarizes the results of the baseline risk assessment for Sites 6 and 7.

As noted earlier, RI results indicate that soils and wastes associated with Sites 6 and 7 do not present a threat to groundwater quality and therefore will not indirectly impact human health via this pathway.

B. Identification of Contaminants of Concern

Tables in Section VII, above, Nature and Extent of Contamination, summarize the range of detected concentrations (minimum and maximum) and the frequency of detection of hazardous substances in sitewide subsurface soils, subsurface soils in Zones 1, 2 and 3 and sitewide surface soils. In the case of each hazardous substance detected in each medium, these tables also identify a representative concentration, which is the lower of the upper 95% confidence limit (UCL) of the mean concentration and the maximum concentration detected. These representative concentrations are the exposure point concentrations which were used to estimate risk to human health. These exposure point concentrations were compared to soil screening levels protective of recreational use developed as part of the RI for NAWC (RI for OU-7, TtNUS, November 1999 and Verification Sampling and Analysis Plan for Site 6 Removal Actions, B&R Environmental, August 1996). In addition, these exposure point concentrations were compared to soil screening levels protective of residential use. The tables in Section VII, above, identify the contaminants of concern, which are the focus of the quantitative risk assessment conducted as part of the RI.

C. Exposure Assessment

Sites 6 and 7 are located on a portion of the base which is not developed, is fenced and not in use at this time. As a result, risk from current exposure is not occurring and was not assessed. A human health risk assessment was conducted assuming recreational use of the property. In addition, while residential use of the property is not reasonably anticipated, potential risks under residential use were also assessed. Industrial/commercial use was not evaluated. Future users were evaluated for exposure to surface soil (0 to 2 feet in depth) and subsurface soils [2 feet to maximum depth of contaminant (up to 15 feet below ground surface)]. In assessing risks posed by subsurface soils under recreational and residential use, it was assumed that these soils may be displaced to the surface (e.g., via excavation) and that resulting surface contaminant concentrations would be unchanged from that detected in the subsurface soils. The exposure routes for human receptors were identified as incidental ingestion of soil/waste and dermal contact with soil/waste.

Inhalation of volatile emissions was not quantitatively evaluated due to the low level and infrequent occurrence of volatile organic compounds. The data was reviewed qualitatively to ensure that inhalation was not a potential contributing factor to the potential risks associated with Sites 6 and 7.

D. Toxicity Assessment

The toxicity assessment characterizes the nature and magnitude of potential health effects associated with human exposure to COCs at a site. Quantitative risk estimates for each COC and exposure pathway are

developed by integrating chemical-specific toxicity factors with estimated chemical intakes discussed in the previous section.

Quantitative risk estimates are calculated using cancer slope factors (CSFs) for COCs exhibiting carcinogenic effects and reference doses (RfDs) for COCs exhibiting systemic (noncarcinogenic) effects. The RfDs and CSFs used in the baseline human health risk assessment are presented in Table 6.

CSFs and RfDs developed by USEPA are based on ingestion (oral) or inhalation routes of exposure rather than dermal contact. Therefore, these values reflect administered doses rather than absorbed doses. USEPA guidance on assessment of dermal exposure recommends that oral toxicity factors used in dermal risk assessment be adjusted for gastrointestinal absorption efficiency, if such data are available. The dermal RfDs and CSFs adjusted for gastrointestinal absorption are listed in Table 6. The dermal toxicity criteria are derived per the methodology presented in Appendix A of the Risk Assessment Guidance for Superfund, Part A (USEPA, 1989). According to USEPA Region III policy, the dermal contact exposure pathway is not evaluated quantitatively for PAHs. Therefore, potential risks from dermal contact exposure to PAHs in soil are not quantified in the risk assessment.

E. Risk Characterization

A risk characterization was performed in the RI to quantify carcinogenic and non-carcinogenic risks presented by Sites 6 and 7 under the planned recreational use. In addition, while not a reasonably anticipated land use, risks under residential use were also assessed. In the case of each contaminant, the exposure concentration corresponds to the representative concentrations discussed above.

Excess lifetime carcinogenic risks are quantified by multiplying the intake level and the CSF. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime, under the specific exposure conditions at a site. Noncarcinogenic risks are estimated using the concept of a hazard quotient (HQ) and a hazard index (HI). The HQ is the ratio of the estimated intake and the RfD for a selected chemical of concern. HIs are the sums of the individual HQs for the COPCs. If the value of the HQ or the HI exceeds unity (1.0), the potential for noncarcinogenic health risks associated with exposure to that particular chemical or particular chemical mixture, respectively, are considered unacceptable (EPA, 1986b). If the individual HQs are less than 1.0 and the HI is greater than 1.0, particular attention should be paid to the target organ(s) affected by each chemical because these are generally the organ(s) associated with RfD-derived effects, and toxicity for different organs is not truly additive. The HI is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

1. Surface Soil

a. Potential Recreational Use

Table 7 indicates the estimated incremental carcinogenic risks which would be incurred by ingestion of and dermal contact with surface soils under recreational land use. The total incremental carcinogenic risk (or the combined risk under both pathways) has been estimated at 2.3×10^{-6},which is within the EPA's acceptable carcinogenic risk range of 1×10^{-6} to 1×10^{-4}.

Table 8 indicates the estimated HQs and HIs for non-carcinogenic risks and the subject target organs. In no case do the cumulative HIs for any target organ exceed 1, indicating that there are no unacceptable noncarcinogenic risks.

TABLE 6

DOSE-RESPONSE PARAMETERS - CHEMICALS OF POTENTIAL CONCERN

NAWC Warminster Sites 6 and 7, Pennsylvania

Chemical of Concern	Fraction of COPC Absorbed in the Gastrointestinal Tract (unitless)**	Toxicity Values								
		RfD*				SF				Weight of Evidence
		Oral* (mg/kg)/day		Dermal (mg/kg)/day		Oral* 1/(mg/kg)/day		Dermal 1/(mg/kg)/day		
Semivolatiles										
benz(a)anthracene	1.0					7.3E-01	E			B2
benzo(a)pyrene	1.0					7.3E+00	I			B2
benzo(b)flouranthene	1.0					7.3E-01	E			B2
dibenz(a,h)anthracene	1.0					7.3E+00	E			B2
indeno(1,2,3-cd)pyrene	1.0					7.3E-01	E			B2
Pesticides/PCBs										
Aroclor-1248	1.0					2.0E+00	I	1.78E+00		B2
Aroclor-1254	1.0	2.0E-05		2.0E-05		2.0E+00	I	1.78E+00		B2
Aroclor-1260	1.0					2.0E+00	I	1.78E+00		B2
Metals										
aluminum	0.27	1.0E+00	E	3.7E+00						
antimony	0.10	4.0E-04		4.0E-05						D
arsenic	0.95	3.0E-04		3.16E-04		1.5E+00		1.43E+00		A
barium	1.0	7.0E-02		7.0E-02						D
beryllium	0.01	5.0E-03		5.0E-01		4.3E+00		4.3E-02		B2
cadmium	0.05	5.0E-04	I	1.0E-02						
chromium	0.01	5.0E-03		5.0E-01						D
copper	0.6	4.0E-02	H	2.4E-02						D
iron	1.0	3.0E-01	E	3.0E-01						
lead	1.0									B2
manganese	1.0	1.4E-01		1.4E-01						
mercury	0.15	3.0E-04		4.5E-05						
nickel	0.1	2.0E-02		2.0E-03						D
silver	1.0	5.0E-03		5.0E-03						D
thallium	1.0	6.5E-05		6.50E-05						
vanadium	0.02	7.0E-03	H	3.50E-01						
zinc	1.0	3.0E-01		3.00E-01						D

No Value = No dose-response value is available for this chemical in this classification
* = All toxicity values are from Integrated Risk Information System (IRIS) unless otherwise noted
** = Modifying factor applied only to dermal RfDs and SFs, from ATSDR
H = Health Effects Assessment Summary Tables
A = HEAST Alternative
E = EPA-NCEA Regional Support provisional service
W = Withdrawn from IRIS or HEAST

TABLE 7

Summary of Risks by COPC, Sitewide Surface Soils - Estimated RME Cancer Risks for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Recreational Receptor		
	Ingestion	Dermal Contact	Total
arsenic	1.18E-06	8.34E-07	2.01E-06
chromium	NT	NT	NT
manganese	NT	NT	NT
thallium	NT	NT	NT
benzo(a)pyrene	2.68E-07	NT	2.68E-07
TOTAL RISK:	1.45E-06	8.34E-07	2.28E-06

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 8

Summary of Risks by COPC, Sitewide Surface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ For Noncarcinogens	Estimated Hazard Index Future Recreational Child			Estimated Hazard Index Future Recreational Youth		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
arsenic	S	2.61E-02	9.38E-03	3.55E-02	4.79E-03	7.54E-03	1.23E-02
chromium	S, K	3.79E-02	4.04E-01	4.42E-01	6.95E-03	3.25E-01	3.32E-01
manganese	CNS	3.97E-03	4.24E-04	4.40E-03	7.29E-04	3.41E-04	1.07E-03
thallium	S, K, L, CNS	7.12E-02	7.60E-03	7.88E-02	1.31E-02	6.10E-03	1.92E-02
benzo(a)pyrene		NT	NT	NT	NT	NT	NT

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

Target Organs: S = Skin, K = Kidney, CNS = Central Nervous System, L = Liver

b. Potential Residential Use

Table 9 indicates the estimated incremental carcinogenic risks which would be incurred by ingestion of and dermal contact with surface soils under residential land use. The total incremental carcinogenic risk (or the combined risk under both pathways) has been estimated at 4.7×10^{-5}, which is within the EPA's acceptable carcinogenic risk range of 1×10^{-6} to 1×10^{-4}.

Table 10 indicates the estimated HQs and HIs for non-carcinogenic risks and the subject target organs. Cumulative HIs based on certain target organs are greater than one for both a residential child and residential adult. The principal COCs in this case are chromium (via ingestion of and dermal contact with surface soils, chromium residential child HI is equal to 6.5 and residential adult HI is equal to 2.4) and thallium (via ingestion of surface soils, thallium residential child HI is equal to 1.3). The target organ for chromium is the kidney. The target organs for thallium are liver, gastrointestinal (GI) tract, and central nervous system (CNS). The total HI for the kidney as the target organ equals 8.0 for a residential child and 2.6 for a residential adult. The total HI for skin as the target organ equals 8.3 for the future residential child and 2.6 for the future residential adult. The total HI for the liver as a target organ equals 1.3 for the future residential child. The total HI for CNS as a target organ equals 1.5 for the future residential child. No other combination of HQs that affect the same target organ for the future resident would result in an HI of greater than 1.0.

2. Subsurface Soil

In addition to assessing risks posed by sitewide subsurface soils, carcinogenic and noncarcinogenic risks were also quantified individually for subsurface soils in Zones 1, 2 and 3. Soils in each of these three zones were found to contain representative contaminant concentrations substantially higher than those in sitewide subsurface soils and were projected to present substantially higher risks than sitewide subsurface soils.

a. Potential Recreational Use

Sitewide

Table 11 indicates the estimated incremental carcinogenic risks which would be incurred by ingestion of and dermal contact with sitewide subsurface soils/waste under recreational use, assuming that subsurface materials became surface materials. In this case, the carcinogenic risk associated with sitewide subsurface soils under recreational use was calculated as 2.8×10^{-6}. This risk is within the USEPA's acceptable target risk range of 1×10^{-6} to 1×10^{-4}.

Table 12 indicates the estimated non-carcinogenic risks. The cumulative HIs based on certain target organs of a recreational child and recreational youth are both greater than 1.0. The principal COC contributing to the noncarcinogenic risk is chromium (via potential dermal contact, chromium recreational child HI is equal to 4.2 and recreational youth HI is equal to 3.2). The target organ for chromium is the kidney. The total HI for kidney as a target organ equals 4.6 for the future recreational child and 3.3 for the future recreational youth. No other combination of HQs that affect the same target organ for the future recreational child or youth would result in an HI of greater than 1.0.

Zone 1

Table 13 indicates the estimated incremental carcinogenic risks which would be incurred by ingestion of and dermal contact with Zone 1 subsurface soils under recreational use. The cumulative ingestion and dermal contact carcinogenic risk for Zone 1 subsurface soils under recreational use is 3.5×10^{-5}, which is within the EPA target cancer risk range of 1×10^{-6} to 1×10^{-4}. The principal COC contributing to this cancer risk is arsenic.

Table 14 indicates the estimated non-carcinogenic risks associated with Zone 1 subsurface soils. The cumulative HIs for certain target organs of a recreational child and recreational youth are both greater than

TABLE 9

Summary of Risks by COPC, Sitewide Surface Soils - Estimated RME Cancer Risks for Site 6
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Residential Receptor		
	Ingestion	Dermal Contact	Total
aluminum	NT	NT	NT
arsenic	2.32E-05	1.35E-05	3.67E-05
barium	NT	NT	NT
beryllium	NT	NT	NT
cadmium	NT	NT	NT
chromium	NT	NT	NT
copper	NT	NT	NT
manganese	NT	NT	NT
mercury	NT	NT	NT
thallium	NT	NT	NT
Aroclor-1260	1.67E-07	1.72E-07	3.39E-07
benz(a)anthracene	5.35E-07	NT	5.35E-07
benzo(a)pyrene	5.28E-06	NT	5.28E-06
benzo(b)fluoranthene	5.49E-07	NT	5.49E-07
dibenz(a,h)anthracene	3.03E-06	NT	3.03E-06
indeno(1,2,3-cd)pyrene	3.93E-07	NT	3.93E-07
TOTAL RISK:	3.32E-05	1.36E-05	4.68E-05

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 10

Summary of Risks by COPC, Sitewide Surface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ For Noncarcinogens	Estimated Hazard Index** Future Residential Child			Estimated Hazard Index** Future Residential Adult		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
aluminum		1.85E-01	6.58E-02	2.51E-01	1.99E-02	2.58E-02	4.57E-02
arsenic	S	4.21E-01	1.36E-01	5.57E-01	4.51E-02	5.33E-02	9.84E-02
barium	C, DS, RS	2.03E-02	1.94E-03	2.31E-02	2.17E-03	7.62E-04	3.13E-03
beryllium		2.58E-03	2.48E-02	2.73E-02	2.77E-04	9.71E-03	9.98E-03
cadmium	K	3.81E-02	7.30E-02	1.11E-01	4.08E-03	2.86E-02	3.27E-02
chromium	S, K	6.11E-01	5.86E+00	6.47E+00	6.55E-02	2.30E+00	2.36E+00
copper	C, K, L	2.43E-02	3.88E-03	2.82E-02	2.60E-03	1.52E-03	4.12E-03
manganese	CNS	6.41E-02	6.14E-03	1.27E-01	6.87E-03	2.41E-03	2.14E-02
mercury	K, CNS	6.35E-02	4.06E-02	1.04E-01	6.81E-03	1.59E-02	2.27E-02
thallium	S, K, L, CNS	1.15E+00	1.10E-01	1.26E+00	1.23E-01	4.32E-02	1.66E-01
Aroclor-1260		NT	NT	NT	NT	NT	NT
benz(a)anthracene		NT	NT	NT	NT	NT	NT
benzo(a)pyrene		NT	NT	NT	NT	NT	NT
benzo(b)fluoranthene		NT	NT	NT	NT	NT	NT
dibenz(a,h)anthracene		NT	NT	NT	NT	NT	NT
indeno(1,2,3-cd)pyrene		NT	NT	NT	NT	NT	NT

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

** -- Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.

Target Organs: S = Skin, K = Kidney, C = Cardiovascular System, L = Liver, CNS = Central Nervous System, DS = Digestive System, RS = Reproductive System

TABLE 11

Summary of Risks by COPC, Sitewide Subsurface Soils - Estimated RME Cancer Risks for Site 6
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Recreational Receptor		
	Ingestion	Dermal Contact	Total
arsenic	1.50E-06	1.06E-06	2.57E-06
beryllium	NT	NT	NT
cadmium	NT	NT	NT
chromium	NT	NT	NT
copper	NT	NT	NT
iron	NT	NT	NT
lead	NT	NT	NT
thallium	NT	NT	NT
zinc	NT	NT	NT
Aroclor-1254	2.32E-08	2.93E-08	5.25E-08
benzo(a)pyrene	1.69E-07	NT	1.69E-07
TOTAL RISK:	1.69E-06	1.09E-06	2.79E-06

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 12

Summary of Risks by COPC, Sitewide Subsurface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ For Noncarcinogens	Estimated Hazard Index Future Recreational Child			Estimated Hazard Index Future Recreational Youth		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
arsenic	S	3.33E-02	1.20E-02	4.52E-02	6.11E-03	9.61E-03	1.57E-02
beryllium		1.57E-04	1.67E-03	1.83E-03	2.88E-05	1.34E-03	1.37E-03
cadmium	K	1.86E-02	3.98E-02	5.84E-02	3.42E-03	3.19E-02	3.53E-02
chromium	S, K	3.61E-01	3.86E+00	4.22E+00	6.63E-02	3.10E+00	3.16E+00
copper	C, K, L	4.56E-03	8.11E-04	5.37E-03	8.36E-04	6.51E-04	1.49E-03
iron	L, DS	1.35E-01	1.44E-02	1.49E-01	2.47E-02	1.15E-02	3.63E-02
lead	C, CNS	NT	NT	NT	NT	NT	NT
thallium	S, K, L, CNS	2.39E-01	2.55E-02	2.64E-01	4.39E-02	2.05E-02	6.43E-02
zinc	C	9.77E-04	4.17E-04	1.39E-03	1.79E-04	3.35E-04	5.15E-04
Aroclor-1254	S, L, RS	5.78E-03	3.70E-03	9.49E-03	1.06E-03	2.98E-03	4.04E-03
benzo(a)pyrene		NT	NT	NT	NT	NT	NT

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

** -- Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.

Target Organs: S = Skin, K = Kidney, Cardiovascular System, L = Liver, CNS = Central Nervous System, DS = Digestive System, RS = Reproductive System

TABLE 13

Summary of Risks by COPC, Zone 1 Subsurface Soils - Estimated RME Cancer Risks for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Recreational Receptor		
	Ingestion	Dermal Contact	Total
antimony	NT	NT	NT
arsenic	2.06E-06	1.46E-06	3.52E-06
chromium	NT	NT	NT
iron	NT	NT	NT
thallium	NT	NT	NT
TOTAL RISK:	2.06E-06	1.46E-06	3.52E-06

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 14

Summary of Risks by COPC, Zone 1 Subsurface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ For Noncarcinogens	Estimated Hazard Index Future Recreational Child			Estimated Hazard Index Future Recreational Youth		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
antimony	C	3.25E-01	3.47E-01	6.72E-01	5.96E-02	2.79E-01	3.38E-01
arsenic	S	4.57E-02	1.64E-02	6.21E-02	8.39E-03	1.32E-02	2.16E-02
chromium	S, K	1.13E+00	1.21E+01	1.32E+01	2.08E-01	9.70E+00	9.91E+00
iron	L, DS	6.13E-01	6.54E-02	6.78E-01	1.12E-01	5.25E-02	1.65E-01
thallium	S, K, L, CNS	1.09E+00	1.16E-01	1.20E+00	1.99E-01	9.31E-02	2.93E-01

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

** -- Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.

Target Organs: S = Skin, K = Kidney, C = Cardiovascular System, L = Liver, CNS = Central Nervous System, DS = Digestive System

1.0. The principal COCs contributing to the noncarcinogenic risk are chromium (via ingestion and dermal contact, chromium recreational child HI is equal to 13 and recreational youth HI is equal to 10) and thallium (via ingestion, thallium recreational child HI is equal to 1.2). The target organ for chromium is the kidney. The target organs for thallium are the liver, the GI tract, and the central nervous system (CNS). The total HI for the kidney as a target organ equals 14.4 for a recreational child and 10.2 for a recreational youth. The total HI for skin as a target organ equals 1.3 for the future recreational child. The total HI for the liver as a target organ equals 1.9 for the recreational child. The total HI for the CNS as a target organ equals 1.2 for the a recreational child. No other combination of HQs that affect the same target organ for the future recreational child and youth would result in an HI of greater than 1.0.

Zone 2

Table 15 indicates the estimated carcinogenic risks which would be incurred by ingestion of and dermal contact with Zone 2 subsurface soils under recreational use. The cumulative ingestion and dermal contact carcinogenic risk for Zone 2 subsurface soils under recreational use is 1.6×10^{-5}, which is within the EPA target cancer risk range of 1×10^{-6} to 1×10^{-4}. The principal COC contributing to this cancer risk is arsenic.

Table 16 indicates the estimated non-carcinogenic risks. The cumulative HIs for certain target organs for a recreational child and recreational youth are both greater than 1.0. The principal COCs contributing to the noncarcinogenic risk are chromium (via ingestion and dermal contact, chromium recreational child HI is equal to 42 and recreational youth HI is equal to 31) and, to a lesser extent, iron and thallium based on the liver as the target organ. The target organ for chromium is the kidney. The total HI for the kidney and skin as target organs equals 43.6 for the future recreational child and 32.1 for the future recreational youth. The total HI for the liver as a target organ equals 1.8 for the future recreational child. No other combination of HQs that affect the same target organ for the future recreational child and youth would result in an HI of greater than 1.0.

Zone 3

Table 17 indicates the estimated carcinogenic risks which would be incurred by ingestion of and dermal contact with Zone 3 subsurface soils under recreational use. The cumulative ingestion and dermal contact carcinogenic risk for Zone 3 subsurface soils under recreational use is 8×10^{-6}, which is within the EPA target cancer risk range of 1×10^{-6} to 1×10^{-4}. The principal COC contributing to this cancer risk is arsenic (via ingestion and dermal contact).

Table 18 indicates the estimated non-carcinogenic risks. The cumulative HIs based on certain target organs of a recreational child and recreational youth are both greater than 1.0. The principal COCs contributing to the noncarcinogenic risk are chromium (via ingestion and dermal contact, chromium recreational child HI is equal to 87 and recreational youth HI is equal to 65) and, to a lesser extent, iron and thallium based on the liver as the target organ. The target organ for chromium is the kidney. The target organs for thallium are the liver, GI tract, and CNS. The total HI for the kidney and skin as target organs equals 87.8 for the recreational child and 65.4 for the recreational youth. The total HI for liver as a target organ equals 1.9 for the recreational child. No other combination of HQs that affect the same target organ for the future recreational child and youth would result in an HI of greater than 1.0.

b. Potential Residential Use

Table 19 indicates the estimated carcinogenic risks which would be incurred by ingestion of and dermal contact with sitewide subsurface soils under residential use. The cumulative carcinogenic risk for the future residential receptor was calculated at 5.6×10^{-5}, which is within the EPA target cancer risk range of 1×10^{-6} to 1×10^{-4}. The principal COC contributing to this cancer risk is arsenic.

Table 20 indicates the estimated non-carcinogenic risks. The cumulative HIs based on certain target organs of a residential child and residential adult are both greater than 1.0. The principal COCs contributing to the noncarcinogenic risk are chromium (via ingestion and dermal contact, chromium residential child HI is equal to 62 and residential adult HI is equal to 23), iron (via ingestion of subsurface soils as future surface soils, iron

TABLE 15

Summary of Risks by COPC, ZONE 2 Subsurface Soils - Estimated RME Cancer Risks for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Recreational Receptor		
	Ingestion	Dermal Contact	Total
antimony	NT	NT	NT
arsenic	9.62E-06	6.82E-06	1.64E-05
cadmium	NT	NT	NT
chromium	NT	NT	NT
iron	NT	NT	NT
lead	NT	NT	NT
thallium	NT	NT	NT
TOTAL RISK:	9.62E-06	6.82E-06	1.64E-05

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 16

Summary of Risks by COPC, Zone 2 Subsurface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ Ep Noncarcinogens	Estimated Hazard Index Future Recreational Child			Estimated Hazard Index Future Recreational Youth		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
antimony	C	1.35E-01	1.44E-01	2.78E-01	2.47E-02	1.15E-01	1.40E-01
arsenic	S	2.13E-01	7.66E-02	2.90E-01	3.91E-02	6.16E-02	1.01E-01
cadmium	K	6.54E-02	1.40E-01	2.05E-01	1.20E-02	1.12E-01	1.24E-01
chromium	S, K	3.63E+00	3.87E+01	4.24E+01	6.66E-01	3.11E+01	3.18E+01
iron	L, DS	6.89E-01	7.36E-02	7.63E-01	1.27E-01	5.91E-02	1.86E-01
lead	C, CNS	NT	NT	NT	NT	NT	NT
thallium	S, K, L, CNS	9.13E-01	9.75E-02	1.01E+00	1.68E-01	7.83E-02	2.46E-01

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

** -- Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.

Target Organs: S = Skin, K = Kidney, C = Cardiovascular System, L = Liver, CNS = Central Nervous System, DS = Digestive System

TABLE 17

Summary of Risks by COPC, Zone 3 Subsurface Soils - Estimated RME Cancer Risks for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Recreational Receptor		
	Ingestion	Dermal Contact	Total
arsenic	3.80E-06	2.69E-06	6.50E-06
cadmium	NT	NT	NT
chromium	NT	NT	NT
iron	NT	NT	NT
lead	NT	NT	NT
thallium	NT	NT	NT
zinc	NT	NT	NT
Aroclor-1254	6.67E-07	8.43E-07	1.51E-06
TOTAL RISK:	4.47E-06	3.54E-06	8.01E-06

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 18

Summary of Risks by COPC, Zone 3 Subsurface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ for Noncarcinogens	Estimated Hazard Index Future Recreational Child			Estimated Hazard Index Future Recreational Youth		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
arsenic	S	8.42E-02	3.03E-02	1.15E-01	1.55E-02	2.43E-02	3.98E-02
cadmium	K	1.20E-01	2.57E-01	3.78E-01	2.21E-02	2.07E-01	2.29E-01
chromium	S, K	7.42E+00	7.92E+01	8.66E+01	1.36E+00	6.36E+01	6.49E+01
iron	L, DS	6.97E-01	7.44E-02	7.72E-01	1.28E-01	5.98E-02	1.88E-01
lead	C, CNS	NT	NT	NT	NT	NT	NT
thallium	S, K, L, CNS	7.61E-01	8.12E-02	8.42E-01	1.40E-01	6.52E-02	2.05E-01
zinc	C	2.08E-01	8.86E-02	2.96E-01	3.81E-02	7.12E-02	1.09E-01
Aroclor-1254	S, L, RS	1.66E-01	1.07E-01	2.73E-01	3.05E-02	8.56E-02	1.16E-01

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

** -- Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.

Target Organs: S = Skin, K = Kidney, C = Cardiovascular System, L = Liver, CNS = Central Nervous System, DS = Digestive System, RS = Reproductive System

TABLE 19

Summary of Risks by COPC, Sitewide Subsurface Soils - Estimated RME Cancer Risks for Site 6
NAWC Warminster, Pennsylvania

COPC	Estimated Cancer Risk Future Residential Receptor		
	Ingestion	Dermal Contact	Total
aluminum	NT	NT	NT
arsenic	2.96E-05	1.72E-05	4.68E-05
barium	NT	NT	NT
beryllium	NT	NT	NT
cadmium	NT	NT	NT
chromium	NT	NT	NT
copper	NT	NT	NT
iron	NT	NT	NT
lead	NT	NT	NT
manganese	NT	NT	NT
mercury	NT	NT	NT
nickel	NT	NT	NT
silver	NT	NT	NT
thallium	NT	NT	NT
vanadium	NT	NT	NT
zinc	NT	NT	NT
Aroclor-1248	1.40E-07	1.44E-07	2.84E-07
Aroclor-1254	4.57E-07	4.73E-07	9.30E-07
Aroclor-1260	5.95E-07	6.15E-07	1.21E-06
benz(a)anthracene	3.22E-07	NT	3.23E-07
benzo(a)pyrene	3.33E-06	NT	3.33E-06
benzo(b)fluoranthene	3.89E-07	NT	3.89E-07
dibenz(a,h)anthracene	2.51E-06	NT	2.52E-06
indeno(1,2,3-cd)pyrene	2.96E-07	NT	2.96E-07
TOTAL RISK:	3.76E-05	1.84E-05	5.61E-05

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

TABLE 20

Summary of Risks by COPC, Sitewide Subsurface Soils - Estimated RME Hazard Indices for Sites 6 and 7
NAWC Warminster, Pennsylvania

COPC	Target Organ For Noncarcinogens	Estimated Hazard Index Future Residential Child			Estimated Hazard Index Future Residential Adult		
		Ingestion	Dermal Contact	Total	Ingestion	Dermal Contact	Total
aluminum		1.99E-01	7.08E-02	2.70E-01	2.14E-02	2.78E-02	4.91E-02
arsenic	S	5.37E-01	1.73E-01	7.10E-01	5.75E-02	6.80E-02	1.26E-01
barium	C, DS, RS	2.37E-02	2.28E-03	2.71E-02	2.54E-03	8.92E-04	3.66E-03
beryllium		2.53E-03	2.43E-02	2.68E-02	2.71E-04	9.51E-03	9.79E-03
cadmium	K	3.00E-01	5.76E-01	8.76E-01	3.22E-02	2.26E-01	2.58E-01
chromium	S, K	5.83E+00	5.59E+01	6.17E+01	6.25E-01	2.19E+01	2.25E+01
copper	C, K, L	7.35E-02	1.17E-02	8.53E-02	7.88E-03	4.61E-03	1.25E-02
iron	L, DS	2.17E+00	2.08E-01	2.38E+00	2.33E-01	8.17E-02	3.15E-01
lead	C, CNS	NT	NT	NT	NT	NT	NT
manganese	CNS	5.41E-02	5.18E-03	1.07E-01	5.79E-03	2.03E-03	1.80E-02
mercury	K, CNS	1.05E-01	6.68E-02	1.71E-01	1.12E-02	2.62E-02	3.74E-02
nickel	CNS	1.73E-02	1.66E-02	3.39E-02	1.86E-03	6.51E-03	8.37E-03
silver	K	2.84E-01	2.72E-02	3.11E-01	3.04E-02	1.07E-02	4.11E-02
thallium	S, K, L, CNS	3.86E+00	3.69E-01	4.22E+00	4.13E-01	1.45E-01	5.58E-01
vanadium		7.45E-02	3.57E-01	4.32E-01	7.98E-03	1.40E-01	1.48E-01
zinc	C	1.58E-02	6.04E-03	2.18E-02	1.69E-03	2.37E-03	4.06E-03
Aroclor-1248		NT	NT	NT	NT	NT	NT
Aroclor-1254	S, L, RS	9.33E-02	5.37E-02	1.47E-01	1.00E-02	2.10E-02	3.10E-02
Aroclor-1260		NT	NT	NT	NT	NT	NT
benz(a)anthracene		NT	NT	NT	NT	NT	NT
benzo(a)pyrene		NT	NT	NT	NT	NT	NT
benzo(b)fluoranthene		NT	NT	NT	NT	NT	NT
dibenz(a,h)anthracene		NT	NT	NT	NT	NT	NT
indeno(1,2,3-cd)pyrene		NT	NT	NT	NT	NT	NT

Notes:

NT -- No toxicity factor (slope factor or RfD) was available or applicable for any COPCs selected for this area of interest and medium.

RME -- Reasonable Maximum Exposure: The combination of activity patterns and intake dose assumptions that yield the highest exposure that is reasonably expected to occur.

** -- Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.

Target Organs: S = Skin, K = Kidney, C = Cardiovascular System, L = Liver, CNS = Central Nervous System, DS = Digestive System, RS = Reproductive System

residential child HI is equal to 2.4), and thallium (via ingestion of subsurface soils as future surface soils, thallium residential child HI is equal to 4.2). The target organ for chromium is the kidney. The target organs for thallium are the liver, GI tract and CNS. The target organs for iron are the liver, pancreas, and the GI tract. The total HI for the kidney as the target organ equals 67.4 for the future residential child and 23.4 for the future residential adult. The total HI for skin as the target organ equals 66.8 for the future residential child and 23.3 for the future residential adult. The total HI the liver as a target organ equals 4.5 for the future residential child. The total HI for the CNS as a target organ equals 4.6 for the future residential child. No other combination of HQs that affect the same target organ for the future resident would result in an HI of greater than 1.0.

The human health risk assessment did not assess carcinogenic or non-carcinogenic residential risks associated with subsurface soils in Zones 1, 2 and 3. However, based on the information presented above, it is clear that subsurface soils within each of these zones would present an unacceptable noncarcinogenic risk under residential use.

Lead Risks

The EPA has developed an approach for evaluating noncarcinogenic risks from lead exposure that recognizes the multimedia nature of lead exposures and incorporates absorption and pharmokinetic information. This approach includes the use of an Integrated Exposure and Uptake Biokinetic (IEUBK) Model to predict the blood levels of lead which may result because of site conditions. When the IEUBK model predicts that more than 5% of the exposed population may have lead blood-levels of greater than 10 micrograms per deciliter (ug/dl), the potential for adverse affects is considered to be significant.

The RI estimated the risks posed by soil, dust and water associated with Sites 6 and 7 to hypothetical residential children (ages 0 through 6), who are considered the most sensitive receptor group. The simulated range of blood-lead values that might occur in a population as a result of exposures to lead was compared to a guideline level of 10 µg/dl. Only risks posed by sitewide subsurface soil (as potential future soil) were evaluated.

Lead was determined not to be a contaminant of potential concern in surface soils because of the low mean and representative concentrations of lead detected in surface soils (38.3 and 46.6 mg/kg, respectively).

With regard to sitewide subsurface soils, 0.43 percent of residential children exposed under similar conditions were predicted to have blood-lead levels exceeding 10 µg/dl. This is below a protective guideline of 5 percent for the maximum proportion of individuals with blood levels exceeding 10 µg/dl.

The human health risk assessment did not assess the risks posed by lead in subsurface soils within Zones 1, 2 and 3. The mean concentrations of lead detected in subsurface soils in Zones 1, 2 and 3 (as indicated by Tables 2, 3, and 4), were 49.2 mg/kg, 5670 mg/kg and 926 mg/kg, respectively. Based on this and other available information, lead levels in subsurface soils within Zones 2 and 3 may present an unacceptable risk.

F. Uncertainty Analysis

A source of uncertainty with regard to the human health risk assessment for OU-7 stems from a lack of speciation data to distinguish whether chromium in Sites 6 and 7 soils is present in hexavalent or trivalent form. (Hexavalent chromium is substantially more toxic.) The estimated noncarcinogenic risks presented above were calculated assuming that all detected chromium was hexavalent in nature. This assumption was conservative and the subject risk calculations have been utilized as a basis for this ROD to ensure protectiveness. To evaluate the impact of this assumption, the RI also calculated the risks assuming that part of the total chromium was trivalent in nature. These alternative assumptions were developed based on an evaluation of soil data for Area A at NAWC (Sites 1and 2, and the Impoundment Area), where chromium was speciated. (The source of chromium in soils within both Sites 6 and 7 and Area A sites may be residuals associated with industrial wastewater treatment sludges reportedly disposed in these areas.)

Speciation data for chromium for soils in Area A sites indicate the maximum representative hexavalent chromium to total chromium ratio in Area A (Site 2) was 0.019 (or 1.9%), while the maximum ratio of hexavalent chromium to total chromium in any one sample collected in Area A (Impoundment Area) was 0.2264 (or 22.64%). The table below provides the HQs for chromium for recreational land use assuming that all the detected chromium was hexavalent (per the risk assessment used as the basis for this ROD),

assuming the percent of hexavalent was equal to the maximum percentage in Area A and assuming the percent of hexavalent chromium corresponds to the maximum representative percentage for Area A.

	Assuming all chromium is hexavalent chromium		**Assuming maximum hexavalent chromium ratio (22.6%)**		**Assuming representative concentration ratio (1.9%)**	
	Child	**Youth**	**Child**	**Youth**	**Child**	**Youth**
Site-wide Subsurface	4.22	3.16	1.0	0.7	0.08	0.06
Zone 1	13.1	9.91	3.0	2.2	0.25	0.19
Zone 2	42.4	31.8	9.6	7.2	0.81	0.6
Zone 3	86.6	64.9	19.6	14.7	1.65	1.23

As indicated by this table, the noncarcinogenic risks attributable to chromium may be significantly lower if the ratio of hexavalent to total chromium is similar to that found in Area A subsurface soils.

In addition, confidence in the study which provides the basis for the RfD for hexavalent chromium is low due to the low number of animals tested, the low number of parameters measured, and the lack of toxic effects at the highest dose tested. Confidence in the database is also low because supporting studies are of similar low quality, and teratogenic and reproductive endpoints are not well studied. The RfD is limited to metallic chromium (VI) of soluble salts. It is unknown whether these hexavalent chromium salts actually exist at Sites 6 and 7. Examples of soluble salts include potassium dichromate (K_2Cr_2O7), sodium dichromate (Na_2Cr_2O7), potassium chromate (K_2CrO_4), and sodium chromate (Na_2CrO_4). An uncertainty factor of 500 has been applied to the oral RfD and this represents two 10-fold decreases in dose to account for both the expected inter-human and inter-species variability in the toxicity of the chemical in lieu of specific data, and an additional factor of 5 to compensate for the less-than-lifetime exposure duration of the principal study.

There is also high uncertainty associated with the estimation of risks due to dermal exposure because of the derivation of the dermal slope factor and reference dose. The dermal toxicity factors are based on default oral absorption factors. This can result in an overestimation of the toxicity factors. The risk assessment finds dermal exposure to be a primary contributor to the HI under recreational and residential use. The uncertainty associated with the dermal exposure route may have overestimated the risk posed by Sites 6 and 7.

An additional uncertainty is introduced by the assumption that subsurface soils will become surface soils. The use of current subsurface soil concentrations to represent future surface exposure concentrations assumes two things that add to the uncertainty of the risk assessment. First, this exposure scenario assumes that soil would be excavated to the sampling depth (a majority of the subsurface soil samples were collected at depths greater than 4 feet). Second, this exposure scenario assumes that once the soil is excavated no degradation of the chemicals in the subsurface soil or mixing with surface soils would have taken place. These uncertainties cause an over-estimation of the exposure at NAWC Warminster Sites 6 and 7 because subsurface soil contaminant concentrations are generally greater than surface soil contaminant concentrations.

G. Conclusions of Human Health Risk Assessment

The total cumulative carcinogenic risks presented by surface and subsurface soils under recreational use are within EPA's acceptable cancer risk range. However, the noncarcinogenic HIs for recreational use are greater than 1.0 for sitewide subsurface soils, as well as for subsurface soils in Zones 1, 2 and 3.

While residential land use is not reasonably anticipated, sitewide surface and subsurface soils both were found to present an unacceptable non-carcinogenic risk under this use. Sitewide surface and subsurface soils were not found to present an unacceptable carcinogenic risk under a hypothetical residential use. Chromium and thallium are the major contributors to the noncarcinogenic risk for Sites 6 and 7 for recreational and residential use.

As noted earlier, any risks posed by Sites 6 and 7 to ecological receptors (e.g., those associated with surface water and sediment downgradient of Site 6 and 7) will be addressed in a future ROD.

In summary, subsurface soils and wastes at Sites 6 and 7 have been determined to present an unacceptable risk to human health under the planned recreational use. In addition, while not reasonably anticipated, both surface and subsurface soils have been determined to present and unacceptable risk to human health under residential land use. Risks to human health under industrial/commercial land use were not evaluated.

Actual or threatened releases of hazardous substances from Sites 6 and 7, if not addressed by a remedial action to be selected in this ROD, may present an imminent and substantial endangerment to public health, or welfare or the environment.

X. REMEDIAL ACTION OBJECTIVES

Based on the results of the human health risk assessment, the objective of the remedial action for Sites 6 and 7 is to prevent human exposure (via incidental ingestion and dermal contact) to soils which contain hazardous substances at levels which have been determined to present an unacceptable risk under the planned recreational use of the property, the reasonably anticipated land use. In addition, since residential use of the subject property is not reasonably anticipated and the soils contain hazardous substances at levels which have been determined to present an unacceptable risk under residential use, the Navy has determined that land use controls must be implemented to ensure that the property is not used for residential purposes. Finally, since there have been suggestions that limited industrial/commercial use of Sites 6 and 7 may be possible and there has been no risk assessment for such use, land use controls must be implemented to require the Navy and/or EPA approval of a risk assessment for such use and additional environmental response work if necessary.

To be protective of recreational use, the remedial action should prevent human ingestion of and dermal contact with COCs in subsurface soils which exceed the concentrations indicated in the table below. These remediation cleanup levels are identified in the Feasibility Study for Sites 6 and 7 and were developed based on the risk assessment contained in the RI.

Remediation Levels for Sites 6 and 7(1)				
COC	**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	-	-	-	1540

(1) Metals concentrations are in mg/kg; Aroclor concentration is in ug/kg. Cleanup Levels were developed for each substance determined to be a significant contributor to an unacceptable non-carcinogenic risk and in each case corresponds to an HQ of 0.1 for the COC to ensure protectiveness.

XI. DESCRIPTION OF ALTERNATIVES

A detailed analysis of the possible remedial alternatives for OU-7 is included in the OU-7 Feasibility Study report. The detailed analysis was conducted in accordance with the U.S. EPA document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* and the National Oil Hazardous Substances Pollution Contingency Plan.

Alternative 1: No Action

This alternative does not involve any remedial action. This alternative is evaluated for the purpose of establishing a basis for comparison with other alternatives.

The following are the cost and duration associated with this Alternative:

Costs: There are no costs associated with the No-Action alternative.
Time to implement: 0 months

Alternative 2: Vegetated Soil Cover, Institutional Controls, and Monitoring

Alternative 2 includes placing and maintaining a 2 foot vegetated soil cover over sitewide subsurface soils which present a threat under the planned recreational use, institutional controls to ensure the maintenance of the soil cover and to control excavation, and monitoring to ensure the cover is maintained and the institutional controls are implemented as planned. In addition, institutional controls would be implemented to prohibit residential use and to prevent industrial/commercial use without Navy and/or EPA approval of a risk assessment for such use and additional environmental response work, if necessary.

This alternative consists of placing/maintaining a two foot vegetated soil cover over sitewide subsurface soils to ensure there is no human exposure to subsurface soils exceeding the cleanup levels identified above. Sitewide subsurface soils are defined as soils in areas where subsurface disposal has occurred. Initially, the site would be evaluated to determine where additional soil, vegetation, engineering controls or other measures are required to establish the vegetated soil cover and the necessary measures would be implemented. Once established, the two foot vegetated soil cover would be permanently maintained.

As part of transfer of the property by the Navy, the deed entered into for transfer of the property shall provide that the vegetated soil cover shall remain permanently in place. In addition, the deed shall provide that any plans for excavation below two feet within the area of sitewide subsurface soils must be approved by the Navy and/or the EPA . Such approval shall consider the available information and be contingent on the submission of a plan which ensures that necessary measures are undertaken to protect human health and the environment. The information to be considered shall include RI data regarding the nature and extent of contaminants of concern per this ROD. The deed shall also provide that the property shall not be used for residential purposes and shall require Navy and/or EPA approval of a risk assessment for industrial/commercial land use and additional environmental response work, if necessary.

Periodic monitoring would be conducted to determine whether any maintenance activities are required for the vegetated two foot soil cover and to ensure adherence to deed restrictions. Any necessary maintenance of the vegetated soil cover shall be performed and necessary actions taken to ensure adherence to deed restrictions.

Every 5 years, a review would be conducted to evaluate the site status and determine whether further action is necessary. Periodic review would be required because this alternative allows contaminants to remain at concentrations which are not protective of unrestricted land use.

The following are the cost and duration associated with this Alternative:

Costs: Estimated capital costs.....$83,000
Estimated annual operation and maintenance costs.....$8,000
Estimated costs for five-year reviews.....$20,000
Estimated 30-year net present worth.....$225,429

Time to implement: Less than 12 months.

Alternative 3: Focused Excavation; Off-Site Treatment/Disposal; Vegetated Soil Cover; Institutional Controls and Monitoring

In addition to including the components of Alternative 2, Alternative 3 includes the excavation and removal of subsurface soils known to exceed remediation levels in Zone 1 and 2. The subsurface soil known to exceed remediation levels within Zones 1 and 2 are less than 6 feet below ground surface. Under this alternative, subsurface soils exceeding remediation levels within Zone 3 would remain in place.

After excavation, the soil/waste of concern would be treated if necessary prior to disposal in an off-base landfill. The excavated area would be backfilled with clean fill and revegetated. If it is determined that certain measures are necessary in the area of excavation to ensure the integrity of the 2 foot soil cover addressing sitewide subsurface soils (e.g., permanent maintenance of a vegetated two foot soil cover over the excavated area), the deed shall provide for such measures to be taken. Figure 6 depicts the areas estimated by the FS to require excavation under this alternative.

Contaminated soils would be excavated from Zones 1 and 2 using mechanical equipment such as excavators, bulldozers, and front-end loaders. Excavation will be accomplished in accordance with Occupational Safety and Health Administration (OSHA) requirements. Erosion control measures would be undertaken as necessary to meet ARARs. Dust control measures will be employed, as necessary, to minimize the risk of airborne contamination to the surrounding community and environment. Verification sampling would confirm that materials left in place meet the established remediation levels. After verification sample results confirm that no soils exceeding remediation levels remain, the excavated area would be backfilled with clean fill, graded, and revegetated. Size separation operations would be employed during the excavation and handling of materials to segregate out large pieces of concrete, stone, etc. for separate handling and/or disposal.

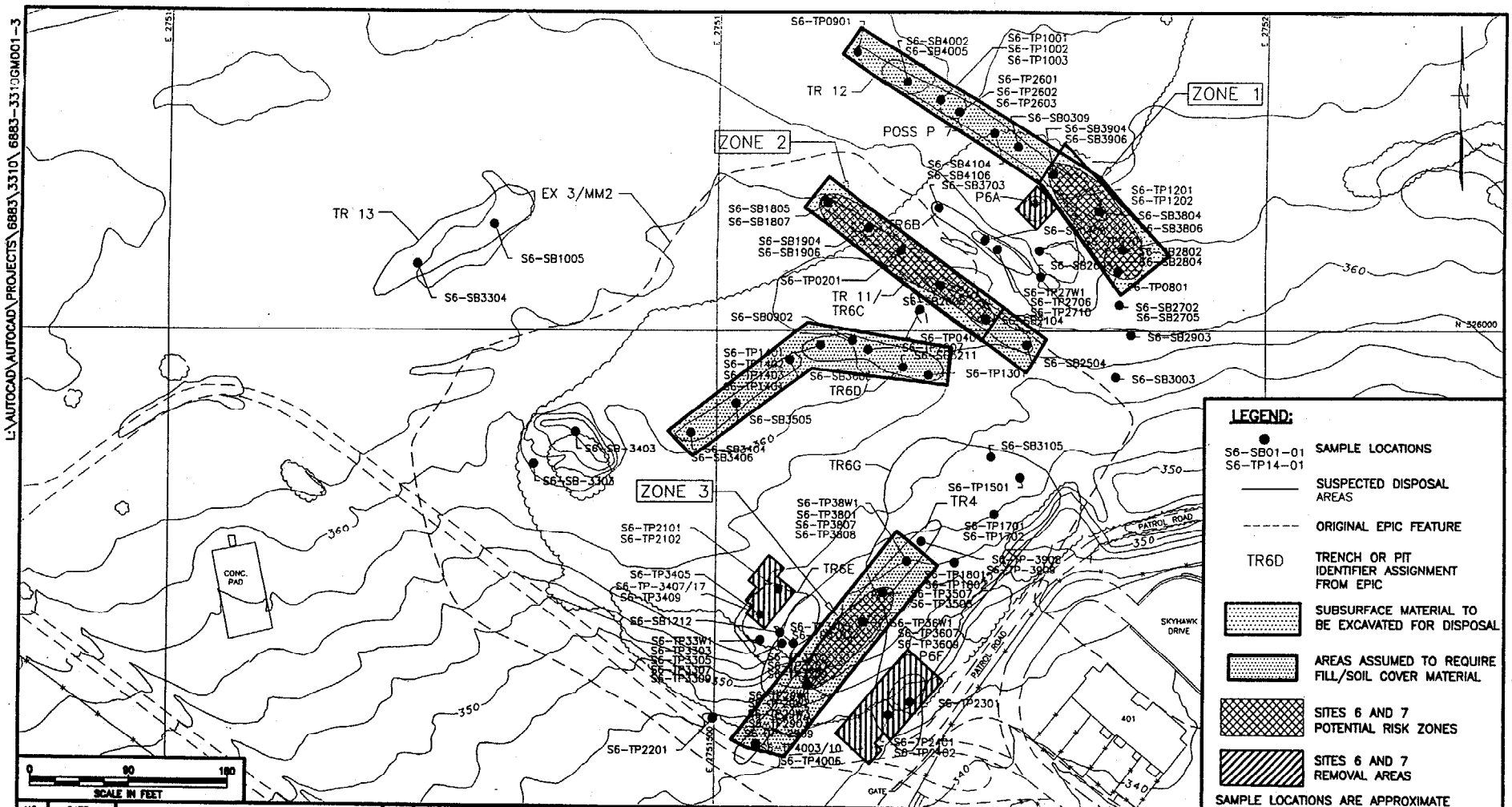
Excavated material would be staged and characterized as necessary prior to being transported and disposed of offsite at a RCRA-permitted treatment, storage or disposal (TSD) facility or a non-hazardous waste landfill, as appropriate. It is estimated that approximately two percent of the excavated materials would be classified as hazardous waste, and would require treatment and/or disposal by a TSD facility. The two percent estimate is based on the amount of materials requiring this treatment during the completed removal actions performed at this site in 1997 (see RI for OU-7, TtNUS 1999).

Every 5 years, a review would be conducted to evaluate site status and determine whether further action is necessary. Periodic review is required because contaminants outside of Zone 1 and 2 will remain at concentrations which are not protective of unrestricted land use.

The following are the cost and duration associated with this Alternative:

Costs: Estimated capital costs..... $1,220,000
Estimated annual operation and maintenance costs..... $8,000
Estimated costs for five-year reviews..... $20,000
Estimated 30-year net present worth..... $1,362,429

Time to implement: Less than 12 months.



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12-2-1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

ALTERNATIVE 3
AREA B – SITES 6 AND 7
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. CTO 0252
APPROVED BY DATE 4/30/99
APPROVED BY DATE
DRAWING NO. FIGURE 6
REV. 3

FORM CADD NO. L:\ACAD14\BLOCKS\BORDERS\TINUS_BH3.DWG

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Alternative 4: Expanded Excavation; Off-Site Treatment/Disposal, Vegetated Soil Cover; Institutional Controls and Monitoring

In addition to including the components of Alternatives 2 and 3, Alternative 4 also includes the excavation of subsurface soils exceeding remediation levels in Zone 3. The majority of subsurface soils exceeding remediation levels in Zone 3 are more than 6 feet below ground surface. The assumed excavation area extends from the patrol road, where data indicates soils exceeding remediation levels are within several feet of ground surface, to a point to the northwest where test pit excavations did not encounter soils exceeding remediation levels. Figure 7 indicates the estimated areas to be excavated. The excavated Zone 3 soils would include any soils exceeding remediation levels which may have been brought to the surface during previous site disturbances.

Every 5 years a review would be conducted to evaluate site status and determine whether further action is necessary. Periodic review is required because contaminants outside of Zones 1, 2 and 3 would remain at concentrations which are not protective of unrestricted land use.

The following are the cost and duration associated with this Alternative:

Costs: Estimated capital costs.....$1,831,000
Estimated annual operation and maintenance costs.....$8,000
Estimated costs for five-year reviews $20,000
Estimated 30-year net present worth.....$1,973,429

Time to implement: Less than 12 months.

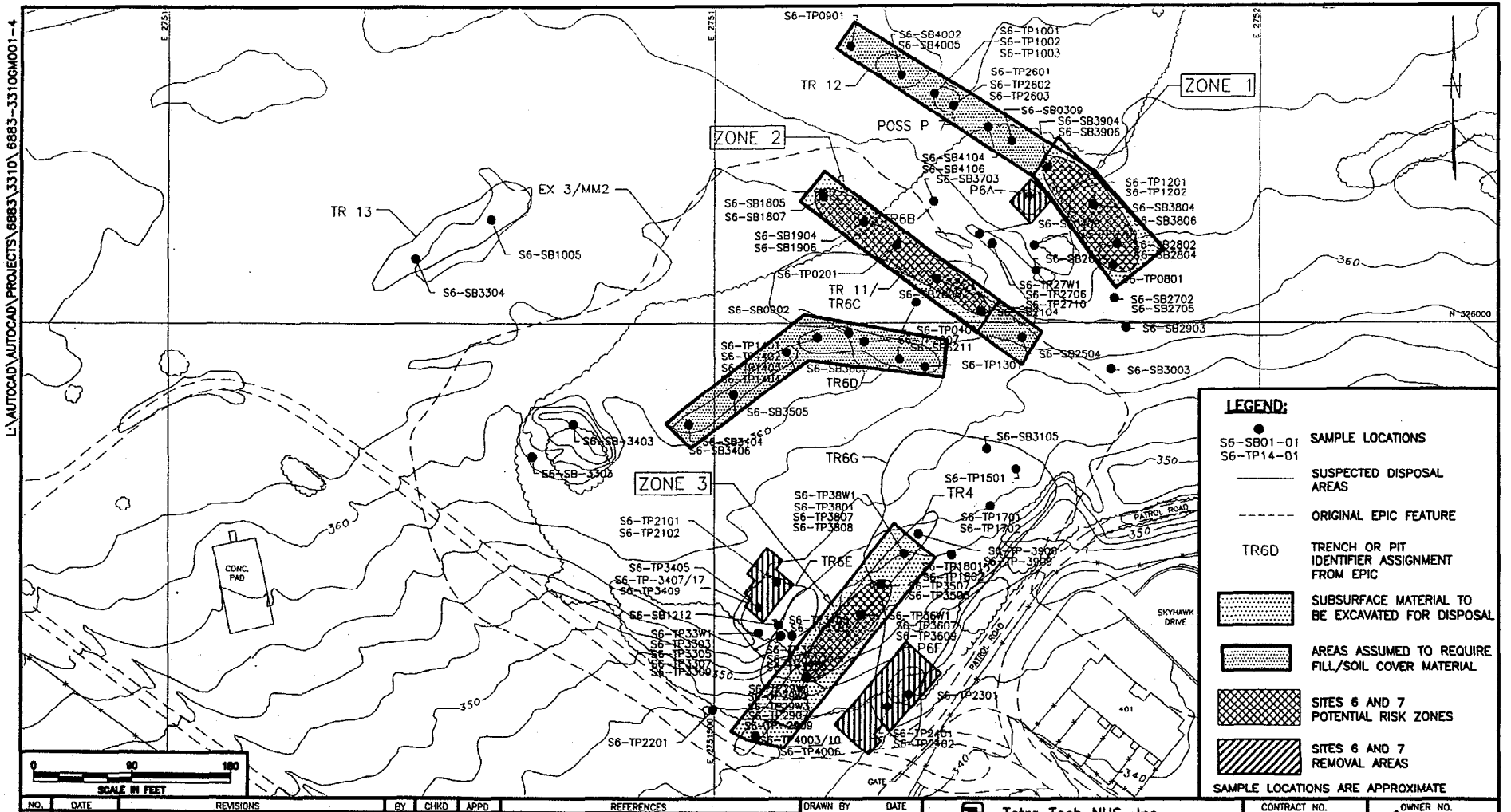
Alternative 5: Complete Excavation; Offsite Treatment/Disposal

Under Alternative 5, sitewide surface and subsurface soils would be excavated and removed. Soils exceeding remediation levels protective of all hypothetical uses, including residential use, would be excavated and removed. This alternative would not include the remedy components which comprise Alternative 2, e.g., a vegetated soil cover, institutional controls (e.g., deed restrictions), monitoring, or maintenance activities. No deed restrictions would be necessary to prohibit residential or industrial/commercial use.

This alternative consists of excavating and removing sitewide surface and subsurface soils/wastes, treating and/or disposing of the material at an off-site location, and backfilling the removal area with clean fill. Under this alternative, sitewide surface soils, which are defined as surface soils which contain residuals associated with waste disposed at Sites 6 and 7, would be excavated to a depth of 2 feet and transported offsite for disposal. Figure 8 depicts the estimated area of sitewide surface soils. This area is approximate and would be defined through additional sample collection and analysis during and after the removal of soils. This alternative also would include the excavation and removal of sitewide subsurface soils, which have been defined as soils within areas used for subsurface disposal that contain contaminants above the remediation goals. The estimated areas which comprise sitewide subsurface soils are shown on Figure 8. In the case of both surface and subsurface soils, excavation would continue until remediation levels protective of all uses are met. These levels, which are identified in the FS and provided in Table 21, are protective of residential use.

Soils would be excavated using mechanical equipment such as excavators, bulldozers, and front-end loaders. Excavation would be accomplished in accordance with OSHA requirements. Dust and erosion control measures would be taken as necessary to minimize impacts on the surrounding community and environment. The excavated area would be backfilled with clean fill, graded, and revegetated. During excavation, size separation to remove large concrete rubble, stone, etc. would be implemented for separate handling and/or disposal.

The actual areas and volume of subsurface soils requiring excavation and disposal may vary based on characterization and attainment sample results. Subsurface soils would be excavated to bedrock or to soil



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COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

ALTERNATIVE 4
AREA B – SITES 6 AND 7
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

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DRAWING NO. FIGURE 7
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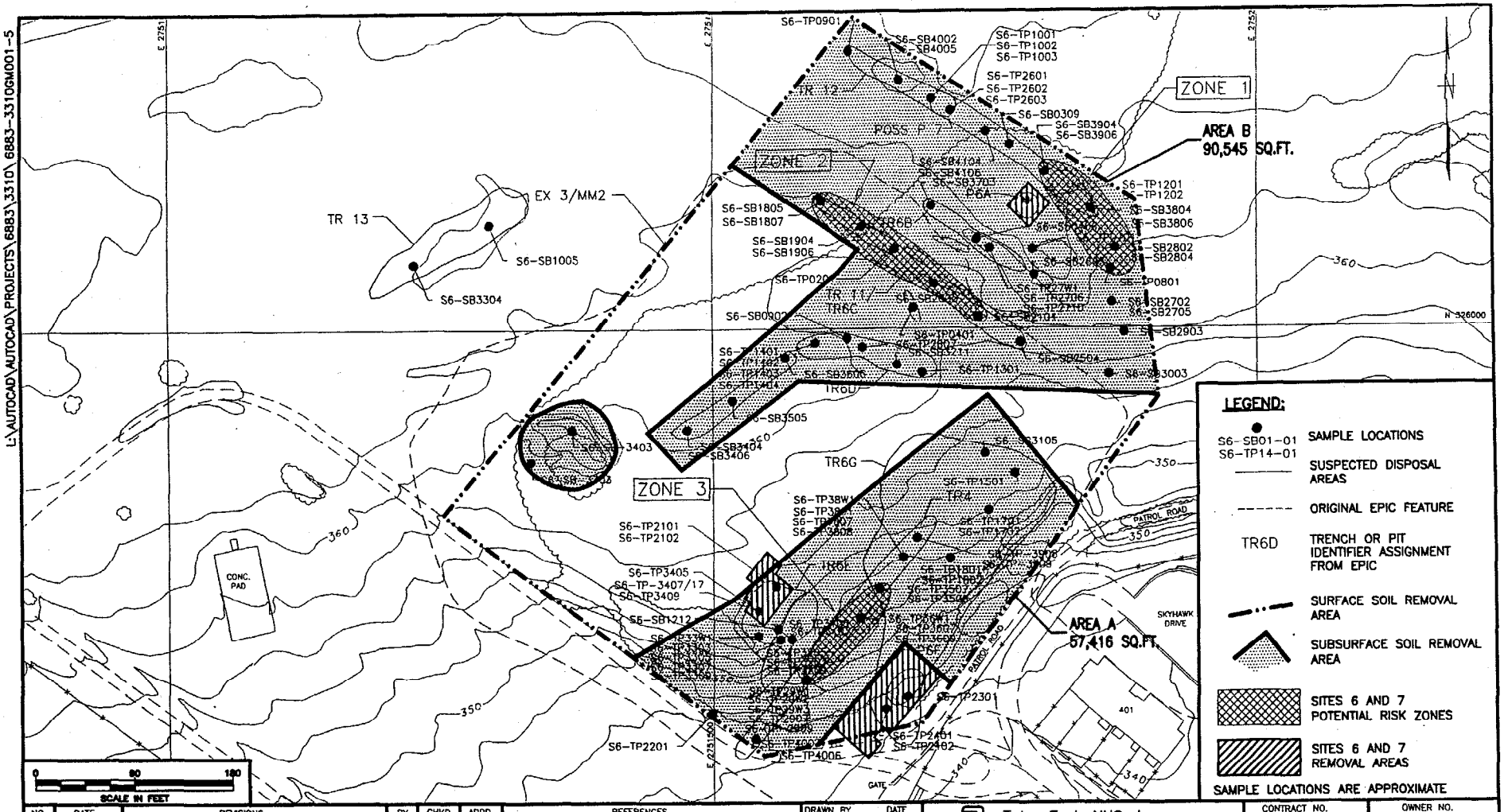

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NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12-2-1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

ALTERNATIVE 5
AREA B – SITES 6 AND 7
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. CTO 0252
APPROVED BY DATE 11/30/99
APPROVED BY DATE
DRAWING NO. FIGURE 8
REV. 5

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that does not exceed remediation levels for Alternative 5, whichever is encountered first. It is assumed, for costing purposes, that these excavations would extend to 12 feet below ground surface, the average depth to competent bedrock across the site. In addition, the soil volume estimate includes the removal of the relatively small mounded area within the western portion of the site. Samples from within this mound indicate the presence of contaminants at levels which exceed remediation levels for Alternative 5. Surface soils would be excavated to two feet. The actual areal extent of surface soil and subsurface soil excavation and the actual depth of subsurface soil excavation would be determined by verification sampling which would be performed to ensure that no soils exceeding remediation levels for Alternative 5 remain.

Excavated material would be staged and characterized as necessary prior to being transported and disposed of offsite at a RCRA-permitted treatment, storage or disposal (TSD) facility or a non-hazardous waste landfill, as appropriate. It is estimated that approximately two percent of the excavated materials would be classified as hazardous waste, and would require treatment and/or disposal by a TSD facility. The two percent estimate is based on the amount of materials requiring this treatment during the completed removal actions performed at this site in 1997 (see RI for OU-7, TtNUS 1999). It is assumed that the remainder of the excavated soils would be disposed as nonhazardous materials.

The following are the cost and duration associated with this Alternative:

Costs: Estimated capital costs.....$10,636,544
Estimated annual operation and maintenance costs.....$0
Estimated costs for five-year reviews $0
Estimated 30-year net present worth.....$10,636,544

Time to implement: 7 months to conduct capitol costs, 20 to 30 years for full restoration/recovery of vegetative cover.

XII. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives described above were evaluated in the Feasibility Study against nine specific criteria as required by the NCP. A description of each criterion and associated evaluation of the alternatives for Sites 6 and 7 is provided below.

A. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced or controlled, through treatment, engineering controls, and/or institutional controls.

Alternatives 2 through 5 each provide protection of human health and the environment and meet the remedial action objectives for planned recreational use. While residential use is not anticipated, Alternative 5 is also protective of residential use. Alternative 1, used for baseline purposes, is not protective of human health under the reasonably anticipated use or residential use. Because Alternative 1 does not meet this threshold criterion, it will not be evaluated any further.

Alternative 2, 3 and 4 eliminate risks posed by the incidental ingestion and dermal contact pathways of concern through a combination of removal, engineering controls and institutional controls. Alternative 5 eliminates these risks through complete removal.

TABLE 21
Preliminary Remediation Goals
Developed for Child and Lifetime Residential
Exposure for Site-Wide Soils
Under Alternative 5

COC	PRG[1]
Arsenic	1.7
Cadmium	2.68
Chromium	3.7
Manganese	553
Mercury	0.478
Silver	35.7
Thallium	0.464
Aroclor – 1254	99.3
Aroclor – 1260	1,570
Benzo(a)Pyrene	874
Dibenzo(a,h,)athracene	873

(1) Metals are mg/kg and organics are in ug/kg. Assumes an acceptable clean-up goal of 1E-05 for individual carcinogens and a 0.1 HQ for individual non-carcinogens under a residential exposure scenario.

B. Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA and Section 300.430(f)(1)(ii)(B) of the NCP require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA section 121(d)(4).

Alternatives 2, 3, 4, and 5 comply with and can be implemented in accordance with ARARs. Potential ARARs in the case of these alternatives are identified in Table 2-2 in the FS and in Appendix C to this ROD. Alternative 5 would require substantial excavation and backfilling and, as a result, the preparation of extensive plans to comply with soil erosion and sedimentation ARARs. In addition, Alternative 5 would require the placement of an extensive amount of backfill. It may be necessary to request a waiver from the PADEP under the Clean Fill Standards as a suitable source for the required amount of fill may not be readily available.

C. Reduction of Toxicity, Mobility or Volume through Treatment

Reduction of toxicity, mobility or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

None of the alternatives contain treatment components as an integral part of the alternative. Alternatives 2, 3, 4, and 5, would include treatment as necessary to meet land disposal restrictions before final disposition at a licensed facility. However, limited treatment is projected to be necessary. As a result, none of the alternatives are expected to reduce contaminant toxicity, mobility or volume through a treatment process. The relatively low contaminant concentrations in Sites 6 and 7 soils and wastes are not conducive to treatment.

D. Long-term Effectiveness

Long-term effectiveness and permanence refers to expected residual risk and the ability of the remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Alternative 5 would result in the permanent removal of all material above human health protection criteria and would not rely on any controls. Alternatives 2, 3, and 4 provide a lesser degree of permanence as each alternative relies on engineering and institutional controls, monitoring and periodic operation and maintenance to manage residual risks. The long-term effectiveness of the soil cover depends on the enforcement of the controls and the maintenance of the cover (see Implementability). Alternative 3 offers an added degree of permanence by removing the more accessible portion of material that is known to present an unacceptable potential risk under reasonably anticipated land uses. Alternative 4 provides a further degree of permanence, by including the removal of deeper contamination in Zone 3. However, the likelihood of exposure to most of known contaminated material in Zone 3 is particularly unlikely if controls, monitoring and maintenance are implemented as necessary. Institutional controls would also be implemented under Alternatives 2, 3 and 4 to prohibit residential use and to prevent industrial/commercial use without Navy and/or EPA approval of a risk assessment for such use and additional environmental response work, if necessary. These controls should be effective over the long-term.

E. Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternative 2 offers the shortest period to completion of the remedial actions with minimal short-term risks to the community. Alternatives 3 and 4 offer slightly longer periods to completion. Operational controls such as dust and erosion control measures could be readily implemented under Alternatives 3 and 4 to limit or manage any short-term potential risks to the community, workers or the environment. Alternative 5, when compared to Alternatives 3 and 4 requires about 4 times longer to complete and would require a more extensive traffic study and scheduling to lessen the impact on the community during implementation. Alternative 5 presents the greatest short-term risk to the environment due to the likely impact on wildlife by the removal of all trees and vegetation.

F. Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternatives 2, 3, and 4 all include the placement and/or maintenance of a vegetated two-foot soil cover over sitewide subsurface soils and institutional controls to prohibit residential use, condition industrial/ commercial use, control excavation and maintain the vegetated soil cover. The institutional controls under these alternatives would be the same with one exception. Since known waste of concern would be excavated from parts or all of Zones 1, 2 and 3 under Alternatives 3 and 4, the controls for these areas could be limited to those necessary to protect the integrity of the soil cover over remaining subsurface soils of concern. Generally, the placement/maintenance of the cover and institutional controls under Alternatives 2, 3 and 4 appear to be equally implementable.

Alternatives 3 and 4 include removal and offsite treatment/disposal of contaminated subsurface materials from parts or all of Zones 1, 2 and 3. This component of these alternatives uses existing and proven technologies and is otherwise readily implementable.

Alternative 5 relies on the same existing and proven technologies as Alternatives 3 and 4, but because of the extensive nature of the action, the ability to fully implement the action in a timely manner is uncertain. The availability of off-site disposal locations and a reliable source of clean fill for the completion of this alternative make the implementation of this alternative more complex.

G. Cost

The following table compares the costs of the alternatives.

Cost Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Capital Costs	$0	$83,000	$1,220,000	$1,831,000	$10,636,544
O&M Costs	$0	$8,000	$8,000	$8,000	0
Five Year Reviews	$0	$20,000	$20,000	$20,000	0
Present Worth	$0	$225,429	$1,362,429	$1,973,429	$10,636,544

H. State Acceptance

The Pennsylvania Department of Environmental Protection, on behalf of the Commonwealth of Pennsylvania, has reviewed the information available for this site and has concurred with this ROD and the selected remedy identified below. A copy of the letter of concurrence from the Commonwealth of Pennsylvania is attached as Appendix A.

I. Community Acceptance

The selected remedy was presented to the public in a meeting along with the Proposed Plan. Minutes of the public meeting are presented in Appendix B. Questions raised by members of the community are addressed in the Responsiveness Summary presented in Section XV of this ROD.

Several local community members and representatives of local municipalities expressed concern that clean-up standards less stringent than residential standards would present unacceptable health risks to future recreational users. As discussed elsewhere in this ROD, the clean-up goals for Sites 6 and 7 were developed in consultation with EPA and PADEP specifically taking into account exposure assumptions for recreational users. Other community members preferred Alternative 4, which involves expanded excavation, believing that such an approach would result in less restrictions on future use of the property. As discussed elsewhere in this ROD, the restrictions required as part of Alternative 4 are not significantly less than those required as part of Alternative 2 and do not significantly offset the greater costs associated with the excavation component of Alternative 4. Yet other members and local Township representatives commented that cost should not be a factor in the remedy selection process. As pointed out in this ROD, CERCLA and the NCP require a comparative evaluation of cost as one of the "balancing" criteria. A summary of public comments and responses is provided in Section XV, below.

J. Principal Threat Wastes

There have been no principal threat wastes, as defined by the NCP, identified in Sites 6 and 7 soils and waste.

XIII. THE SELECTED REMEDY

The selected remedy is Alternative 2, which includes placing and maintaining a 2 foot vegetated soil cover over sitewide subsurface soils, institutional controls to ensure the maintenance of the soil cover and to control excavation, and monitoring to ensure the cover is maintained and the institutional controls are implemented as planned. Institutional controls shall also be implemented to prohibit residential use and prevent industrial/commercial use, especially day care facilities, without Navy and/or EPA approval of a risk assessment for such use and additional environmental response work, if necessary.

A. Summary of the Rationale for the Selected Remedy

Alternative 2 meets the threshold criteria of overall protection of human health and the environment and compliance with ARARs. Alternative 2 also provides the best balance of tradeoffs with respect to the balancing and modifying criteria. While Alternatives 3 and 4 would include the removal of known soil / wastes of concern, a sitewide cover and sitewide institutional controls would still be required under these alternatives. Given the additional cost associated with Alternatives 3 and 4, the benefit of the removal would appear to be minimal. While no cover or controls would be required under Alternative 5, the extensive removal and fill operations present implementability concerns and would result in substantially higher costs.

B. Description of the Selected Remedy

A two-foot vegetated soil cover will be placed and maintained over sitewide subsurface soils to ensure that subsurface soils exceeding remediation levels are not available for human exposure (see table below for remediation levels). Sitewide subsurface soils are defined as soils in areas where subsurface disposal has occurred. Engineering controls will be implemented as necessary to establish and maintain the soil cover. Initially, the site will be evaluated to determine where soil and/or vegetation must be placed and to identify any engineering controls necessary to establish/maintain a permanent soil cover. Soil/vegetation will be placed and engineering controls implemented as necessary based on this evaluation. Once established, the two foot vegetated soil cover will be permanently maintained.

Institutional controls to ensure permanent maintenance of the soil cover and establish excavation controls shall consist of deed restrictions. In particular, the deed prepared by the Navy for transfer of the property shall provide that the vegetated soil cover present at the time of transfer shall remain in place and provide that any plans for excavation below two feet within the area of sitewide subsurface soils must be approved by the Navy and/or the EPA. Such approval shall consider the available information and be contingent on the

submission and approval of a plan which ensures that necessary measures are undertaken to protect human health and the environment. The information to be considered shall include RI data regarding the nature and extent of contaminants of concern per this ROD. The deed shall also provide that the property shall not be used for residential purposes. Also, the deed shall prevent industrial/commercial use, especially day care facilities, without Navy and/or EPA approval of a risk assessment for such use and additional environmental response work, if necessary.

Periodic monitoring will be conducted to identify maintenance activities required for the vegetated two foot soil cover and to ensure adherence to deed restrictions. Any necessary maintenance of the vegetated soil cover shall be performed and any necessary actions taken to enforce deed restrictions.

Every 5 years, a review will be conducted to evaluate the site status and to determine whether further action is necessary. Periodic review will be required because the selected remedy allows contaminants to remain at concentrations which are not protective of unrestricted land use.

Remediation Levels of Subsurface Soils (greater than 2 feet bgs)				
COC	**Site-Wide**	**Zone 1**	**Zone 2**	**Zone 3**
Chromium	54.1mg/kg	54.1mg/kg	54.1mg/kg	54.1mg/kg
Thallium	7.43mg/kg	7.43mg/kg	7.43mg/kg	7.43mg/kg
Arsenic	-	-	27.9mg/kg	27.9mg/kg
Cadmium	-	-	40.2mg/kg	40.2mg/kg
Aroclor 1254	-	-	-	1540ug/kg

C. Performance Standards

1. Soil Cover

A two foot vegetated soil cover shall be established over sitewide subsurface soils. Sitewide subsurface soils are defined as soils in areas where subsurface disposal has occurred. The objective of the cover shall be to prevent human exposure to subsurface soils exceeding the remediation cleanup levels identified in this ROD. A work plan describing the planned initial placement of soil cover and vegetation and any necessary engineering controls shall be submitted to EPA and PADEP for review and comment. The work plan shall refer to the results of a field inspection as necessary to support the work proposed.

2. Institutional Controls

The institutional controls to be implemented under the selected remedy shall consist of restrictions included in the deed(s) entered into for transfer of the property. The restrictions will 1) require that the two foot vegetated soil cover remain permanently in place over sitewide subsurface soils, 2) require Navy and/or EPA approval for any excavation below two feet within the area of sitewide subsurface soils, 3) prohibit residential use within the area of sitewide soils and 4) prevent industrial/commercial use, especially day care facilities, without Navy and/or EPA approval of a risk assessment for such use and additional environmental response work, if necessary. Approval to excavate below two feet in the area of sitewide subsurface soils shall be contingent on the submission and approval of a plan which ensures that necessary measures are undertaken to protect human health and the environment and are in accordance with federal and state regulations. Any such plan shall consider the location of soils known to exceed remediation levels within Zones 1, 2, and 3 and the area of the unnamed trench southwest of trench 6D. The coordinates of these three zones, sitewide subsurface soils and sitewide surface soils will be included in the deed(s).

3. Monitoring

Periodic monitoring of the sitewide surface and subsurface soils will be performed to identify any maintenance activities which may be required for the vegetated two foot soil cover and to determine adherence to deed restrictions. A workplan describing the periodic monitoring plan shall be submitted to EPA for comment. The work plan shall, at a minimum, detail the frequency and nature of the inspections and the manner in which records will be maintained. For each monitoring event, a report summarizing the findings of the monitoring will be issued and submitted to EPA.

4. Maintenance / Deed Restriction Enforcement

Maintenance will be performed as necessary to maintain the vegetated two foot soil cover based on the findings and recommendations of periodic monitoring. In addition, if deed restrictions are not being adhered to as required, the Navy shall undertake the actions necessary to enforce the restrictions of concern.

D. Summary of the Estimated Remedy Costs

The estimated cost (or the total present worth) of the selected remedy is $225,429. The FS provides a detailed breakdown of the basis for this estimated cost. The estimated capital cost of $83,000 includes $20,000 to establish deed restrictions and $63,000 to complete the vegetated two foot soil cover over sitewide subsurface soils of concern. In developing the capital cost estimate, it was assumed that the areas depicted in Figure 9 would require the placement of two feet of soil and that 44,000 square feet of lawn and ground cover would be required. Annual monitoring and maintenance costs were estimated at $5,000 and five year reviews were estimated to cost $20,000.

E. Expected Outcomes of the Selected Remedy

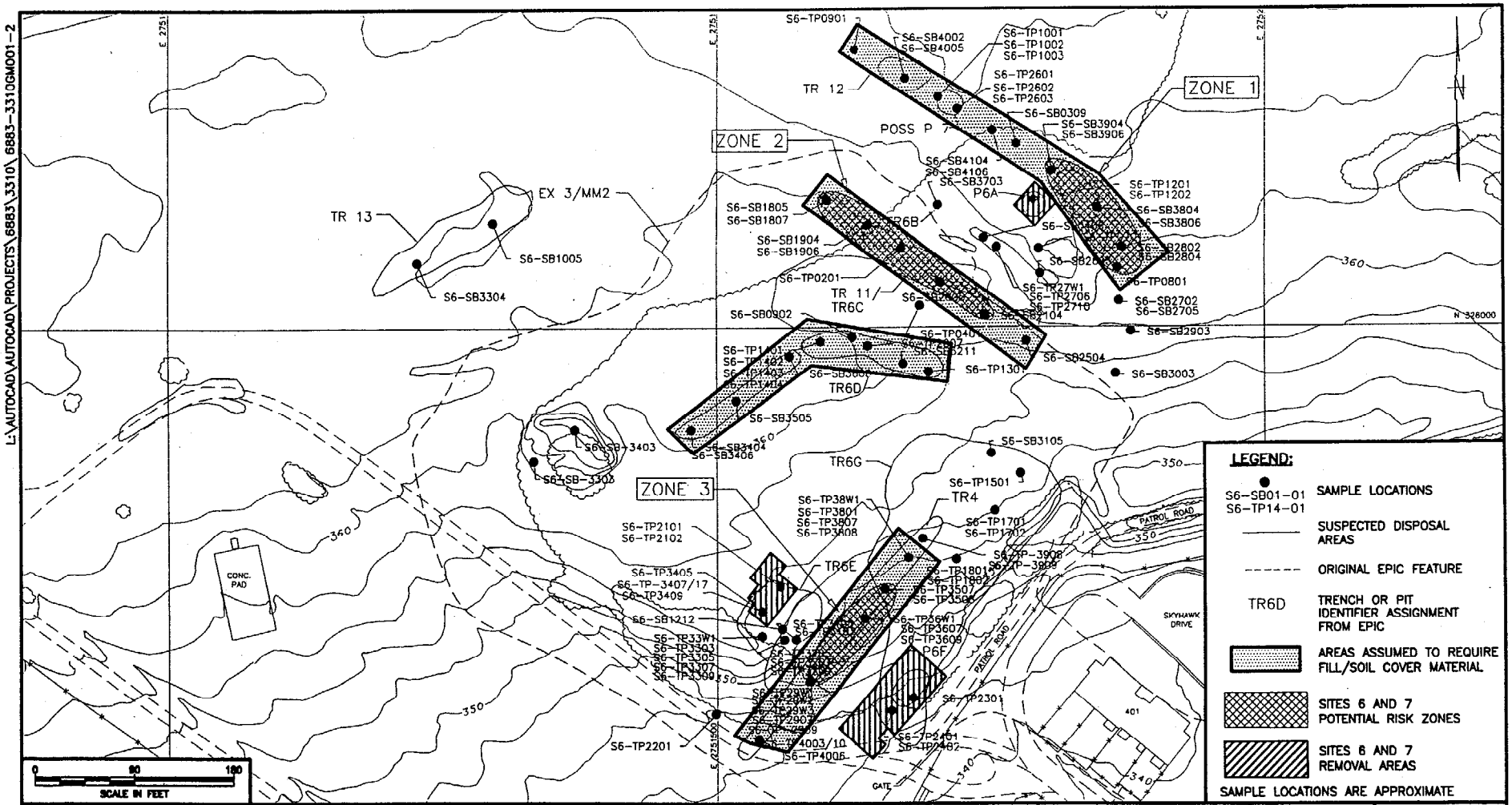
Upon implementation of the remedy, Sites 6 and 7 will be suitable for recreational use. The remedy should be implemented (i.e., a stable vegetated soil cover established and deed restrictions in place) approximately 6 months after the award of a remedial action contract. The vegetated soil cover shall prevent human contact with soil / waste which exceeds remediation levels for recreational use.

XIV. STATUTORY DETERMINATIONS

The selected remedy satisfies the statutory requirements of Section 121 of CERCLA, 42 U.S.C. Section 9621 as discussed below. Remedial actions undertaken at NPL sites must achieve adequate protection of human health and the environment, comply with federal and state ARARs, be cost-effective, and utilize, to the maximum extent practicable, permanent solutions and alternative treatment or resource recovery technologies. Also, remedial alternatives that reduce the volume, toxicity, and/or mobility of hazardous waste as the principal element are preferred. The following discussion summarizes the statutory requirements that are met by the selected remedy.

A. Protection of Human Health and the Environment

The selected remedy for Sites 6 and 7 will adequately protect human health through engineering and institutional controls. In particular, potential unacceptable risks to human health posed by exposure to Sites 6 and 7 subsurface soils via incidental ingestion and dermal contact will be eliminated by preventing human



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12-2-1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

ALTERNATIVE 2
AREA B – SITES 6 AND 7
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. CKD 0252
APPROVED BY DATE 11/30/99
APPROVED BY DATE
DRAWING NO. Figure 9
REV. 2

FORM CADD NO. L:\ACAD14\BLOCKS\BORDERS\TINUS_BH3.DWG

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contact with the Sites 6 and 7 soils of concern. Exposure levels will be reduced to within EPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ for carcinogenic risk and below the HI of 1 for non-carcinogens. Implementation of the remedy will not pose unacceptable short-term risks or cross-media impacts .

B. Compliance with ARARs

The selected remedy will comply with all applicable or relevant and appropriate requirements specific to this action. Site preparation and the placement and maintenance of the vegetated soil cover shall be conducted in compliance with the Pennsylvania Storm Water Management Act (Act No.167). This Act is considered applicable and requires measures to control storm water runoff during remedial actions or during land development. The Pennsylvania Erosion Control Act (PA Code, Title 25, Chapter 102) is also considered applicable and shall also be complied with during the implementation and maintenance of the permanent vegetated soil cover. This Act requires measures to control storm water runoff during remedial actions or during land development activities. Because Sites 6 and 7 are CERCLA sites, any future risk assessments and or remedial action plans shall be prepared in compliance with EPA Risk Assessment Guidance documents and contaminant levels shall be screened against EPA Region 3 Risk Based Concentrations (RBCs), as of the most recent publication date(s), to determine remediation levels. These EPA and EPA Region 3 guidance documents are considered To Be Considered requirements under this action.

C. Cost-Effectiveness

While Alternatives 3 and 4 would include the removal of known soil/waste of concern, a sitewide soil cover and sitewide institutional controls would still be required under these alternatives. As a result, the benefit to be gained by the additional costs incurred under these alternatives would appear to be minimal. While no cover or controls would be required under Alternative 5, the cost of this alternative would be substantial, i.e., over 40 times that of Alternative 2. Under these circumstances, Alternative 2 appears to be the most cost-effective alternative.

D. Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedy provides long-term effectiveness; it uses a permanent solution that effectively controls or eliminates the pathway of potential exposure. Alternative treatment technologies and/or resource recovery technologies were found to not be appropriate for the site conditions.

E. Preference for Treatment as a Principal Element

The selected remedy does not utilize treatment as a principal element. Treatment is not suitable for the site conditions.

F. Five-Year Review Requirements

Because this remedy will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a five-year review will be required pursuant to CERCLA Section 121(c) and the NCP Section 300.430(f)(5)(iii)(C).

G. Documentation of Significant Changes

The Proposed Plan for Sites 6 and 7 was released for public comment on February 17, 2000. The Proposed Plan identified Alternative 2, a permanent vegetated soil cover and institutional controls, as the Preferred Alternative for soil remediation. The Navy reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

XV. RESPONSIVENESS SUMMARY

In a Proposed Plan released for public comment on February 17, 2000, the Navy, with the support of the EPA, identified Alternative 2 as the preferred remedial alternative for OU-7. Alternative 2 is described in Section

XI of this ROD. A public comment period on the Proposed Plan was open from February 17 through March 17, 2000. A public meeting was held on March 1, 2000 to present the Proposed Plan for OU-7 and to answer any questions on the Proposed Plan and on the documents in the information repositories. A brief presentation was provided during which questions were answered and informal discussions took place. A summary of questions asked at the public meeting and a "sign in sheet" for attendees are presented in Appendix B. Written comments received during the public comment period are also contained in Appendix B.

This Responsiveness Summary presents a review of the community involvement in the CERCLA process at NAWC and provides a summary of the comments received during the public comment period for OU-7 along with responses to those comments.

A. Background on Community Involvement

The Navy and NAWC Warminster have had a comprehensive public involvement program for the last ten years. In 1989, NAWC Warminster prepared a draft Community Relations Plan for RI/FS activities. Community relations activities have been conducted in accordance with this plan. These activities have included regular technical and restoration activity meetings with local officials, communications with the media and the establishment of information repositories.

The Navy organized a Technical Review Committee (TRC) in January 1989 to review and discuss NAWC CERCLA issues with local community officials and concerned citizens. The TRC was reorganized into the Restoration Advisory Board (RAB) in November 1993. The RAB consists of representatives of the Navy, EPA, PADEP, the Bucks County Health Department, the Northampton Township Municipal Authority, the Warminster Township Municipal Authority, Ivyland Borough, and Upper Southampton Township, as well as members of the community and concerned environmental organizations. The RAB and a technical subcommittee (TSC), consisting of representatives from the RAB, have met on a regular monthly basis since its formation. The RAB has been assisting in the planning and review of environmental investigation, remedial alternative evaluation, and remediation activities, along with future land use planning. The RI/FS and the Proposed Plan for OU-7 were discussed at the RAB meetings.

RAB meeting minutes along with reports presenting the results and findings of investigations are maintained in two local information repositories that contain the Administrative Record for NAWC Warminster. One repository is located at the base; Navy Caretaker Site Office located at 860 Flamingo Alley, Warminster, Pennsylvania; and the other is located in a local library; Bucks County Library located at 150 South Pine Street, Doylestown, Pennsylvania.

Community relations activities for the final selected remedy include the items below:

- The documents concerning the investigation and analysis at OU-7 were presented in RAB and TSC meetings and draft and final copies were provided to all RAB members for review, discussion, and comment.
- The documents concerning the investigations and analysis at OU-7, as well as a copy of the Proposed Plan, were placed in the information repositories.
- The Navy mailed copies of the Proposed Plan to about 450 local area residents whose names appeared on the RAB mailing list.

- Newspaper announcements on the availability of documents and the public meeting and comment period were published in the *Bucks County Courier Times, Philadelphia Inquirer,* and *Intelligencer.*

- The Navy established a 30-day public comment period starting February 17, 2000 and ending March 17, 2000. Written comments received are presented in Appendix B.

- A Public Meeting was held on March 1, 2000 to present the Proposed Plan and to answer questions concerning OU-7. Approximately 10 people, including representatives of the local municipalities, attended the meeting.

B. Summary of Comments and Responses

The local community and representatives of local municipalities have expressed concern regarding the preferred alternative (Alternative 2) presented in the Proposed Plan. In general, these concerns and comments deal with the clean-up standards applicable to the remedial alternatives. The majority of the commenters indicated that they wanted the Navy to remediate the property to residential standards. The Navy has taken these concerns into consideration and believes that Alternative 2 adequately and appropriately addresses the contamination associated with OU-7 and achieves the clean-up goals, as mandated by CERCLA, in a cost effective and responsible manner.

Comment 1. Many commenters indicated that the cleanup goals for Sites 6 and 7 must meet Pennsylvania Department of Environmental Protection (PADEP) Statewide Health Standards for Residential Direct Contact to be protective of human health and requested that all soils that do not meet these standards be removed.

Response 1: The cleanup goals for Sites 6 and 7 identified in this ROD have been established in consultation with both PADEP and the EPA. As indicated in Section V of this ROD, the reuse plan for the former NAWC developed by the Federal Lands Reuse Authority (FLRA) of Bucks County and approved by Warminster Township and other municipalities identifies the future use of Sites 6 and 7 as recreational. There is no available information which would suggest that the property may be used for residential purposes. Based on this information, PADEP has indicated that remedial actions for the property should ensure that the property be safe for recreational use and that site-specific standards be developed and met to achieve this goal. Similarly, EPA has indicated that the cleanup standards for Sites 6 and 7 should be protective of recreational use, which is the reasonably anticipated use of the property. In response, the Navy has identified hazardous substance levels in soils at Sites 6 and 7 which present a threat to human health under the planned recreational use and selected a remedy which ensures that community members will not be exposed to soils which exceed the substance levels of concern. Furthermore, the selected remedy prohibits future residential use of the property.

In a related note, it is assumed that the Statewide Health Standards for Residential Direct Contact referenced by the commenters are in fact the Statewide Health Standard Medium-Specific Concentrations, Direct Contact Numeric Values developed for residential soils as defined in Chapter 250 of Title 25 of the Commonwealth of Pennsylvania Code. This Statewide Health Standard is one of three remediation standards available for use in response actions conducted by Pennsylvania under the authority of the referenced code. This standard is not applicable to the CERCLA action being taken by the Navy at Sites 6 and 7. However, cleanup goals established for Sites 6 and 7 are protective of the reasonably anticipated land use of recreation and consistent with the requirements of this code.

Comment 2: A commenter indicated that since several contaminants exceed PADEP Statewide Health Standards for Residential Direct Contact, the type of recreation at Sites 6 and 7 should be limited to passive recreation and should not include focused active recreation such as a toddler playground. To support this recommendation, the commenter questioned the soil remediation levels identified in the FS, which were developed with the assumption that Sites 6 and 7 would be used by a person 24 days a year. The commenter thought that 24 days of use per year was low given the proximity of residents and that the risk posed by Site 6 and 7 soils under recreational use therefore may have been underestimated. The commenter requested that the source and basis of this assumption should be included in the ROD.

Response 2: As noted in the response to Comment #1, PADEP has indicated that Statewide Health Standards for Residential Contact are not applicable or relevant and appropriate in this case. Site-specific soil remediation levels protective of recreational use have been developed in this case in accordance with CERCLA requirements and consistent with PADEP requirements as referenced in the response to Comment 1. In developing these goals, it has been assumed that persons may be exposed to Sites 6 and 7 soils for up to 24 days per year. This assumption was made based on EPA guidance entitled Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), EPA 540/1-89/002, and agreed to by PADEP . In developing input parameters for the risk estimations all input values are viewed as a set rather than as individual parameters to ensure that the overall assessment represents a Reasonable Maximum Exposure (RME). The exposure frequency of 24 days does not seem unreasonable when one considers that the other adjacent 240 acres of recreational land, other nearby public parks, and nearby open fields and residential lots are available for recreational use. As indicated above, the exposure parameters used in the risk estimation need to be viewed as a whole rather than individually. The exposure assumption assumes that an individual will spend 24 full days per year for 16 years within the OU-7 site area only, ingest 200 mg of contaminated soil per exposure day for 5 of the 16 years and 100 mg per exposure day for the remaining 11 years, and that contaminants will be absorbed through both ingestion and through the skin. In addition, the subsurface assessment assumes that the individual will be exposed to the materials currently buried beneath several feet of soil. This exposure scenario represents a conservative RME scenario for recreational use. It is notable that a further review of the risk assessment reveals that surface soils at Sites 6 and 7 would not present an unacceptable risk under recreational land use even if the number of days of exposure was doubled to 48 days. In addition, the risk assessment assumed exposure during toddler years. Under these circumstances, surface soils at Sites 6 and 7 should not present a threat under recreational use and the calculated risks do not appear to have been underestimated. There does not appear to be a need to prohibit recreation such as a toddler playground.

Comment 3: A commenter indicated that since the Township has withdrawn the area of Sites 6 and 7 from a Public Benefit Conveyance application, the property may be used for purposes other than recreation. In this case, the commenter has requested that specific exposures relative to a change in use be evaluated and that the ROD should outline the conditions under which a change in proposed use can be considered.

Response 3: As indicated in Section V of this ROD, while recreational use is the reasonably anticipated use of the property, it has been suggested that limited industrial/commercial use of the property may be possible. In the event that industrial/commercial use is anticipated or proposed in the future, the selected remedy requires that the deed entered into for transfer of the property shall include a restriction that industrial/commercial use may be permitted, but only upon Navy and/or EPA approval of a risk assessment for such use and additional environmental response work, if necessary. Since there is no information that would suggest that residential use of the property may be possible and given the results of the risk assessment which indicate both surface and subsurface soils at Sites 6 and 7 would pose an unacceptable risk to human health under residential use, the selected remedy requires that the deed entered into for transfer of the property prohibit residential use.

Comment 4: In those cases where disposed waste materials are either visible or were encountered within 2 feet, the materials should be covered with at least 2 feet of compacted clean soil cover. In areas where settlement has occurred or has potential to occur in the future, more than 2 feet of compacted soil cover will be required.

Response 4: The selected remedy provides that a two foot vegetated soil cover shall be established and maintained over sitewide subsurface soils, which are defined in the ROD as soils where subsurface disposal has occurred. In this case, any waste placed in the subsurface should be covered with at least two feet of soil. As suggested in the comment, in those cases where settlement of buried waste has occurred, the soil cover will likely need to be greater than 2 feet in depth to ensure the stability of the entire 2 foot soil cover.

Comment 5: Based on a review of the RI, there is a possibility of additional undiscovered drums at Sites 6 and 7. In the event that all buried wastes are not excavated by the Navy, controls are necessary to limit future excavation which may disturb remaining wastes and cause a release to the environment. The deed should mention the possibility of encountering buried drums if any excavation of the site is conducted.

Response 5: The selected remedy includes excavation controls under the planned recreational use of the property. These controls, to be incorporated in the deed, require that the Navy and/or EPA approve any excavation below two feet in the area of sitewide subsurface soils and that such approval be contingent on the submission and approval of a plan which ensures that necessary measures are undertaken to protect human health and the environment and are in accordance with federal and state regulations. The deed will indicate that the plan should consider the results of the RI for Sites 6 and 7. This RI includes the results of geophysical surveys which were conducted in part to detect any buried metal drums. All potential drum locations detected by these surveys were investigated by test pits. The remnants of up to 10 drums were discovered Sites 6 and 7 during these investigations. Only two of the drums contained waste and the waste was solid in nature. Notably, during the course of all RI work conducted throughout NAWC, no buried metal drums containing liquid wastes were discovered.

Comment 6: Many commenters indicated a preference for Alternative 4, which included removal of the known subsurface soil of concern located in Zones 1, 2 and 3.

Response 6: After fully evaluating all of the alternatives, Alternative 4 was determined not to be as cost-effective as Alternative 2. In particular, while Alternative 4 would include the removal of known soil of concern, a sitewide two foot soil cover and sitewide institutional controls would still be required to address the unacceptable risks presented by sitewide soils. Given the $1.75 million additional cost associated with Alternative 4, the benefit of the removal would appear to be minimal.

Comment 7: Several commenters indicated that cost should not be a factor or consideration in selecting a remedy.

Response 7: Both CERCLA and the NCP require that cost be one of the evaluation criteria for selecting a CERCLA remedy. The Navy has considered cost as one of the "balancing criteria" in evaluating the remedial alternatives as required. Balancing criteria are used to weigh major trade-offs among alternatives. The NCP mandates that each remedial action selected shall be cost effective.

Comment 8: While the RI reports that there is no pattern to elevated levels of arsenic in surface soils, a comparison between the locations of elevated surface and subsurface levels of arsenic indicates similar locations.

Response 8: Elevated levels of arsenic in surface soil do appear to be present in areas where arsenic is elevated in subsurface soil. The selected remedy considers the risks presented by arsenic in both surface and subsurface soil and considers the locations of elevated arsenic levels.

Comment 9: Various comments were received regarding the adequacy of a 2 foot vegetated soil cover.

Response 9: As indicated in the ROD and detailed in the Remedial Investigation Operable Unit 7 (OU-7) Soils and Waste at Sites 6 and 7 Report (TtNUS 1999), the current surface conditions at the site do not present a risk to recreational users. The 2-foot soil cover included in the selected remedy is an additional barrier to prevent incidental ingestion and contact with subsurface soils at the site. The use of a 2-foot soil cover, along with permanent maintenance and institutional controls as included in the selected remedy, constitutes a remedial action under federal and state programs and is fully protective given the site conditions and the reasonably anticipated land use.

Comment 10: Full removal is the only way to discern the true and full extent of the contamination and to allow for the safe recreational use of the property.

Response 10: The nature and extent of the contamination has been adequately characterized through the extensive investigations discussed in this ROD and detailed in RI reports available in the Information Repositories. The results of the RI indicate that the property does not present an unacceptable risk to

potential recreational users unless intrusive activities such as excavation take place. The current site conditions do not present a risk under recreational uses. The selected remedy ensures that any potential risk of exposure to subsurface soils by recreational users is adequately addressed and controlled.

Comment 11: What is the depth to the buried known soil/waste of concern.

Response 11: The depth of buried materials varies throughout the site. The majority of known soil/waste of concern in Zones 1, 2, and 3 is at depths greater than 4 feet. Known soil/waste of concern was identified at 1.5 to 2 feet below ground surface at the southern end of Zone 3. However, the majority of the known soil/waste of concern in Zone 3 is greater than 6 feet in depth. Section 2 of the Remedial Investigation Operable Unit 7 (OU-7) Soils and Waste at Sites 6 and 7 Report (TtNUS 1999) describes the findings of test pits and borings which characterize the depth of these soils/wastes, while Appendix E of that report contains detailed field logs for the subject test pits and borings.

Comment 12: Are Sites 6 and 7 sources of the groundwater contamination identified in an adjacent housing community, Casey Village.

Response 12: Sites 6 and 7 are not sources of groundwater contamination in the nearby housing area. Groundwater associated with Sites 6 and 7 is being investigated as a separate operable unit referred to in the Administrative Record as Area B Groundwater. The Navy, EPA, and the United States Geological Survey have studied the groundwater extensively around Sites 6 and 7. Groundwater associated with Sites 6 and 7 flows to the south and southeast. The housing area mentioned is located east and northeast of Sites 6 and 7. Groundwater investigations conducted in the housing area and in and around Sites 6 and 7 have concluded that the groundwater in the housing area to the east of Sites 6 and 7 is not impacted by Sites 6 and 7 or the groundwater associated with Sites 6 and 7.

Comment 13: What would happen if additional contamination was found after property transfer.

Response 13: CERCLA 120(h) establishes what the Navy's response would be to the discovery of additional contamination unknown or unidentified at the time of transfer.

Comment 14: Would it be possible for a future landowner to construct a building or a structure with a basement on the property.

Response 14: Under the selected remedy, the property deed and transfer documents will include excavation controls and a disclosure regarding the site conditions. The excavation controls will require that a plan that adequately protects the final remedy, site workers, and local citizens and also ensures compliance with applicable laws and regulations be submitted to the Navy and the EPA for review and approval before any excavation is undertaken. Compliance with applicable laws and regulations and the implementation of such a plan would be the responsibility of the new landowner.

Comment 15: Why doesn't the Navy retain the property since it is located adjacent to current Navy Enlisted Housing.

Response 15: The Navy is not permitted under the current Federal law to retain the property declared surplus to the needs of the Government.

Comment 16: What would happen if the property was not transferred to the Township for parks and recreation but was sold and the new owner wanted to use the property for residential or other purposes.

Response 16: If the property is not transferred to the Township through a Public Benefit Conveyance for park and recreational uses and is sold, the new property owner would be required to comply with all local, state and federal requirements and deed restrictions regarding use of the property. The transfer documents and deeds for the property would contain full disclosure regarding the site conditions as well as the remedial actions taken by the Navy and would include the use restrictions included in the selected remedy.

Comment 17: It appeared that the Navy and EPA did not agree on who was responsible for the long-term maintenance required under Alternative 2.

Response 17: The Navy has ultimate responsibility for the long-term maintenance and operation of the selected remedy and 5-year reviews of the protectiveness of the remedy. The EPA evaluates the 5-year reviews and has the ultimate regulatory responsibility to monitor the Navy's compliance with the selected remedy.

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Pennsylvania Department of Environmental Protection
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June 14, 2000

Southeast Regional Office

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Fax 610-832-6022

Mr. Orlando Monaco
Naval Facilities Engineering Command (NAVFACENGCOM)
Northern Division
Environmental Contracts Branch, Mail Stop No. 82
10 Industrial Highway
Lester, PA 19113

Re: Warminster Naval Air Development Center
NPL Site
Warminster Township
Bucks County
Record of Decision, Operable Unit 7
Letter of Concurrence

Dear Mr. Monaco:

The Record of Decision (ROD) dated June 2000, for Operable Unit 7 (OU 7), which pertains to soil and waste at Sites 6 and 7, Warminster Naval Air Development Center (the Site), has been reviewed by the Commonwealth of Pennsylvania's Department of Environmental Protection (Department).

The main components of the OU 7 work, as described in the ROD are:

1. This ROD pertains to the soils and wastes at Sites 6 and 7, one of several Areas of Concern (AOCs) at the Site that have been investigated during the last several years. The groundwater at Sites 6 and 7 is addressed under an Interim ROD for OU 1 (1993), and a Final ROD will be issued in the future. Surface water and sediment associated with Sites 6 and 7 are being addressed under the RI/FS for Site 5, adjacent to the subject Sites.

2. Based on results of the RI work at Sites 6 and 7, a removal action was conducted in May through July 1997. The action included removal of surface rubble, and approximately 3,698 tons of soil and debris from discrete portions of the site. Post removal sampling confirmed that the cleanup goals for the removal were met.

3. A final RI report was issued for soils and waste at Sites 6 and 7 in November 1999. This report characterized the site conditions after the removal action. There are known areas where wastes remain in place.

4. Soil and waste associated with Sites 6 and 7 do not include any source materials constituting a principal threat as defined by the NCP.

5. The reasonably anticipated re-use is recreational. Residential use of the property is not reasonably anticipated.

6. The human health risks associated with potential exposure to soils and waste at Sites 6 and 7 have been evaluated as part of the RI.

7. Future recreational and residential exposures were studied for both surface and subsurface soils. There is a great deal of uncertainty in the non-carcinogenic analyses due to the lack of chromium speciation data; the assessments were done with the very conservative assumption that all of the chromium detected was hexavalent. Chromium is a major driver for all of the non-carcinogenic risks reported below:

   a. There are no exceedances of the EPA's acceptable range for either carcinogenic or non-carcinogenic risks in the surface soil for the recreational land use. For a possible residential use, there are no exceedances of the carcinogenic risk range for surface soils; however, the non-carcinogenic risk for residential child and adult both are greater than one.

   b. For subsurface soils, the risk assessment was calculated two ways: the first was for sitewide soils, and the second for specific zones were samples indicated waste materials were left in place, at an average of 8 feet below ground surface.

      i. Site-wide recreational use, assuming that subsurface soils became surface soils, poses no increased carcinogenic risks above EPA's acceptable target range. The non-carcinogenic risk for both child and youth recreational users are both greater than one; also assuming subsurface soils were raised to the surface.

      ii. For the three specific zones selected for assessment, there were no exceedances of EPA's acceptable risk range for carcinogenic risks. There are exceedances of non-carcinogenic risk ranges for recreational child and youth for each of the three zones.

      iii. For site-wide residential use, there are no exceedances of the EPA's acceptable carcinogenic risk range. The cumulative non-carcinogenic risks for both adult and child are greater than 1.0.

The selected remedy for the Site includes the following major components, as specified in the selected remedy of the ROD:

1. Placing and maintaining a 2-foot vegetated soil cover over site-wide subsurface soils.

2. Institutional controls to ensure the maintenance of the soil cover and to control excavation.

3. Monitoring to ensure the cover is maintained and the institutional controls are implemented as planned.

4. Institutional controls shall also be implemented to prohibit residential use and prevent industrial/commercial use, without Navy and/or EPA approval of a risk assessment for such use.

The Department hereby concurs with the remedy selected for the Warminster Naval Air Development Center NPL Site OU 7 for the following reasons and with the following conditions:

Pennsylvania's Land Recycling and Environmental Remediation Standards Act, Act 2 of 1995, 35 P.S. Sections 6026.101 – 6029.909 ("Act2"), Pennsylvania's Solid Waste Management Act, Act 97 of 1980, as amended, 35 P.S. Section 6018.101 et seq. ("Act 97"), and the regulations adopted pursuant to these statutes are ARARs for this response. Implementation of any component or components of this response will not necessarily result in protection from liability pursuant to Act 2 for any party.

This concurrence with the selected remedial actions is not intended to provide any assurance pursuant to CERCLA Section 104(c)(3), 42 U.S.C. Section 9604(c)(3).

The Department reserves its rights and responsibilities to take independent enforcement actions pursuant to state and federal law.

This letter documents the Department's concurrence with the remedies selected by the Navy in the ROD for OU 7 for the Warminster Naval Air Development Center NPL Site. If you have any questions regarding this matter, please feel free to contact me at the above telephone number.

Sincerely,

Joseph A. Feola

Joseph A. Feola
Regional Director
Southeast Regional Office

cc: Mr. Fidler
Mr. Beitler
Mr. Danyliw
Mr. Hartzell
Mr. Sheehan
Ms. Tremont
Ms. Flipse
Re 30 (GJC00)173-2