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Feasibility Study Report for Operable Unit 7 (OU-7) Soils/Waste at Sites 6/7

Former Naval Air Warfare Center

Warminster, Pennsylvania

Northern Division

Naval Facilities Engineering Command

Contract No. N62472-90-D-1298

Contract Task Order 252

December 1999

TETRA TECH NUS, INC.

PHIL-13621

FEASIBILITY STUDY REPORT
for
OPERABLE UNIT 7 (OU-7) - SOILS/WASTE AT SITES 6/7

FORMER NAVAL AIR WARFARE CENTER
WARMINSTER, PENNSYLVANIA

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
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Contract No. N62472-90-D-1298
Contract Task Order 252

December 1999

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EXECUTIVE SUMMARY

This feasibility study (FS) for Sites 6 and 7 (Operable Unit 7) at the former Naval Air Warfare Center (NAWC) Warminster, Pennsylvania has been prepared for the Northern Division, Naval Facilities Engineering Command as authorized under Contract Task Order (CTO) 252 under Contract N62472-90-D-1298. This work is part of the Navy's Installation Restoration Program (IRP), which is designed to identify contamination of Navy and Marine Corps facilities resulting from past operations and to institute corrective measures, as needed. This report also serves to meet the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

PURPOSE

The purpose of this FS is to present remedial alternatives for contaminated soils present at Sites 6 and 7. These sites are both located within Area B of the former NAWC on property that has been designated for transfer to Warminster Township. The Navy conducted removal actions at Sites 6 and 7 in 1997. This FS addresses soils and residual waste materials remaining at these sites after the removable action; the Navy is addressing groundwater concerns associated with Area B under a separate FS. The remedial investigation (RI) report for Sites 6 and 7 (OU-7) (TtNUS, 1999) identifies the nature and extent of the contamination and presents an evaluation of the potential human health risks associated with these sites. Based on the available information and data, it has been determined that final remedial actions for the residual contamination can be selected at this time. This FS presents the remedial alternatives as part of that remedy selection process.

REMEDIAL ACTION OBJECTIVES

Sites 6 and 7 are contained within a parcel of land that has been designated for transfer to Warminster Township under a Public Benefit Conveyance. The re-use plan for this area, prepared by the Federal Land Reuse Authority (FLRA) and approved by the local municipalities, identifies recreational use as the designated use for this land. The area comprising Sites 6 and 7 is anticipated to be used for passive recreational activities (buffer zone, walking trails, picnicking, etc.).

The baseline risk assessment completed as part of the RI identified an unacceptable risk associated with the potential exposure to surface and subsurface contamination under future residential re-use of OU-7. As indicated above, the transfer of the property under a Public Benefit Conveyance for recreational re-use is planned. The baseline risk assessment for future recreational re-use identified no unacceptable risks presented by current surface soils. However, the potential risk associated with recreational exposure to

subsurface contamination was identified to exceed the EPA acceptable risk range. A detailed review of the OU-7 data identified three areas that represent discrete areas of potential higher risk. These areas have been designated as Zones 1, 2, and 3.

The potential risks identified for OU-7 were mainly associated with the presence of inorganic (metals) contamination. Some major uncertainties exist in evaluating the risks presented by the metals contamination present at the site. The major risk driver was identified to be chromium. Chromium can be present in several forms. No specific analysis was performed at OU-7 to determine the form of the chromium present. Because no form-specific analysis was performed, the risk assessment conducted under the RI conservatively assumed that the chromium was present in the most toxic form. This form of chromium is less common than the less toxic forms and is not expected to be present at significant levels at OU-7. Section 1.5 of this report presents a summary of the uncertainties associated with this risk assessment approach. A detailed discussion of these uncertainties is contained within the OU-7 Remedial Investigation report (TtNUS, 1999).

Based on site findings and the results of the baseline risk assessment the Remedial Action Objectives (RAO) for OU-7 have been determined to be:

> Prevent potential future human receptor exposure to contamination that presents an unacceptable risk due to contamination with metals.

REMEDIAL ALTERNATIVES DEVELOPMENT

This FS was prepared based on data obtained through previous investigations and presented in the OU-7 RI (TtNUS, 1999), using EPA guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (OSWER Directive 9355.3-01, October 1988), the revised National Contingency Plan (NCP) (40 CFR 300, March 1990), and the Navy/Marine Corps Installation Restoration Manual (February 1992).

Based on site contaminants, characteristics, completed response actions, remedial objectives, and general response actions, technologies and process options were identified. These technologies and options were screened for effectiveness, implementability, and relative cost. Remedial alternatives were assembled using those technologies and options that passed the screening. In addition, CERCLA requires that the no action alternative be evaluated as a baseline alternative. The alternatives that were assembled are briefly described below:

Alternative 1: No Action: Under this alternative, no action would be undertaken to prevent exposure to subsurface contamination. This alternative would also include a discontinuation of any further studies or monitoring by the Navy.

Alternative 2: Vegetated Soil Cover, Institutional Controls, and Monitoring: This alternative would include the placement of clean fill materials in subsided areas, the placement and maintenance of a soil cover of at least 2 feet in thickness, and the preparation and implementation of institutional controls to prevent the use of the property for non-recreational uses and would impose excavation restrictions on the property. Deed and use restrictions would be prepared and recorded for the property at the time of transfer. Monitoring and periodic maintenance of the soil and vegetative cover would be performed. Five-year reviews would be required under this alternative because residual waste materials remain at the site.

Alternative 3: Focused Excavation, Off-Site Treatment/Disposal, Vegetated Soil Cover, Institutional Controls, and Monitoring: This alternative would include the excavation of potential risk zones 1 and 2, off-site treatment/disposal of the excavated material, backfilling and seeding of these zones, placement of minimum of 2 feet of soil cover, institutional controls, and monitoring. The excavated, filled, and covered areas would be revegetated under this alternative. The institutional controls would be similar to those presented for Alternative 2, but the excavation restrictions may apply to a smaller area. Monitoring and 5-year reviews would also apply to this alternative.

Alternative 4: Expanded Excavation, Off-Site Treatment/Disposal, Vegetated Soil Cover, Institutional Controls, and Monitoring: This alternative is similar to Alternative 3 but also includes the excavation and off-site treatment/disposal of Zone 3. All other requirements described under Alternative 3 would apply to Alternative 4. The area subjected to excavation restrictions would be more limited than required under Alternative 3. Monitoring and 5-year reviews would be required for this alternative.

Alternative 5: Complete Excavation with Off-Site Treatment/Disposal: This alternative would include the development of clean-up goals based on the most restrictive possible re-use (residential), the excavation and off-site treatment/disposal of surface soils throughout the site, the excavation and off-site treatment/disposal of all subsurface soils in excess of clean-up goals, the placement of backfill, and the reestablishment of grasses, shrubs, and trees. No institutional controls, long-term monitoring, or 5-year reviews would be required under this alternative because all residual waste materials would be removed from the site.

EVALUATION OF ALTERNATIVES

Each alternative was evaluated using seven of the nine criteria specified in the NCP and the previously referenced EPA guidance. These criteria include overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The other two criteria, state acceptance and community acceptance, will be applied and evaluated by the Navy after comments are received on the Proposed Plan and in public meetings. In addition to the individual alternative evaluation, a comparative evaluation applying the same criteria among all the alternatives was completed. The purpose of the comparative evaluation was to identify the positive and negative attributes of each alternative to assist decision-makers in selecting a final remedial action.

In general, with the exception of Alternative 1, all the alternatives are protective of human health and the environment. Alternative 5 achieves goals in excess of those required by the reasonably anticipated land use. Alternatives 2 through 5 comply with and can be implemented in accordance with ARARs. Alternative 5 requires extensive excavation, off-site transportation and disposal, and backfilling. Implementation of this alternative would require close coordination with appropriate agencies to maintain compliance with ARARs, and compliance with Pennsylvania "Clean-Fill" criteria may be complicated.

Alternatives 2 through 5 meet the long-term effectiveness and permanence requirements. Alternative 5 (complete removal of all residual wastes) is the most effective and permanent alternative. The long-term effectiveness and permanence of Alternatives 2, 3, and 4 are dependent on the adequate enforcement of controls and the performance of maintenance. None of the identified alternatives include a significant reduction of toxicity, mobility, or volume through treatment component.

Each of the alternatives can be implemented to provide for protection under the short-term effectiveness criteria. Alternative 2 poses the fewest and the most manageable potential short-term risks to workers, the environment, and the community as a result of implementing the alternative. This alternative is expected to reach RAOs in the shortest time frame. Alternatives 3 and 4 are similar in scope because readily available and practiced engineering and operational controls can be implemented to manage any short-term risks, and they can be completed in a similar time frame. Alternative 5 presents the greatest short-term risk to workers, the environment, and the community. These short-term risks can be managed and controlled through the implementation of engineering and operational controls. The impact on the environment as a result of the complete removal of all trees and vegetation in the area would be significant. The immediate impact of these actions on area wildlife and downstream areas has not been

evaluated in detail. Implementation of Alternative 5 would require significant truck traffic through the immediate community during both the excavation and backfilling stages. This alternative would require the greatest period of time to fully meet RAOs.

All of the alternatives can be implemented at Sites 6 and 7. Alternative 2 includes the preparation of institutional controls and use restrictions and the performance of inspections and landscaping-type maintenance. These components are readily available and are widely practiced. Alternatives 3 and 4, in addition to these components, require the application of widely practiced commercially available excavation and disposal, transportation, and backfilling components. Alternative 5, although made up of the same major components as Alternatives 3 and 4, is less implementable because of the extraordinary volumes of material involved in the alternative. The implementation of this alternative requires the availability of adequate off-site disposal locations and sufficient sources of backfill material that complies with Pennsylvania regulations.

Alternative 2 is the least costly compliant alternative. The cost for each alternative is presented below. Capital costs represents the initial cost to implement the major components of the alternative. Alternatives 2, 3 and 4 require annual operation and maintenance (O&M) as well as 5-year reviews. The cost associated with these items has been estimated for a 30-year period and is presented in the following table. All total costs are shown as present worth based on a 30-year duration.

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

In summary, Alternative 2 represents the least costly and most readily implemented alternative that complies with all requirements. As required by the NCP, public and state acceptance criteria need to be considered in the final selection of a remedial action for Sites 6 and 7.

1.0 INTRODUCTION

In response to Contract Task Order No. 252 under Contract No. N62472-90-D-1298, Tetra Tech NUS, Incorporated is submitting this Feasibility Study (FS) for contaminated soils within Area B Operable Unit 7 (OU-7) - Sites 6 and 7 of former Naval Air Warfare Center (NAWC) Warminster, Pennsylvania. This work is part of the Navy's Installation Restoration Program (IRP), which is designed to identify contamination of Navy and Marine Corps facilities resulting from past operations and to institute corrective measures, as needed. IRP activities are typically performed in four distinct phases. The first phase consists of a preliminary assessment (PA) and is followed by a site inspection (SI). The third phase is a remedial investigation/feasibility study (RI/FS), which is intended to characterize physical and chemical parameters and risks associated with the facility and to develop viable remedial alternatives for those media that require remediation. The last phase consists of remedial action design and implementation. In addition to meeting the objectives of the Navy's IRP, the purpose of the FS is to meet the requirements of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980), as amended by SARA (Superfund Amendments and Reauthorization Act of 1986).

1.1 PURPOSE OF REPORT

This FS incorporates the results of the RI to develop and evaluate potential remedial alternatives for addressing unacceptable risks to human health and the environmental posed by soil/wastes at OU-7. Since a separate FS has been prepared to address groundwater contamination in this area (Area B) at former NAWC Warminster groundwater is not discussed in this FS.

Remedial technologies and process options for OU-7 soils were evaluated and screened to select those that are most viable for the remedial action objectives. The selected technologies and process options were then combined to form remedial alternatives to address site contamination. The remedial alternatives are evaluated to distinguish advantages and disadvantages of each.

1.2 ORGANIZATION OF REPORT

Section 1.0 provides an introduction and background information. Background information includes descriptions and physical characteristics of the facility, the known nature of soil and contamination, and a risk assessment summary.

Section 2.0 discusses chemicals and media of concern, applicable or relevant and appropriate requirements (ARARs) pertaining to this site, the determination of preliminary remediation goals (PRGs), and the volume calculation of contaminated media.

Section 3.0 presents the identification and screening of technologies and process options.

Section 4.0 presents the development and screening of remedial alternatives.

Section 5.0 presents the detailed analysis of remedial alternatives for OU-7.

Section 6.0 presents a comparative analysis of the remedial alternatives.

Appendix A contains information supporting excavation volume calculations.

Appendix B contains supporting data for determining costs of remedial alternatives.

Appendix C presents preliminary remediation goal development.

This FS was prepared using EPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1998), the revised National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300, March 1990), and the Navy/Marine Corps Installation Restoration Manual (February 1992).

1.3 SITE BACKGROUND AND HISTORY

The former NAWC Warminster is located in Warminster Township, Bucks County, Pennsylvania. The facility lies in a populated suburban area surrounded by private homes, various commercial/industrial activities, and a golf course. Figure 1-1 shows the general facility location. The entire base is approximately 820 acres. Activities on the base ceased operation in the fall of 1996, but the facility is maintained by the Navy. The facility consists of various buildings and building complexes connected by paved roads, the runway and ramp area, mowed fields, and small wooded areas.

The facility has been divided into four general areas of concern based on groupings of suspected disposal sites, contamination, geographical areas, common sources and receptors, and facility use characteristics. These areas are referred to as A, B, C, and D. (Figure 1-2 presents these areas.) The areas of concern addressed in this report, Sites 6 and 7, are located in Area B.

Sites 6 and 7 are located in the central portion of Area B (see Figure 1-3). Area B was designated as an area of concern because of the reported presence of three disposal sites in this area (Sites 5, 6, and 7) and because of the presence of volatile organic compound (VOC) contamination in the groundwater.

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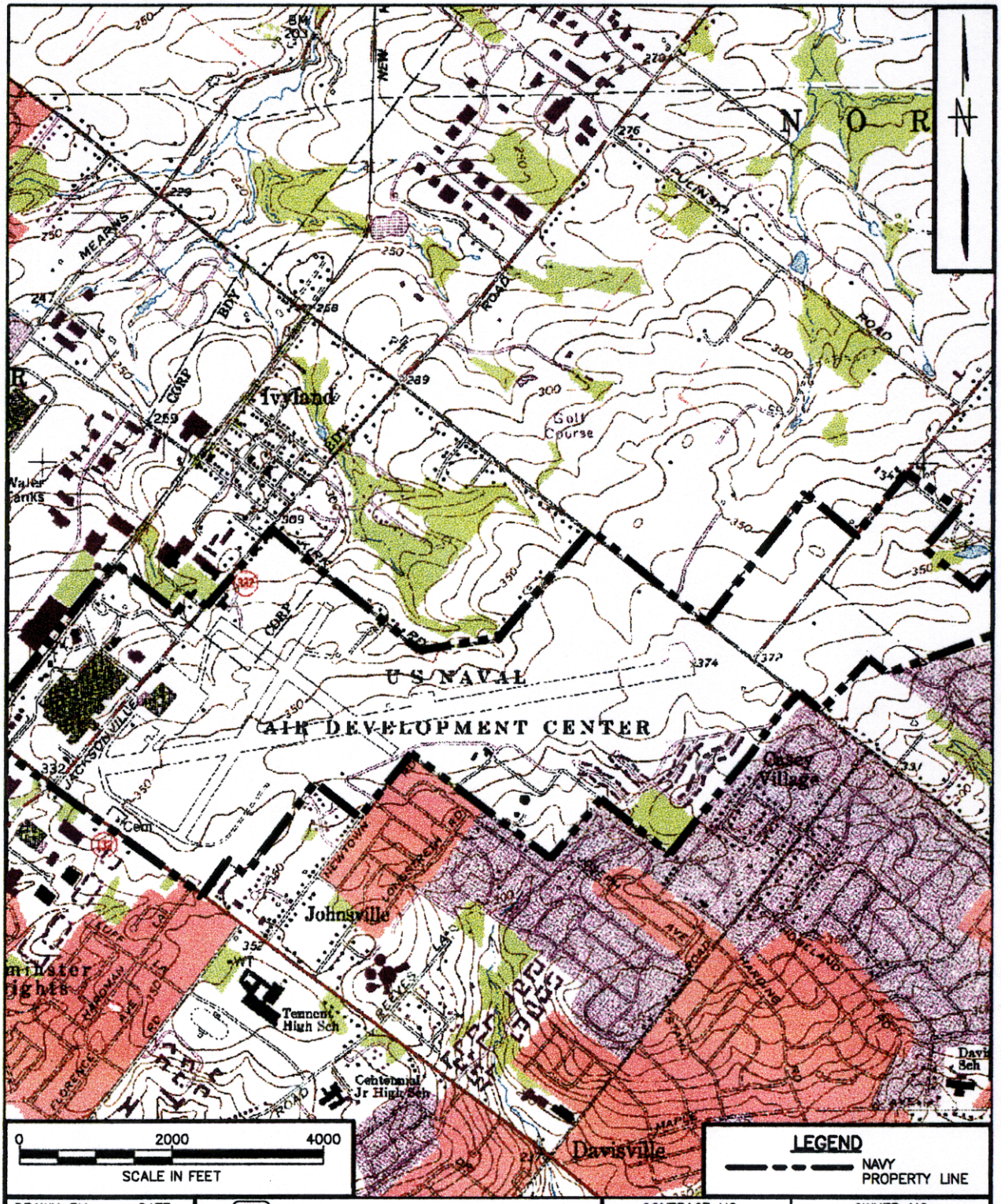

DRAWN BY A.S.M. DATE 11/24/1998	Tetra Tech NUS Inc.	CONTRACT NO. N62472-90-D-1298	OWNER NO. CTO 0252
CHECKED BY DATE	SITE LOCATION MAP	APPROVED BY	DATE 6/29/99
COST/SCHED-AREA	FORMER NAWC WARMINSTER	APPROVED BY	DATE
SCALE 1 in.=2000 ft.	WARMINSTER, PENNSYLVANIA	DRAWING NO. FIGURE 1-1	REV. 0

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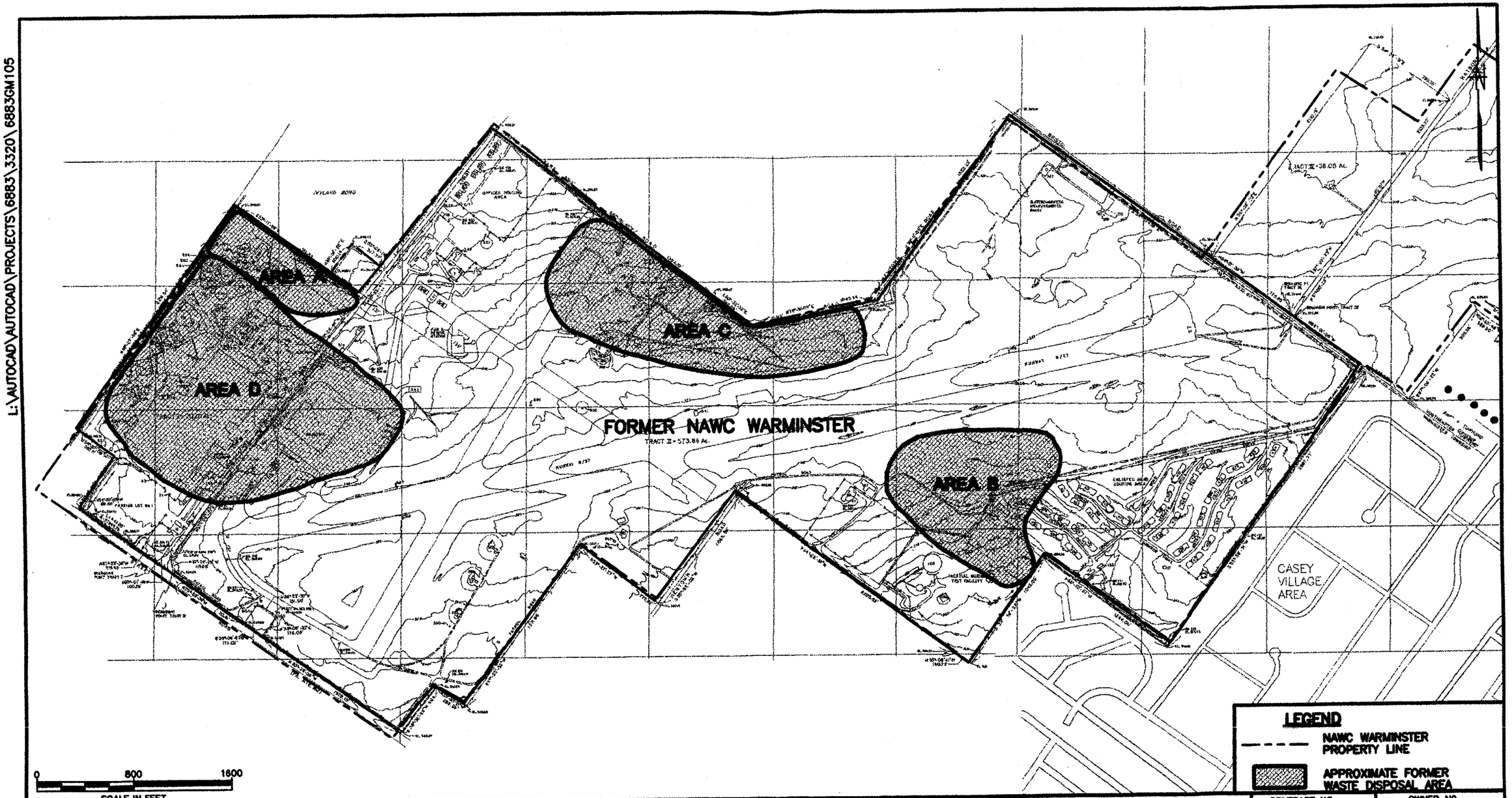

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DRAWN BY A.S.M. DATE 11/23/1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 800 ft.

Tetra Tech NUS, Inc.

APPROXIMATE LOCATION OF AREAS OF CONCERN
FORMER NAWC, WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. CTO 0252
APPROVED BY
DATE 1/28/99
APPROVED BY
DATE
DRAWING NO. FIGURE 1-2
REV. 0

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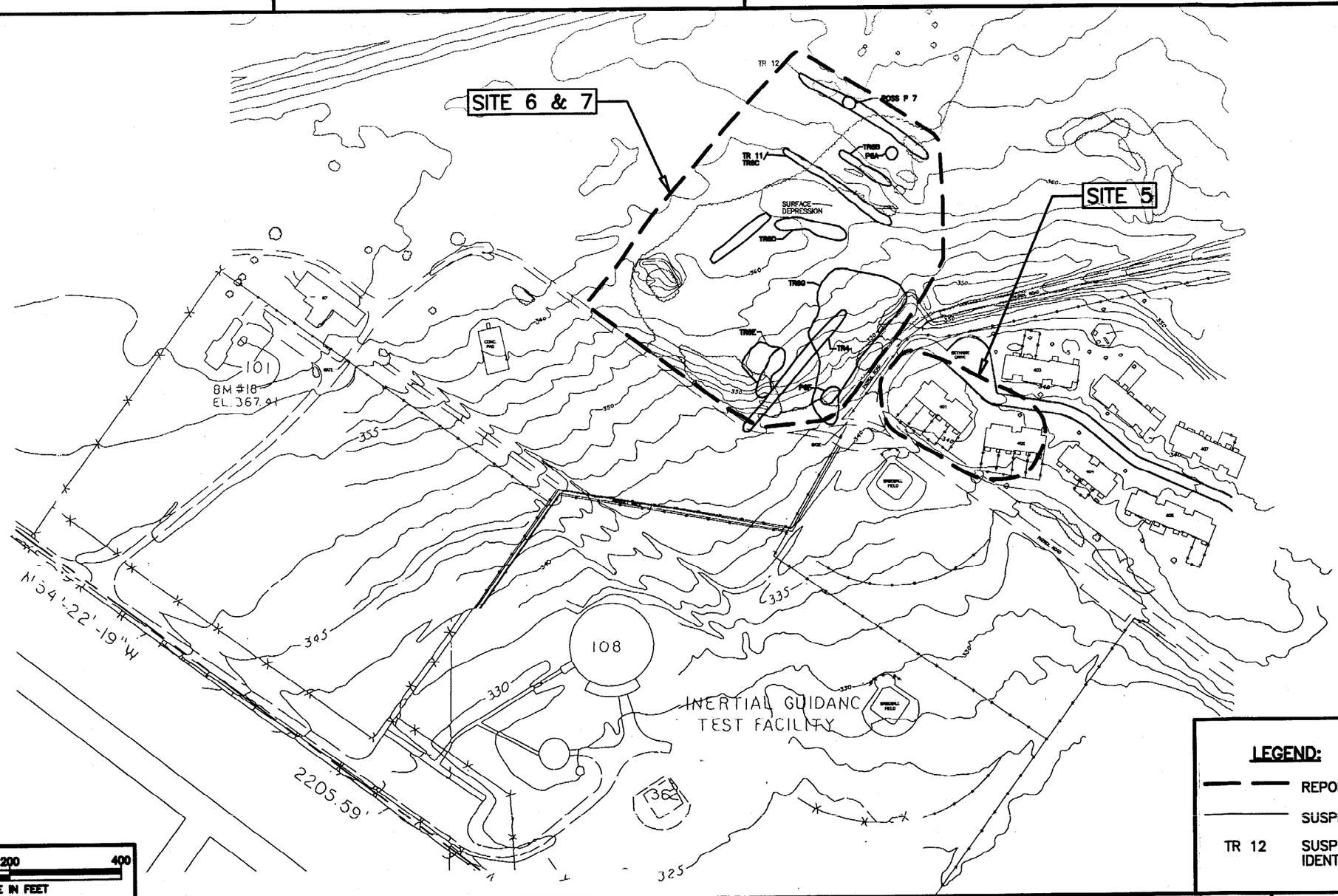

LEGEND:

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

0 200 400
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES
1	6/8/99	TITLE & DISPOSAL AREAS UPDATED	LDL			

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 6/30/99
APPROVED BY
DATE
DRAWING NO. FIGURE 1-3
REV. 2

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Area B is part of a parcel of land that is scheduled for transfer from the Navy to Warminster Township. At this time, the reuse plan approved by the Federal Lands Reuse Authority identifies this area as property to be used for recreational purposes. The property is currently targeted for transfer to Warminster Township under a Public Benefit Conveyance that would provide for the property to be used for this purpose. Site 5 is not included in the parcel to be transferred. Site 5 is located in the Navy housing area and is to be retained by the Navy.

The eastern portion of the NAWC facility, including Area B, was purchased by the Navy in 1951. Before the Navy purchase, the land was reported to consist of open fields used for farming [Basewide Environmental Baseline Survey, EA Engineering, Science, and Technology, Incorporated, 1995 (EA Engineering)]. Shortly after this land was purchased, the main runway was extended and the existing concrete aprons around Hangar 4 were replaced. No other major construction occurred in the area until the early 1970s, when construction began on Navy housing units located southeast of Sites 6 and 7.

Site 6 was reportedly used for disposal activities from 1960 until 1980. The site reportedly received unknown quantities of waste paint, solvents, oil, flammable wastes, grease trap waste, and demolition debris. These materials were reportedly disposed in pits excavated by backhoe and through general dumping and backfilling throughout the area.

Site 7 reportedly consisted of two disposal trenches that were used from 1950 to 1955 to receive sludges from the wastewater treatment plant. The trenches were reportedly 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. Upon site closure in 1955, the trenches were covered with 2 feet of soil, regraded, and reseeded.

The Sites 6/7 area was used for the disposal of demolition and construction debris from the mid-1950s to the 1970s. Large quantities of the demolished runway aprons and parking areas around Hangar 4 were deposited in this area during the 1950s.

Numerous investigations of Sites 6 and 7 have been completed. The most significant investigations included the performance of geophysical surveys, soil gas studies, and test pit excavations, placement of exploratory borings, and collection of surface and subsurface samples. Initial sample results were used to direct an initial removal action conducted by the Navy in 1997. The removal actions resulted in the excavation and off-site disposal of 3,698 tons of material. See the final RI for OU-7 (TtNUS, 1999) for a complete description of the site background and the completed investigations and removals.

This FS report addresses those soils and wastes remaining on site after the completion of the referenced removal actions. The area of concern is noted on Figure 1-3.

1.4 NATURE AND EXTENT OF CONTAMINATION

As indicated in Section 1.3, the Navy completed a removal action at Sites 6 and 7 in 1997. This removal action focused on those areas that contained VOC contamination presenting a risk to groundwater and on other areas that contained concentrations of waste material and contamination presenting a high likelihood of risk from direct contact. Additional investigations and sampling were conducted outside these removal areas. The soils and/or wastes described below and otherwise addressed in this FS report are those that remain on site after the removal actions.

Surface soil samples were collected from the top 6 inches of soils throughout the site. A total of 29 surface soil samples were collected and analyzed, in general, for full Target Compound List (TCL) organic and Target Analytical List (TAL) metal parameters. No VOC contamination at levels that exceed groundwater or human health protection criteria was identified in any of these samples. The majority of the contaminants identified in surface soils were metals. Most of these were present at levels that were slightly elevated above background and/or screening levels.

Subsurface samples were collected from test pits and from exploratory borings. Samples were collected, in general, from the mid-depth range between the surface and bedrock, at soil interfaces, from waste layers or material, and from soils immediately below any waste materials. Most waste materials were encountered at depths ranging from 4 to 9 feet below ground surface. However, in some specific areas, evidence of waste materials was encountered within 2 feet of the surface. In addition, portions of the site have subsided and discrete depressions are evident.

A total of 86 subsurface soil samples were collected and analyzed, in general, for full TCL organic and TAL metal parameters. No VOC contamination in excess of groundwater or human health protection screening criteria was identified. Analytical results for other parameters indicated the presence of several inorganic contaminants (metals) at significant levels. Arsenic, chromium, and thallium were the main contaminants found at significant levels throughout the sites. The occurrence and distribution of contaminant levels, along with the results of subsurface investigations, were used to identify three areas (Zones 1, 2, and 3) where potential human health direct contact and/or concentrated waste zones potentially presented higher risks. (See Figure 1-4) In addition to evaluating the data from the entire site for risks, data from each of these zones was evaluated separately. (See OU-7 RI report, TtNUS 1999 for a more detailed presentation of site findings.)

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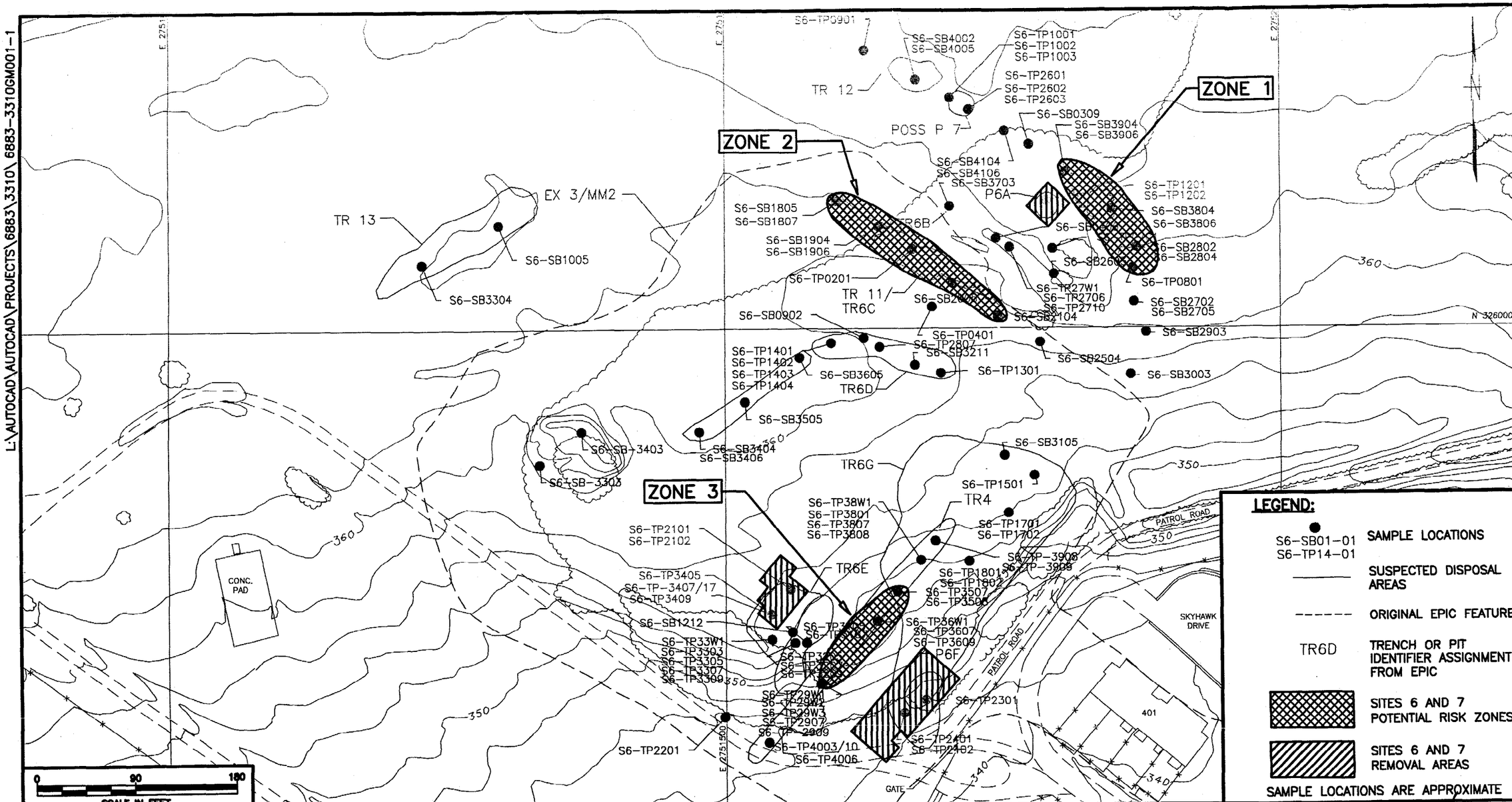

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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

Tetra Tech NUS, Inc.

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 6/30/99
APPROVED BY
DATE
DRAWING NO. FIGURE 1-4
REV. 1

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1.5 BASELINE HUMAN HEALTH RISK ASSESSMENT

Quantitative estimates of risk were calculated according to risk assessment methods outlined in current guidance (EPA, 1989). Lifetime cancer risks are expressed in the form of dimensionless probabilities based on Cancer Slope Factors (CSFs). Noncarcinogenic risk estimates are presented in the form of Hazard Quotients or Hazard Indices that are determined through a comparison of intakes with published Reference Doses (RfDs).

An Incremental Cancer Risk (ICR) of 1E-6 indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. EPA has defined the range of 1E-6 to 1E-4 as the "target range" for most hazardous waste facilities addressed under CERCLA. Typically, individual or cumulative ICRs greater than 1E-4 are not considered to be protective of human health, whereas ICRs below 1E-6 are.

Noncarcinogenic risks were assessed using the concept of Hazard Quotients (HQs) and Hazard Indices (HIs). An HI is generated by summing the HQs for the individual chemicals. If the value of the HI exceeds unity (1.0), there is a potential noncarcinogenic health risk associated with exposure to that particular chemical mixture (EPA, 1986). At that time, particular attention should be paid to the target organs associated with exposure to each chemical, as not all noncarcinogenic health effects are considered to be additive. The HI is not a mathematical predication of the severity of toxic effects and, therefore, is not a true "risk." It is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

1.5.1 Summary of Carcinogenic Risks

Risk assessments were performed for recreational and residential land use scenarios. In addition, quantitative risk estimates were calculated for surface and subsurface soils site-wide and for the zones of higher concentration of subsurface contamination.

The total cumulative carcinogenic risks for future recreational receptors, considering the site-wide data, are within the EPA's target risk range for surface soil exposure at Sites 6 and 7 (2E-6). The total cumulative carcinogenic risks associated with potential exposure to subsurface soils for the recreational receptor also are within this target risk range (1E-5).

Total cumulative carcinogenic risks for future recreational receptors potentially exposed to subsurface contaminants at Zones 1, 2, and 3 are all within EPA's target risk range (4E-06, 2E-05, and 8E-06,

respectively).

The total cumulative carcinogenic risks for future residential receptors, considering site-wide data, exposed to surface and subsurface soils are at or slightly exceed EPA's target risk range (1E-4 for surface soils and 2E-4 for subsurface). The principal contaminants contributing to these risks are arsenic and beryllium. The carcinogenicity of arsenic is not certain, and the risk estimate is based on a conservative approach.

1.5.2 Summary of Noncarcinogenic Risks

The noncarcinogenic HI for recreational receptors exposed to surface soils, considering site-wide data, is less than unity (1.0). The noncarcinogenic HIs are greater than unity (1.0) for the subsurface soil (site-wide, Zones 1, 2, and 3) recreational exposure scenarios. Chromium and, to a lesser degree, thallium and iron are the major contributors to these estimated risks.

Potential noncarcinogenic risks (HIs) for residential receptors exposed to surface and subsurface soils are greater than unity (1.0). As with the recreational scenarios, chromium and, to a lesser degree, thallium and iron are the major contributors to these estimated risks.

Potential risks associated with lead contamination were evaluated according to EPA protocols. This evaluation, based on potential exposure to future residential children, the most sensitive receptor, resulted in a predicted risk well below the EPA acceptable threshold.

Major uncertainties exist for the human health risk assessment (HHRA) that should be taken into account when deciding remedial actions for OU-7. The subsurface exposure scenarios are based on the assumption that all subsurface material is exposed at the surface (even though the majority of wastes are greater than 2 feet below ground surface). In addition, it was assumed that recreational receptors would limit visits or exposures to the discrete areas identified.

Of major significance to the noncarcinogenic risk estimates is the assumption made regarding the form of chromium present at the site. Chromium accounts for the majority of the significant calculated HIs. No chromium speciation analysis was performed on samples obtained from OU-7. Chromium can be present in either trivalent or hexavalent forms. Because no site-specific data were available, the initial baseline risk assessment, to be conservative, assumed that all chromium was present as hexavalent chromium. Hexavalent chromium is about 200 times more toxic than the more common trivalent form of chromium. This assumption regarding the form of chromium present at OU-7 may result in an overestimation of the noncarcinogenic risks.

The HHRA presented in the RI (TtNUS, 1999) evaluates the impact of this assumption regarding chromium by comparing chromium speciation data from other NAWC Warminster sites with waste of similar origin and chemical content to the OU-7 data. The results of applying this data comparison (ratio of hexavalent to total chromium) has a major impact on the estimated moncarcinogenic risks. If the representative hexavalent to total chromium ratio is applied to OU-7, only Zone 3 subsurface soils exceed unity (1.0) for recreational receptor scenarios. The referenced RI for OU-7 presents a detailed discussion of the impact of chromium speciation assumptions (TtNUS, 1999).

2.0 REMEDIAL ACTION OBJECTIVES

Section 2.1 presents the remedial action objectives (RAOs) for remedial action at Sites 6 and 7. Section 2.2 and Section 2.3 present compounds of concern (COCs) for subsurface soils at Sites 6 and 7, as well as a preliminary listing of applicable or relevant and appropriate requirements (ARARs) and other guidance to be considered (TBCs). Section 2.4 identifies the preliminary remediation goals (PRGs), clean-up goals for site remediation, and Section 2.5 presents a discussion of the estimated volume of contaminated media potentially requiring remediation under the remedial alternatives.

2.1 REMEDIAL ACTION OBJECTIVES

The primary objective of any remediation performed at Sites 6 and 7 is the protection of human health and the environment. Meeting this objective will facilitate the planned property transfer of the area to the township as part of base closure. The Sites 6 and 7 area is addressed in the approved re-use plan. The re-use plan was developed by the Federal Land Reuse Authority (FLRA) and approved by the local townships and municipalities. The Sites 6 and 7 area has been designated for parks and recreational uses. The current approved plan calls for passive recreational uses (buffer zone, walking and hiking, picnicing, play fields, etc.) for this specific area. Based on this approved reuse plan, recreational use is the most likely reasonable future use of the area. However, as summarized in Section 1.5, contamination presents an unacceptable risk to future residential receptors and this risk must be addressed in remedy selection. Groundwater (being addressed through other FS efforts) is not a medium of concern for this FS. OU-7 soils/wastes have not been identified as a threat to groundwater.

Based on the compounds and media of concern, the results of the risk assessment and future land use, the RAO for Sites 6 and 7 media other than groundwater is as follows (groundwater RAOs are not discussed in this report).

- Prevent potential human exposure by future receptors to subsurface material that presents an unacceptable risk due to contamination with metals (mainly chromium and thallium).

2.2 CONTAMINANTS AND MEDIA OF CONCERN

The contaminants identified as COCs for Sites 6 and 7 addressed in this FS are those that contribute a non-carcinogenic Hazard Quotient (HQ) greater than 0.1 towards a cumulative (across pathways) Hazard Index (HI) for a particular target organ of greater than 1.0. Because the planned future land use for Sites

6 and 7 is recreational, COCs that pose potential risks to recreational receptors and potential residential receptors were developed separately. The quantitative risk assessments did not identify a carcinogenic risk, under the recreational land use scenario outside of the EPA's acceptable risk range. Similarly, noncarcinogenic risks for surface soils under the recreational land use scenario have an HI of less than 1.0. Carcinogenic risks associated with theoretical future residential land use scenarios identified an unacceptable risk from subsurface contamination only.

Based on this evaluation and these criteria the COCs for Sites 6 and 7 as well as Zones 1, 2, and 3 are shown in Table 2-1.

TABLE 2-1
COCs – Subsurface Soils
Sites 6 and 7
NAWC Warminster, Pennsylvania

	Recreational				Residential
COC	**Site-Wide**	**Zone 1**	**Zone 2**	**Zone 3**	**Site-Wide**
Chromium	X	X	X	X	X
Thallium	X	X	X	X	X
Arsenic			X	X	X
Cadmium			X	X	X
Aroclor - 1254				X	X
Beryllium					X
Manganese					X
Mercury					X
Silver					X
Aroclor 1260					X
Benzo(a)pyrene					X
Dibenzo(a,h)anthracene					X

Note: Assumes concentrated exposure to individual areas or zones (see Risk Assessment RI for Sites 6 and 7, TtNUS, 1998).

2.3 COMPLIANCE WITH ARARs AND TBCs

ARARs are promulgated, enforceable federal and state environmental or public health requirements that are determined to be legally applicable or relevant and appropriate to the hazardous substances, remedial actions, or other circumstances at a CERCLA site. The National Contingency Plan (NCP) Section 300.430 states that on-site remedial actions at CERCLA sites must meet ARARs unless there are grounds for invoking a waiver. A waiver is required if ARARs cannot be achieved. The two classes of ARARs, "applicable" and "relevant and appropriate," are defined below.

- **Applicable Requirements** - Section 300.5 of the NCP defines applicable requirements as those remediation standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Only those state standards that are identified by a state in a timely manner, are enforced in a consistent manner, and that are more stringent than Federal requirements may be considered as applicable requirements.

- **Relevant and Appropriate Requirements** - Section 300.5 of the NCP defines relevant and appropriate requirements as those remedial standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not directly applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be considered as relevant and appropriate requirements.

ARARs fall into three categories, base on the manner in which they are applied. The characterization of these categories is not perfect, as many requirements are combinations of the three types of ARARs. The three categories of ARARs are as follows.

- Contaminant-Specific: Health/risk-based numerical Values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include MCLs and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC).

- Location-Specific: Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples of location-specific ARARs include wetland regulations.

- Action-Specific: These are regulations and guidelines that must be followed depending on the activity performed on site. For example, proper handling, storage and disposal of hazardous substances maybe regulated by EPA or State guidelines.

TBCs (standards and guidance to be considered) are non-promulgated advisories or guidance issued by federal or state governments that are not legally binding but may be considered during development of remedial alternatives. For example, EPA Health Advisories and Reference Doses are non-promulgated criteria that are used to assess health risks from contaminants present on CERCLA sites.

Summaries of the potential federal and state chemical-specific ARARs and TBCs and their consideration in the FS are provided in Table 2-2.

2.4 PRELIMINARY REMEDIATION GOALS

Compound-specific preliminary remediation goals (PRGs) were developed for Sites 6 and 7 and the specific risk zones identified in the RI. PRGs were developed for the recreational human health risk future land use scenario for the site and each Zone. To support the development and evaluation of an alternative that did not require the use of any land use restrictions, the future residential human health risk scenario was developed. PRG's for site-wide future residential use were calculated to support this alternate approach. All PRGs were developed using the risk exposure assumptions presented in the OU-7 RI (TtNUS, 1999). As indicated in that report and in Section 1.5.2 of this report, it was assumed that all chromium was present as hexavalent chromium. This assumption is a conservative approach and results in the formulation of conservative PRG's.

For non-carcinogenic risks, the future child and future youth exposure scenario was developed. For future residential use, both the child and lifetime receptor exposure scenarios were considered.

In developing PRGs, risk-based contaminants of concern (COCs) consisted of COCs from the Risk Assessment that:

BLE 2-2
SUMMARY OF POTENTIAL ARARs AND TBC CRITERIA SITES 6 AND 7
NAWC WARMINSTER, WARMINSTER, PENNSYLVANIA

Requirement	Citation	Status	Synopsis	Comment
Contaminant-Specific ARARs and TBC				
Safe Drinking Water Act (SDWA) MCLs Secondary MCLs (SMCLs) MCL Goals (MCLGs)	42 USC 300f et seq. 40 CFR Parts 141-143	MCLs are relevant and appropriate SMCLs and MCLGs are TBC	MCLs, SMCLs, and MCLGs established under this act are health-based limits for certain chemical substances in drinking water.	Relevant and appropriate or TBC for the derivation of soil PRGs protective of groundwater. Groundwater was not identified as a concern under the RI for this FS.
CWA Ambient Water Quality Criteria (AWQC)	33 USC 1251 et seq. Section 304(a)(1)	TBC	Water-quality criteria are non-enforceable guidance and are used by the state in conjunction with the designed use for a stream segment to establish water quality standards under CWA 303.	During remedial activities, groundwater or treatment by-products may be collected. AWQCs are TBC if this water is discharged to surface waters.
EPA Health Advisories	EPA 822-B-96-002	TBC	EPA Office of Drinking Water guidelines for chemicals that may be intermittently encountered in public water supply systems.	TBC for the derivation of soil PRGs protective of groundwater. Groundwater was not identified as a concern under the RI for this FS.
EPA Generic Soil Screening Levels (SSLs)	EPA 540-R-96-018 Appendix A	TBC	Federal guidance that provides screening levels for protection of human health and groundwater from soil contaminants.	TBC for determining PRGs.
Clean Air Act (CAA)	42 USC 7401 et seq.	Relevant and Appropriate	Federal legislation that addresses air pollution control.	Pertinent sections of this Act are discussed as follows.
National Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Relevant and Appropriate	Non-source specific limitations for ambient air quality.	Any air emission would require appropriate controls to meet NAAQS as required by PADEP's State Implementation Plan.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61	Not an ARAR	Emission standards for existing source types that emit hazardous air pollutants.	Existing source types are not present on site.
New Source Performance Standards (NSPS)	40 CFR Part 60	Relevant and Appropriate	Emission standards established for new sources of air emissions.	Relevant and appropriate to NAWC Warminster If the pollutants emitted and the technology employed (e.g., air stripping) during the clean-up action are sufficiently similar to the pollutant and source category regulated by an NSPS and are well suited to the circumstances at the site.
OSWER Directive 9355.0-28	OSWER Directive 9355.0-28	TBC	Guidelines for control of air emissions from air strippers at Superfund groundwater remediation sites.	TBC if treatment of off-gasses from remedial activities occurs.

TABLE 2-2
SUMMARY OF ARARs AND TBC CRITERIA
NAWC WARMINSTER, WARMINSTER, PENNSYLVANIA

Requirement	Citation	Status	Synopsis	Comment
Contaminant-Specific ARARs and TBC				
The Resource Conservation and Recovery Act (RCRA) Subtitle C – Hazardous Waste Identification and Listing Regulations	40 CFR Part 261	Applicable	These rules are used to identify a material as a hazardous waste, and thus determine applicability or relevance of RCRA subtitle C Hazardous Waste Rules.	Soils may exceed toxicity characteristics leaching procedure (TCLP) criteria. If so, management of these contaminated soils should be conducted in compliance with RCRA requirements.
RBCs	EPA Region III, October 1998	TBC	RBCs are screening levels calculated for a Target Hazard Quotient of 1.0 for noncarcinogenic effects and a Target Risk of 1.0E-6 for carcinogenic effects.	TBC for determining PRGs.
Pennsylvania Land Recycling and Environmental Standards Act	Act 2	TBC	Primary law establishing the land and recycling program.	Installation restoration work is being pursued under Superfund. Site-specific risk-based PRGs have been developed after human health risk assessment.
Pennsylvania Medium Specific Concentrations (MSCs)	PA Code, Title 25, Chapter 250	TBC	Statewide guidance for protection of human health and the environment from soil and groundwater contaminants.	TBC for determining PRGs.
Pennsylvania Water Quality Standards	PA Code, Title 25, Chapter 16 and 93	Potentially Applicable	Standards applicable for actions involving the discharge of pollutants to surface water. Based upon water uses that are protected and will be considered by the PADEP.	During remedial activities, groundwater or treatment byproducts may be collected. AWQCs are applicable if this water is discharged to surface waters.
Pennsylvania Air Pollution Control Regulations	PA Code, Title 25, Chapter 121 - 143	Relevant and Appropriate	Regulations for the control and prevention of air pollutants and guidance for the design and operation of air pollution sources.	Relevant and appropriate if treatment of off-gasses from remedial activities occurs.
Pennsylvania Safe Drinking Water Regulations	PA Code, Title25, Chapter 109	Relevant and Appropriate	Drinking water quality standards at least as stringent as the National Primary Drinking Water Regulations.	Relevant and appropriate for the derivation of soil PRGs protective of groundwater. Groundwater was not identified as a concern under the RI for this FS.
Location Specific ARARs and TBC				
Federal Protection of Wetlands Executive Order	Executive Order (EO) 11990	Potentially Applicable	Requires the action of federal agencies to minimize the destruction, loss, or degradation of wetlands and preserve and enhance the natural and beneficial values of wetland.	Wetlands were assessed along the unnamed tributary of Little Neshaminy Creek. Retained in the event that wetland areas are affected.
The Endangered Species Act of 1978	16 USC 1531 40 CFR Part 502	Not Applicable	Requires federal agencies to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the future existence or critical habitat of any endangered or threatened species.	No endangered or threatened species are known to permanently or seasonally reside in the vicinity of the base.
The Fish and Wildlife Coordination Act	16 USC 661	Potentially Applicable	Protects fish and wildlife when Federal actions result in the control or modification of a natural stream or body of water.	Applicable if surface water is diverted or disturbed during remedial actions.
The Fish and Wildlife Improvement Act of 1978	16 USC 742a	Applicable	Protects fish and wildlife against impacts that may affect their protected habitats	Applicable because fish and wildlife are present downgradient of Area A.

TABLE 2-2
SUMMARY OF ARARs AND TBC CRITERIA
NAWC WARMINSTER, WARMINSTER, PENNSYLVANIA

Requirement	Citation	Status	Synopsis	Comment
Location – Specific ARARs and TBCs				
The Fish and Wildlife Conservation Act of 1980	16 USC 2901	Applicable	Protects fish and wildlife against impacts that may affect their protected habitats.	Applicable as fish and wildlife are present downgradient of Area A.
Federal Floodplain Management	EO 11988	Potentially Applicable	Requires federal agencies to evaluate the potential effects of impacts associated with occupancy and modification of a floodplain.	Applicable if surface water is diverted or disturbed during remedial actions.
Action Specific ARARs and TBC				
RCRA Subtitle C	42 USC 6901	Potentially Applicable	Establishes design and operating criteria for hazardous waste landfills.	Potentially applicable if soil is determined to be hazardous.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Potentially Applicable	Regulations with which a generator that treats, stores, or disposes of hazardous waste on site must comply.	Applicable for removed wastes determined to be hazardous.
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Potentially Applicable	Regulations for the manifest and record keeping systems, and for the immediate action and cleanup of hazardous waste discharges (spills) during transportation.	Applicable for removed wastes determined to be hazardous that is transported off site.
Standards for Owners and Operators of Hazardous Waste TSD Facilities	40 CFR Part 264	Potentially Applicable	Regulations that govern the treatment, storage, and disposal of hazardous waste.	These regulations would be applicable to waste removed from this site including both on-site and off-site management; however, the reuse of treated soils as backfill would not be subject to the disposal facility standard.
RCRA Subtitle D	40 USC 6901	Potentially Applicable	Establishes design and operating criteria for solid waste (non-hazardous) landfills.	Potentially applicable if soil is determined to be nonhazardous.
RCRA Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Potentially Applicable	Criteria to determine which solid waste disposal facilities pose a probability of adverse health effects and therefore prohibit open dumps.	Applicable if soil is stockpiled at various locations on site.
Department of Transportation (DOT) Rules for Hazardous Materials Transport	49 CFR Parts 107 and 171 – 179	Potentially Applicable	Regulations for the transportation of hazardous materials. Requirements cover packaging, marking, labeling, and transportation methods.	Off-site shipments of any contaminated soil that is classified as a hazardous material from this site would have to comply with these regulations.
CWA – National Pollution Discharge Elimination System (NPDES)	40 CFR Part 122	Potentially Applicable	Regulations for discharge, dredge, or fill materials and oil or hazardous waste spills into the United States waters.	These requirements are applicable for all alternatives that include a water discharge.
National Environmental Policy Act (NEPA)	42 USC 4321 40 CFR Part 6	Potentially Applicable	Requires federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement.	Alternatives could constitute significant activities, thereby making NEPA requirements ARARs. Activities conducted in accordance with the NCP are considered to meet the substantive NEPA requirements.

TABLE 2-2
SUMMARY OF ARARs AND TBC CRITERIA
NAWC WARMINSTER, WARMINSTER, PA
PAGE 4 OF 5

Requirement	Citation	Status	Synopsis	Comment
Action-Specific ARARs and TBC				
The Occupational Health and Safety Act (OSHA)	29 USC Sections 651 through 678	Potentially Applicable	Regulates worker health and safety during implementation of remedial actions.	Because this is a federal Superfund site, these regulations are applicable to all investigations and remedial activities at NAWC Warminster.
Pennsylvania Hazardous Waste Management Regulations	PA Code, Title 25, Article VII	Potentially Applicable	Regulations (similar to RCRA Subtitle C) that may be relevant to on-site remedial actions and applicable to the transport of hazardous waste off site.	Applicable for removed site wastes determined to be hazardous.
Pennsylvania Solid Waste Disposal Regulations	PA Code, 25, Chapter 75	Potentially Applicable	Establish the disposal of solid wastes including municipal and industrial materials.	Applicable for removal of site solid wastes including municipal and industrial materials.
Pennsylvania Industrial Waste Management Regulations	PA Code, 25, Chapter 97	Potentially Applicable	Regulate the disposal of industrial waste materials.	Applicable for removal site wastes that are classified as industrial.
Pennsylvania NPDES Rules	PA Code, Title 25, Chapter 92	Potentially Applicable	Establish the requirements for point-source discharge into Pennsylvania waters.	These requirements are applicable for all alternatives that include a water discharge.
Pennsylvania Wastewater Treatment Regulations	PA Code, Title 25, Chapter 95	Potentially Applicable	Regulations for remedial actions, which include a discharge to surface, water.	Applicable for remedial actions that includes a discharge to surface water.
Pennsylvania Storm Water Management Act	Act No. 167	Potentially Applicable	Requires measures to control stormwater runoff during remedial alternatives or development of land.	Required if remedial actions take place.
Pennsylvania Special Water Pollution Regulations	PA Code, Title 25, Chapter 101	Potentially Applicable	Establish a procedure for mandatory notification of downstream users in the case of an accident in which a toxic substance enters surface waters.	These regulations may be applicable for remedial actions that include on-site treatment of solid waste.
Pennsylvania Erosion Control Regulations	PA Code, Title 25, Chapter 102	Potentially Applicable	Require measures to control stormwater runoff during remedial alternatives or development of land.	These regulations may be applicable because remedial action may include excavation of site soils.
Pennsylvania Hazardous Substances Transportation Regulations	PA Code, Title 13, And Title 15	Potentially Applicable	Govern the transport of flammable liquids and solids, oxidizing materials, poisons, and corrosive liquids.	Off-site shipments of any contaminated soil that is classified, as a hazardous material from this site would have to comply with this site would have to comply with these regulations.
Pennsylvania Construction, Modification, Reactivation, and Operation of Sources Regulations	PA Code, 25, Chapter 127	Potentially Applicable	Regulations for the construction, modification, or reactivation of an air contaminant source and the installation of an air cleaning device.	Applicable if treatment of off-gassing from remedial actions is required.

TABLE 2-2
SUMMARY OF ARARs AND TBC CRITERIA
NAWC WARMINSTER, WARMINSTER, PA

Requirement	Citation	Status	Synopsis	Comment
Action-Specific ARARs and TBC				
Pennsylvania Hazardous Waste and Petroleum Products Contamination Cleanup Projects	PA Guidance	TBC	State guidance document that requires the approval of equipment designed to remove volatile contaminants from soil, water, and other materials.	TBC if treatment of off-gassing from remedial actions is required.
Pennsylvania Air Quality Permitting Criteria for Remediation Projects Involving Air Strippers and Soil Decontamination Units.	PA Guidance	TBC	State guidance document that provides a permit exemption policy for remediation projects involving the Bureau of Air Quality Control	TBC if treatment of off-gassing from remedial actions is required.

- Provide a non-carcinogenic HQ contribution greater than 0.1 toward a cumulative (across pathways) HI for a particular target organ of greater than 1.0.
- Individually contribute a risk of greater than 1E-06 towards a cumulative cancer risk (considering all pathways, media and route of exposure) of greater than 1E-04.

Tables 2-3 and 2-4 present the COCs and the potential compound specific PRG's developed for clean up alternatives at each site. Although PRGs were developed for multiple receptors, the PRG associated with the most sensitive receptor is presented in these tables. Similarly, alternate PRGs were developed based on the acceptance of variable residual risks. The PRGs presented in Tables 2-3 and 2-4 are based on the most sensitive receptors and establish contaminant-specific clean-up goals for noncarcinogens at 0.1 HQ and for carcinogens at 1E-5. Appendix C presents the full range of PRGs developed for variable receptors and residual risk levels.

2.5 VOLUME OF CONTAMINATED MEDIA

Surface soils, site wide, do not present an unacceptable risk under the planned recreational reuse scenario. However, surface soils, site wide, have been identified as presenting an unacceptable potential risk to future residential receptors. Subsurface soils have also been identified as presenting an unacceptable potential risk to both future residential and recreational receptors. Therefore, both surface and subsurface soils have been identified as the media of concern.

Based on known/confirmed disposal areas and sample analytical data (see OU-7 RI report, TtNUS, 1999) the approximate area of surface soils presenting a potentially unacceptable risk to residential receptors is shown in Figure 2-1. This area is approximated based on the nature and extent of contamination in excess of residential risk PRGs in soil samples collected from the top 2 feet of soil collected from the disposal area. A 2-foot depth, based on EPA guidance and practice, was used to calculate the volume of material contained within this area.

Area of surface soil = 253,259 square feet
Depth of soil = 2 feet
Volume = 506,518 cubic feet = 18,760 cubic yards

Similarly, Figure 2-1 also depicts the approximate area of subsurface material, based on known/confirmed disposal areas and the nature and extent of contamination, that presents potentially unacceptable subsurface risks to receptors. The depth of the contamination varies throughout this area. It is assumed

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NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY A.S.M. DATE 12/11/1998
CHECKED BY DATE
COST/SCHED-AREA
SCALE 1 in. = 90 ft.

Tetra Tech NUS, Inc.

ESTIMATED AREAS OF CONTAMINATED MEDIA
OU-7, SITES 6 AND 7
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. N62472-90-D-1298
OWNER NO. CTO 0252
APPROVED BY
DATE 6/30/99
APPROVED BY
DATE
DRAWING NO. FIGURE 2-1
REV. 2

FORM CADD NO. L:\ACAD14\BLOCKS\BORDERS\TtNUS_BH3.DWG

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TABLE 2-3
Preliminary Remediation Goals
Developed for Child Recreational Exposure to Subsurface Soil
Sites 6 and 7 NAWC Warminster, PA

	PRG[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
Cadium	-	-	40.2	40.2
Aroclor 1254	-	-	-	1540

(1) Metals concentrations are in mg/kg; Aroclor concentration is in ug/kg. Clean-up goals based on exposures for child recreational user assuming exposure to concentrated areas or zones (see risk assessment in OU-7RI, TtNUS 1999). Individual compound clean-up goals were established to result in a compound-specific HQ of 0.1.

TABLE 2-4
Preliminary Remediation Goals
Developed for Child and Lifetime Residential
Exposure for Site-Wide Subsurface Soil
Sites 6 and 7 NAWC Warminster, PA

COC	PRG[1]
Arsenic	1.7
Beryllium	0.081
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.

for costing purposes that over-excavation below known contaminated zones would be required to achieve PRGs. The depth to bedrock is relatively shallow in much of this area and it is assumed that this will control or dictate the depth of the excavation required. This depth varies, in general, from 8 feet to more than 17 feet. For estimating purposes, it is assumed that the average depth of excavation would be 12 feet. However, as estimated above, the top 2 feet of material have been addressed as surface soil. Therefore, the volume estimate for this area is estimated using 10 feet of subsurface material.

Area of subsurface media (from Figure 2-1) = 147,961 square feet

Depth of media = 10 feet

Volume = 1,479,610 cubic feet = 54,800 cubic yards

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3.1 INTRODUCTION

This section identifies, develops, and screens applicable technologies and process options for assembling remedial action alternatives for Sites 6 and 7. The basis for technology identification and screening began in Section 2.0 with the following:

- Identification of ARARs
- Development of PRGs
- Calculation of volumes of media of concern

Technology screening is completed and technology evaluations performed in this section with the completion of the following analytical steps:

- Identification of general response actions
- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

3.2 GENERAL RESPONSE ACTIONS

General response actions (GRAs) describe categories of actions that could be implemented to satisfy or address a component of a RAO for the site. Typically, the formation of remedial action alternatives represents the coupling of general response actions to fully address remedial action objectives. When implemented, the coupled GRAs are capable of achieving the PRGs that have been generated for each contaminated medium at the site. For Sites 6 and 7, the contaminated media of concern consists of surface and subsurface soil. General response actions presented in OSWER Directive No. 9355.3-01, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, were evaluated for their applicability to site specific conditions, environmental media the nature of the contaminants, and how the potential risks would be mitigated.

General response actions that may be applicable to the contaminated soils at the site include the following:

- No Action
- Institutional Controls
- Containment

- Removal
- Treatment
- Disposal

3.3 IDENTIFICATION, SCREENING, AND EVALUATION OF REMEDIAL TECHNOLOGIES

3.3.1 Preliminary Screening

During this phase of alternative formulation, preliminary screening is performed to reduce the universe of potentially applicable technology types and process options. The purpose of screening is to investigate all available technologies and process options and to eliminate those obviously not applicable to specific conditions based on the established remedial action objectives and general response actions. The technology identification considers the demonstrated performance of each technology with site conditions and contaminants. Potential remedial technologies and process options are identified and screened according to their overall applicability to the media, primary contaminants of concern, and conditions present at the site. The preliminary screening of remedial technologies is presented and summarized in Table 3-1.

3.3.2 Evaluation of Remedial Technologies

A detailed evaluation of technologies and process options retained in the preliminary screening step is conducted to further focus the alternatives development process. In this step, process options are evaluated with respect to other processes in the same technology category. One representative process option is selected, if possible, for each technology type, to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedy selection or remedial design. The evaluation of technologies and process options utilizes three criteria, effectiveness, implementability, and relative cost. The Guidance for Conducting Remedial Investigation focus on the effectiveness criterion, with less emphasis directed at the implementability and relative cost criteria. Evaluations of the remedial technologies and process options are presented in Table 3-2.

TABLE 3-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FEASIBILITY STUDY FOR SITES 6 AND 7
NAWC, WARMINSTER, PENNSYLVANIA

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	No Action	No action	No remedial actions taken	Retained as baseline for comparison, as required by NCP.
Institutional Controls	Use Restrictions	Deed Restrictions and Covenants	Administrative action is used to restrict future site activities within potentially contaminated areas. Activities such as excavation or residential development could be restricted or prohibited.	Potentially viable. Retained.
		Local Ordinances	Administrative actions, such as zoning restrictions are used to limit property use and activities.	Potentially viable. Retained.
	Access Restrictions	Fencing	Security fence is installed around contaminated areas to restrict access.	Does not achieve the RAO of supporting recreational activity. Eliminated.
	Monitoring	Visual Inspections	Periodic monitoring of native soil and vegetative cover.	Potentially viable. Retained.
Containment	Cap	Soil Cover	A layer of native soil placed over the site with a vegetative cover to prevent direct contact and minimize erosion and surface migration of contaminated soils.	Potentially viable. Partial soil cover currently in place. Retained.
		Single Barrier	Cap constructed with one low-permeability layer (clay or synthetic membrane) over the site to prevent direct contact and to minimize erosion.	Potentially viable to prevent direct contact and to reduce erosion. Retained.
		Composite (Double) Barrier	Multi-media cap with two low-permeability layers (clay and/or synthetic membranes) constructed over the site to prevent direct contact. Provides better protection against failure than a single-barrier cap.	Potentially viable to prevent direct contact and to reduce erosion. Retained.
	Vertical Barrier	Slurry Wall/Sheet Piling	Low-permeability barriers to prevent horizontal migration of contaminants.	Horizontal contaminant migration patterns are unlikely. Eliminated.
Removal	Excavation	Mechanical Excavation	Mechanical removal of solid materials using conventional earth-moving equipment such as bulldozers, excavators, and front-end loaders.	Potentially applicable. Excavation is an accepted method of removing soil contamination. Retained.

TABLE 3-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FEASIBILITY STUDY FOR SITES 6 AND 7
NAWC, WARMINSTER, PENNSYLVANIA
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
In-Situ Treatment	Biological	Biodegradation	In-situ degradation of organics using microorganisms in an aerobic/anaerobic environment. Nutrients could be injected into the subsurface to promote biological activity.	Not an effective technology for treatment of inorganic compounds Eliminated.
	Physical/ Chemical Thermal	Chemical Fixation/ Solidification	In-situ process where cement, lime, or other pozzolanic materials are mixed with soil in the vadose zone to immobilize contaminants.	The presence of debris would limit effectiveness. Eliminated.
		Soil Flushing	In-situ flushing of contaminants from the vadose zone into the saturated zone using water or solvents in conjunction with an injection/extraction well system.	Not an effective technology for treatment of inorganic compounds. Eliminated.
		Air Sparging/ Soil Vapor Extraction	In-situ system of air injection and extraction wells to promote biodegradation and transfer of volatile organics to the vapor matrix.	Not an effective technology for treatment of inorganic compounds. Eliminated.
	Thermal	Virtrification	High-power electric current passed through an area of contamination in situ to melt the material into a glass-like, solid matrix.	Eliminated on the basis of high capital costs and implementability concerns.
Ex-Situ Treatment	Biological	Bioslurry/ Land Farming	Treatment of excavated soil in a slurry reactor or by tilling under controlled conditions using natural or cultured microorganisms to biodegrade organic contaminants.	Not effective for treatment of inorganic compounds. Eliminated.
	Physical/ Chemical	Chemical Fixation/ Solidification	Ex-situ mixing of cement, lime, or other pozzolanic materials with excavated soil to immobilize contaminants.	Potentially applicable. Retain for treatment of inorganic compounds. Retained

TABLE 3-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FEASIBILITY STUDY FOR SITES 6 AND 7
NAWC, WARMINSTER, PENNSYLVANIA
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Ex-Situ Treatment	Physical/Chemical	Soil Washing/Solvent Extraction	Ex-situ treatment to move contaminants from soil phase into a leaching agent using chemical and solubilization processes. Converts contaminants to a more concentrated or less toxic form.	Not effective for treatment of inorganic compounds. Eliminated.
		Size Separation	Minimize waste by physically screening out size fractions of soils or sediments containing minimal contamination.	Potentially applicable if large quantities of concrete debris are encountered.Retained
		Thermoplastic Solidification	Ex-situ process where soil is mixed with asphalt, bitumen, paraffin, polyethylene or other organic polymers, and heated to form a stable solid.	Typically applies to highly contaminated wastes (nuclear) and mobile wastes that are not amenable to chemical fixation. Eliminated.
	Thermal	Thermal Desorption	Application of heat at relatively high temperature to remove volatile and semivolatile organics from excavated soil by volatilization. Vapor phase is treated by incineration or carbon adsorption.	Not effective for treatment of inorganic compounds. Eliminated.
		Incineration	Use of high temperature to pyrolize or oxidize organic contaminants in excavated soil into less toxic gases.	Not effective for treatment of inorganic compounds. Eliminated.
		Vitrification	Excavated soil is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics.	Eliminated, based on the high capital costs and the availability of less costly technologies that are expected to be effective in accomplishing the prevention of direct contact exposure.
Disposal	On Site	Consolidation/ Engineered Disposal Cell	Excavation and deposition of all contaminated soil in an engineered disposal cell to minimize space and closure requirements, reduce infiltration, and minimize direct contact the contaminants.	Eliminated, based on the high capital costs and the availability of less costly technologies that are expected to be effective in accomplishing the prevention of direct contact exposure.
	Off Site	Permitted Treatment, Storage, and Disposal (TSD) Facility	Disposal of contaminated soil at a permitted commercial TSD facility.	Potentially applicable. Excavation is an accepted method of removing soil contamination. Retained.
		Solid Waste Disposal Facility	Disposal of landfill contents at an offsite, permitted, solid waste facility.	Potentially applicable. Excavation is an accepted method of removing soil contamination. Retained.

TABLE 3-2
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS
FEASIBILITY STUDY FOR SITES 6 AND 7
NAWC, WARMINSTER, PENNSYLVANIA

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
No Action	No Action	No action	Would not achieve remedial action objectives.	Implementable.	Capital: None O&M: None	Retained per NCP requirement.
Institutional Controls	Institutional Controls	Deed Restrictions and Local Ordinances.	Would achieve RAOs, but effectiveness depends on continued future enforcement to prevent excavation or development. No contaminant reduction of toxicity, mobility or volume.	Implementable. Deed restrictions could be put in place at time of property transfer and zoning ordinances needed to be developed for the property.	Capital: None O & M: None	Retained for possible use in conjunction with other technologies.
	Monitoring	Visual Inspections	Would allow assessment of soil cover material and vegetative cover to identify required maintenance activities to prevent direct contact exposure. No contaminant reduction of toxicity, mobility, or volume.	Readily implementable; numerous companies with personnel and equipment to perform inspection and maintenance.	Capital: Low O & M: Low	Retained for possible us in conjunction with other technologies.
Containment	Cap	Soil Cover	Would prevent direct contact exposure to contaminated soils. Would minimize erosion and surface migration of contaminated soils. No contaminant reduction of toxicity, mobility, or volume.	Implementable. Partial soil cover currently exists. Maintenance of cover is implementable using standard methods and readily available equipment.	Capital: Low O & M: Low	Retained for possible use in conjunction with other technologies.
		Single Barrier	Would prevent direct contact exposure to contaminated soils and surface migration of contaminated soils. No contaminant reduction of toxicity, mobility, or volume.	Implementable by standard construction techniques; would require specialized, but readily available, equipment and materials to install synthetic cap.	Capital: Moderate O & M: Low	Eliminated. Native soil cover currently in place. Would require unnecessary disruption and destruction of current environmental conditions with minimal increase in effectiveness compared to native soil cover.

TABLE 3-2
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS
FEASIBILITY STUDY FOR SITES 6 AND 7
NAWC, WARMINSTER, PENNSYLVANIA
PAGE 2 of 2

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
Containment (continued)		Composite (Double) Barrier	Same as single barrier. Second impermeable barrier would provide greater assurance against cover failure.	Implementable by standard construction; would require specialized equipment and materials to install double barrier cap. More care required to install than soil cover or single barrier.	Capital: High O & M: Low	Eliminated. Native soil cover currently in place. Same concerns as single barrier.
Removal	Excavation	Mechanical Excavation	Effective method for removing contaminated soils. Would reduce volume of contamination at site, but no overall reduction in toxicity, mobility, or volume.	Implementable with standard construction equipment. Equipment and resources are readily available from various contractors.	Capital: Volume dependent O & M: None	Retained.
Ex-Situ Treatment	Physical/ Chemical	Chemical Fixation/ Solidification	Effective method for stabilizing material with high levels of leachable contamination. Sites 6/7 media do not uniformly contain these high levels of contamination and leaching of contaminants has not been identified as a concern.	Implementable only after bench-scale tests and pilot studies. Requires large stockpile, treatment, and handling area.	Capital: high O&M: low	Eliminated. Nature and level of contaminants do not warrant costs. Would require disruption of current environment and placement and cover in place. Capping option more applicable.
		Size Separation	Effective in segregating rocks and potential concrete debris from contaminated media.	Implementable by standard construction excavation practices. May require washing of segregated debris.	Capital: low O&M: low	Retained for possible use in conjunction with other technologies.
Disposal	Off Site	Permitted Treatment, Storage, and Disposal (TSD) Facility	Effectively eliminates direct contact exposure potential. Materials may require treatment prior to disposal to meet land disposal requirements. May result in reduction of toxicity, mobility, and volume.	Readily implementable for moderate soil volumes. Commercial facilities are available. Implementation becomes more difficult if excavated materials require segregation or treatment prior to disposal.	Capital: Moderate O :& M: None	Retained
		Solid Waste Disposal Facility	Effectively eliminates direct contact exposure potential. Reduces volume of contamination at site, but no overall reduction in toxicity, mobility, or volume.	Readily implementable for moderate soil volumes. No implementability concerns.	Capital: Low O & M: Low	Retained

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The purpose of the alternative development and screening process is to assemble an appropriate range of possible remedial options to achieve the remedial action objectives (RAOs) identified for Sites 6 and 7. In this process, technically feasible technologies, retained for further evaluation from Section 3, are combined to form remedial alternatives that provide varying levels of risk reduction.

The alternatives developed in this section are as follows:

- No action
- Vegetated soil cover, institutional controls, monitoring, and maintenance of soil cover.
- Focused excavation, with off-site treatment and/or disposal, vegetated soil cover, and institutional controls.
- Expanded excavation, with off-site treatment and/or disposal, vegetated soil cover, and institutional controls.
- Complete excavation, with off-site treatment and/or disposal.

4.1 INTRODUCTION

Factors, considered in formulating the remedial alternatives to address the RAOs for Sites 6 and 7, are discussed below:

Protection from Surface and Subsurface Soil Contamination - The RAOs for protection of human health specify preventing human exposure under residential land use scenarios to contamination in surface and subsurface soil. The reasonable expected future land use for the site is recreational. The RAOs for the protection of human health specify preventing exposure to subsurface soils under future recreational land use. These objectives have been addressed in the formulation of remedial alternatives.

Navy/Marine Corps policy (as stated in the Installation Restoration Manual) dictates that the procedures outlined in the National Oil and Hazardous Substances Contingency Plan (NCP, 40 CFR 300.430) be followed for all IR sites. In accordance with this policy, alternative development for Sites 6 and 7 were conducted in compliance with statutory requirements of the NCP, and in consideration of the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final), (RI/FS Guidance), OSWER Directive No. 9355.3-01, EPA/540/G-89/004, October 1988.

The NCP and the EPA RI/FS guidance present a broad framework for the formulation, evaluation, and selection of remedial alternatives for uncontrolled hazardous waste sites. The NCP encourages development of a range of treatment alternatives, including one or more engineering control alternatives

(such as containment or fencing), one or more innovative treatment alternatives, and the baseline no-action alternative. Treatment technologies are favored to address principal threats and engineering controls are favored to address relatively low long-term threats.

In an effort to streamline the RI/FS process dictated by the NCP and RI/FS guidance, EPA has undertaken the presumptive remedies initiative to speed up selection of remedial actions at certain categories of waste sites. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluations of performance data on technology implementation.

Sites 6 and 7 are not well suited to the development of alternatives that apply innovative or treatment technologies. Consideration was given to these technologies and process options, but site conditions, pending property transfer, the nature and extent of contamination, and the relatively low long-term threat associated with the future land use are not conducive to their application. Similarly, the use of presumptive remedies is not well suited to Sites 6 and 7. The relative absence of VOC contamination, the nature of disposal practices, and the designated future land use, make application of presumptive remedies inappropriate or not applicable to this site.

4.2 DEVELOPMENT OF ALTERNATIVES

4.2.1 Alternative 1: No Action

No action is required for this alternative. This alternative, required by the NCP, is used as a baseline for comparison with other alternatives. For this alternative, any existing remedial activities, monitoring programs, and institutional controls would be discontinued.

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

This alternative consists of the placement and/or maintenance of a vegetated soil cover of at least 2 feet in thickness over sitewide subsurface soils, and institutional controls.

Institutional controls, including land use restrictions and excavation restrictions, would be imposed by deed restrictions, covenants, or zoning restrictions to eliminate or limit human dermal and ingestion pathways of exposure to contaminants at the site and to maintain the soil cover. Land use restrictions would prohibit residential use over sitewide surface and subsurface soils. Long-term monitoring would include periodic inspections of the area. Maintenance activities would include replacement of cover

material and vegetation as necessary. Institutional controls for previously completed removal areas could be limited to those necessary to protect the integrity of the cover in adjacent areas.

4.2.3 Alternative 3: Focused Excavation, with Off-Site Treatment/Disposal, Vegetated Soil Cover, and Institutional Controls

In addition to components of Alternative 2, this alternative also includes the focused excavation of subsurface materials and soils from two discrete areas of known contamination where the majority of materials of concern are within 6 feet of ground surface; Zone 1 and Zone 2.

Soils in excess of recreational risk-based PRGs would be excavated, transported off site, and disposed at a suitable facility. Verification sampling and analysis would be conducted to ensure that the soils left in place at the excavation limits do not exceed the PRGs. For costing purposes, PRGs for the most sensitive receptor and a conservative clean-up goal were selected. Appendix C presents the range of potentially acceptable PRGs. The excavated areas would be backfilled with clean fill. This alternative also includes the placement of clean fill material in other areas of subsidence and the placement of a minimum of 2 feet of soil cover in areas that have inadequate cover (less than 2 feet of cover at the time of remediation). The excavated, filled, and covered areas would be revegetated under this alternative.

Institutional controls, including land use restrictions and excavation restrictions would be imposed by deed restrictions, covenants, or zoning restrictions to eliminate or limit human dermal and ingestion pathways of exposure to contaminants at the site. Institutional controls for Zones 1 and 2 and other previously completed removal areas could be limited to those necessary to protect the integrity of the cover in adjacent areas. Long-term monitoring and maintenance activities would include periodic inspections of the soil cover and replacement of cover material and vegetation as necessary.

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

In addition to the components of Alternative 3, this alternative also includes the excavation and offsite treatment/disposal of known contamination of concern in Zone 3. This material presents the highest calculated potential risk at the site. However, the majority of the material of concern in Zone 3 is a discrete layer of contamination at 6 to 12 feet below ground surface. After removal of contamination within Zone 3, institutional controls for this area could also be limited to those necessary to protect the integrity of the cover in adjacent areas.

This alternative includes the excavation of soils from potential risk zones identified as Zone 1, Zone 2, and Zone 3. Soils identified at each area in excess of recreational risk-based PRGs would be excavated, transported off site, and disposed at a suitable facility. Verification sampling and analysis would be conducted to ensure that the soils left in place at the excavation limits do not exceed the PRGs. For costing purposes, PRGs for the most sensitive receptors and a clean-up goal were selected. Appendix C presents the range of potentially acceptable PRGs. The excavated areas would be backfilled with clean fill. This alternative also includes the placement of clean fill material in other areas of subsidence and the placement of a minimum of 2 feet of soil cover in areas that have inadequate cover (less than 2 feet of cover at the time of remediation). The excavated, filled, and covered areas would be revegetated under this alternative.

Institutional controls, including land use restrictions, and excavation restrictions would be imposed by deed restrictions, covenants, or zoning restrictions. Long-term monitoring and maintenance activities would include periodic inspections of the area and replacement of cover material and vegetation as necessary.

4.2.5 Alternative 5: Complete Excavation with Off-Site Treatment/Disposal

Alternative 5 was developed to evaluate a remedial option that did not require the use of institutional controls or a sitewide vegetated soil cover. This alternative represents the upper-end of the remedial alternatives as Alternative 1 represents the lower end or baseline for comparison purposes. Under this alternative, excavation would proceed until recreational and residential clean-up goals were attained. The attainment of these PRGs would allow for the release of the property with no use restrictions or encumbrances. For costing purposes, PRGs were selected to represent a conservative approach to attaining clean-up goals. Appendix C presents the full range of potentially acceptable PRGs for this alternative.

This alternative consists of the complete removal of sitewide surface soils (top 2 feet) (see Figure 2-1). This area contains surface soil contamination that presents an unacceptable potential risk to future residential receptors. In addition, sitewide subsurface soils (those in excess of the residential PRGs) would be completely excavated, transported off site, and disposed at a suitable facility. Verification sampling and analysis would be conducted to ensure that the soils left in place at the excavation limits do not exceed residential risk-based PRGs. The excavated areas would be backfilled with clean fill, seeded, and revegetated with suitable trees and shrubs.

No long-term control measures or maintenance activities are associated with this alternative.

4.3 SCREENING OF ALTERNATIVES

The EPA RI/FS process and guidelines allow for the further screening of alternatives at this stage. The purpose of the screening is to allow for the refinement or addition/deletion of alternatives based on a screening of the alternatives themselves rather than process options. In this section, alternatives are evaluated generally with regard to effectiveness, implementability, and cost to further determine the most plausible array of remedial alternatives for Site 6/7. The screening is presented in Table 4-1.

The alternatives previously described are considered to represent an appropriate range of alternatives, with all alternatives being considered effective and implementable. Therefore, all the alternatives presented will be retained for detailed analysis.

TABLE 4-1
SCREENING OF REMEDIAL ALTERNATIVES
SITES 6 and 7 FEASIBILITY STUDY
FORMER NAWC WARMINSTER

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
1	No Action	Provides no additional protection of human health. Does not reduce potential for human exposure to metals in soil or landfill contents. No reduction in toxicity, mobility, or volume of contaminants.	Readily implementable. No technical or administrative difficulties.	Capital: none O&M: none	Retained as baseline alternative in accordance with NCP. Retained.
2	Vegetated Soil Cover, Institutional Controls and Long-Term Monitoring	Provides added protection of human health under the recreational scenario through maintenance of a soil cover and institutional controls. No reduction in toxicity, mobility, or volume of contaminants.	Readily implementable. No technical or administrative difficulties.	Capital: low O&M: low	Relative to Alt. 1, provides significant additional protectiveness for little additional cost. Retained.
3	Vegetated Soil Cover, Focused Excavation, Institutional Controls, and Long-Term Monitoring	Provides added protection of human health under the recreational scenario through subsurface soil removal maintenance of a soil cover and institutional controls. Reduction of toxicity or mobility of contaminants may be accomplished by off-site treatment/disposal.	Readily implementable. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are widely available.	Capital: moderate O&M: low	Retained.
4	Vegetated Soil Cover, Expanded Excavation, Institutional Controls, and Long-Term Monitoring	Provides added protection of human health under the recreational scenario through extensive subsurface soil removal, maintenance of a soil cover, and institutional controls. Reduction of toxicity or mobility of contaminants may be accomplished by off-site treatment/disposal.	Readily implementable. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are widely available.	Capital: moderate O&M: low	Retained.
5	Complete Excavation with Off-Site Treatment/Disposal	Provides protection for all potential human health risks arising from past disposal practices, resulting in unrestricted future land use. Reduction of toxicity or mobility of contaminants may be accomplished by off-site treatment/disposal.	Readily implementable. No technical or administrative difficulties. Although this would be a large project requiring significant management and coordination, personnel and materials necessary to implement alternative are widely available.	Capital: high O&M: low	Retained

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

This section discusses the remedial alternatives outlined in Section 4.0 and analyzes these alternatives in detail in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (OSWER Directive 9355.3-01, EPA October, 1988) and the NCP (40 CFR 300).

5.2 CRITERIA FOR DETAILED ANALYSIS

The following nine criteria were used for the detailed analysis for each remedial alternative:

- Overall protection of human health and the environment
- Compliance with ARARs and TBCs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State and EPA acceptance
- Community acceptance

The nine evaluation criteria are grouped into three categories: threshold criteria, primary balancing criteria, and modifying criteria. The threshold criteria include overall protection of human health and the environment and compliance with ARARs. An alternative must achieve these criteria to be considered for selection. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These criteria are used to differentiate among alternatives during the selection process. The modifying criteria include state and community acceptance. These two criteria are not considered in the FS. The state's concerns are considered after the RI/FS comments are received, and the community's concerns are considered after comments on the proposed plan are received.

1. Overall Protection of Human Health and the Environment. The primary requirement for CERCLA remedial actions is that they be protective of human health and the environment. A remedy is

protective if it adequately eliminates, reduces, or controls all current and potential health risks. All pathways of exposure must be considered when evaluating the remedial alternative. After the remedy is implemented, if hazardous substances remain without engineering or institutional controls, then the evaluation must consider unrestricted use and unlimited exposure for human and environmental receptors. For those sites where hazardous substances remain and unrestricted use and unlimited exposure are not allowable, engineering controls, institutional controls, or some combination of the two must be implemented to control exposure and thereby ensure reliable protection over time. In addition, implementation of a remedy cannot result in unacceptable short-term risks or cross-media impacts with regard to human health and the environment.

2. Compliance with ARARs and TBCs. Compliance with ARARs and TBCs is one of the statutory requirements for remedy selection. Alternatives are developed and refined throughout the RI/FS process to ensure that they will meet all of their respective ARARs or that there is good rationale for obtaining a variance or exemption. During the detailed analysis, information on federal and state action-specific ARARs will be assessed, along with previously identified chemical-specific and location-specific ARARs. Alternatives will be refined to ensure compliance with these requirements.

3. Long-Term Effectiveness and Permanence. This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the future, and in the near term. In evaluating alternatives for their long-term effectiveness and the degree of permanence they afford, the analysis should focus on the residual risks that will remain at the site after the completion of the remedial action. This analysis should include consideration of the following:

   - Degree of threat posed by the hazardous substances remaining at the site.
   - Adequacy of any controls (e.g., engineering and institutional controls) used to manage the hazardous substances remaining at the site.
   - Reliability of those controls.
   - Potential impacts on human health and the environment should the remedy fail, based on assumptions included in the reasonable maximum exposure scenario.

4. Reduction of Toxicity, Mobility and Volume through Treatment. This criterion addresses the statutory preference for remedies that employ treatment as a principal element by ensuring that the

relative performance of the various treatment alternatives in reducing toxicity, mobility, or volume will be assessed. Specifically, the analysis should examine the magnitude, significance, and irreversibility of reductions.

5. Short-Term Effectiveness. This criterion examines the short-term impacts of the alternatives (i.e., impacts of the implementation) on the neighboring community, the workers, or the surrounding environment, including the potential threat to human health and the environment associated with excavation, treatment, and transportation of hazardous substances. The potential cross-media impacts of the remedy and the time to achieve protection of human health and the environment are also evaluated. The time required to meet RAOs is also evaluated under this criterion.

6. Implementability. Implementability considerations include the technical and administrative feasibility of the alternatives, as well as the availability of the goods and services (e.g., treatment, storage, or disposal capacity) on which the viability of the alternative depends. Implementability considerations often affect the timing of various remedial alternatives (e.g., limitations on the season in which the remedy can be implemented, the number and complexity of materials-handling steps that must be followed, the need to obtain permits for off-site activities, and the need to secure technical services such as well drilling and excavation).

7. Cost. Cost encompasses all capital costs and operation and maintenance costs incurred over the life of the project. The focus during the detailed analysis is on the net present value of these costs. Costs are used to identify the least expensive (or most cost-effective) alternative that will achieve the remedial action objectives. For purposes of calculating the present worth for the annual operating and maintenance costs, a 30-year maintenance life and a 7 percent annual discount factor are used (EPA, 1996).

8. State and EPA Acceptance. This criterion, which is an ongoing concern throughout the remediation process, reflects the statutory requirement to provide for substantial and meaningful state involvement.

9. Community acceptance. This criterion refers to the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are taken into account throughout the RI/FS process.

5.3 DESCRIPTION AND ANALYSIS OF ALTERNATIVES

This section describes and analyzes each of the alternatives that were assembled in Section 4.0. These alternatives are analyzed using the criteria described in Section 5.2.

5.3.1 Alternative 1: No Action

5.3.1.1 Detailed Description

This alternative does not involve any remedial action. This alternative is evaluated for the purpose of establishing a basis for comparison with other alternatives. In this alternative, any existing remedial activities, monitoring programs, and institutional controls would be discontinued.

5.3.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Although current risks to recreational users exposed to surface soils is within the acceptable range, this alternative offers no means to control future risks posed by subsurface contamination. The potential for COCs in the subsurface soils to enter the human exposure pathway through incidental ingestion and dermal contact continues to exist.

Compliance with ARARs and TBCs

Alternative 1 does not achieve the stated RAO of preventing human exposure by future recreational receptors to subsurface contamination. This alternative offers no means of achieving ARARs and TBCs associated with controlling, minimizing, or preventing unacceptable risks to future receptors.

Long-term Effectiveness and Permanence

Since no action would occur in Alternative 1, the potential threats to human health would remain. No measurements would be undertaken to control exposure to the subsurface soil which presents a dermal/ingestion threat to humans.

Under this alternative there are no long-term management controls for the site. Also, there would be no

long-term monitoring programs to ensure that contaminants do not present a threat.

Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative 1 does not include treatment to reduce toxicity, mobility, or volume of the hazardous substances at the site. No treatment processes would be employed, and therefore no materials would be treated or destroyed.

Short-term Effectiveness

Since no action is to occur, Alternative 1 would not pose risks to the local community or on-site workers during implementation and there would be no environmental impacts from implementation. None of the PRGs would be achieved. This alternative could be implemented immediately; however, the RAO would not be achieved.

Implementability

Implementability is not applicable because actions would not occur.

Cost

There are no costs associated with the no-action alternative.

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

5.3.2.1 Detailed Description

This alternative consists of placing/maintaining a two foot vegetated soil cover over sitewide subsurface soils. The site would be evaluated to determine where this cover is required. In addition, the area would be vegetated to control erosion and maintain the soil cover. Figure 5-1 depicts the potential areas requiring soil cover. Actual areas may vary based on field surveys.

This alternative also consists of implementing institutional controls and monitoring to eliminate or limit human dermal and ingestion exposure pathways to contaminants at the site. Land use restrictions would preclude residential use and excavation restrictions or controls would be imposed by deed restrictions,

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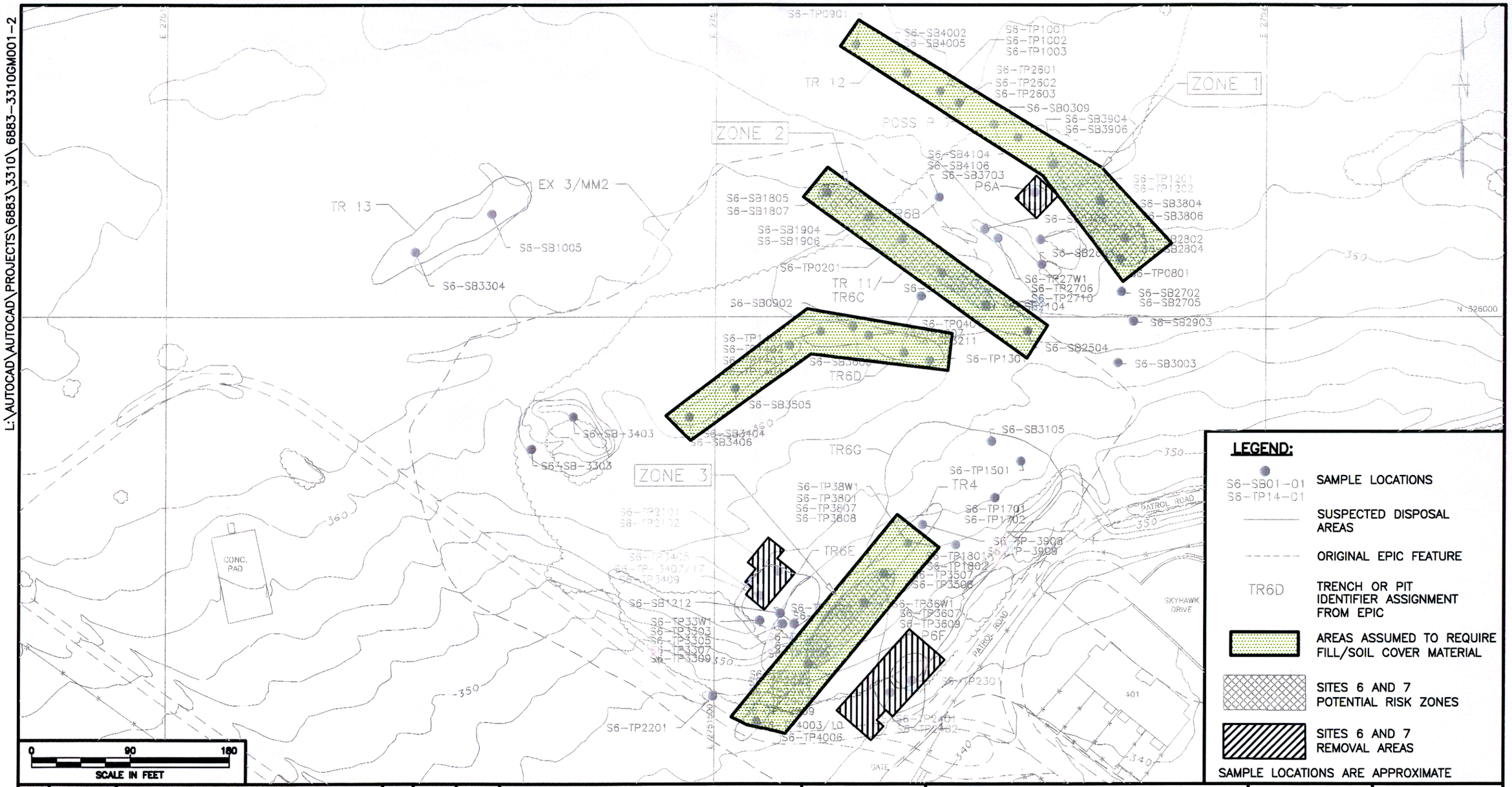

LEGEND:

- S6-SB01-01 / S6-TP14-01 — SAMPLE LOCATIONS
- SUSPECTED DISPOSAL AREAS
- ORIGINAL EPIC FEATURE
- TR6D — TRENCH OR PIT IDENTIFIER ASSIGNMENT FROM EPIC
- AREAS ASSUMED TO REQUIRE FILL/SOIL COVER MATERIAL
- SITES 6 AND 7 POTENTIAL RISK ZONES
- SITES 6 AND 7 REMOVAL AREAS

SAMPLE LOCATIONS ARE APPROXIMATE

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. CTO 0252
APPROVED BY [illegible] DATE 1/30/99
APPROVED BY DATE
DRAWING NO. FIGURE 5-1
REV. 2

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covenants, or zoning restrictions. Records on the presence, nature, and extent of contaminants would be maintained to ensure that adequate measures are implemented in the future to minimize exposure to contaminants. Long-term monitoring and maintenance would include periodic inspections of the area(s) of concern and replacement of cover material and vegetation as necessary.

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 that exceed PRGs.

Overall Protection of Human Health and the Environment

Alternative 2 is protective of human health by limiting the potential for exposure through the placement/maintenance of a vegetated soil cover and land use restrictions. Monitoring and maintenance activities would ensure the restrictions are enforced and the cover maintained.

Compliance with ARARs and TBCs

Alternative 2 achieves RAOs as developed and presented in Section 2 of this FS and complies with ARARs.

Long-Term Effectiveness and Permanence

Alternative 2 would prevent or limit exposure to contaminated media by prohibited residential use, controlling intrusive activities and by maintaining a soil cover over the contaminated media. The degree of effectiveness for this alternative would depend on the reliability and enforcement of the institutional controls and maintenance of the cover (see Implementability).

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 2 does not include treatment to reduce toxicity, mobility, or volume.

Short-Term Effectiveness

Short-term activities for Alternative 2 involve placing of fill and soil cover materials and the implementation of institutional control measures, preparation of deed restrictions, and placing notices on the property. These activities do not pose short-term risks to human health or the environment. The existing soil cover

provides short-term protection from any existing potential risk. It is anticipated that development and implementation of deed restrictions and other administrative controls may take up to one year.

Implementability

Alternative 2 includes standard construction/landscaping methods, administration of institutional controls, and monitoring and maintenance. Prior to property transfer, the Navy will be required to prepare a deed for the property. Appropriate deed restrictions or covenants, including those necessary to control excavation activities and/or establish subsurface soil excavation and soil handling protocols or requirements, would be addressed at this time during the preparation of the original document. Similarly, long-term access to the property for the purpose of conducting maintenance and/or monitoring activities could also be addressed. The Navy, through the use of operation and maintenance contracts accessible through existing contracting mechanisms, could perform routine inspections of the area. Long-term maintenance of the vegetated soil cover could be addressed by the Navy through standard contracting means with a local landscaping company. As an alternative, these needs could also be addressed through agreements with the new property owner that would be executed at the time of property transfer. In either case the Navy would be responsible for assuring that these maintenance activities and inspections were performed and documented. The Navy would retain the responsibility to conduct five-year reviews for the property.

Cost

Estimated costs for this alternative are as follows:

- 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

Appendix B presents a detailed cost estimate for this alternative.

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

In addition to the components of Alternative 2, Alternative 3 also includes the removal of materials known to exceed recreational PRGs from two subsurface soil areas, Zones 1 and 2. Known waste of concern in Zone 3, which is generally greater than 6 feet below ground surface, would remain in place.

5.3.3.1 Detailed Description

This alternative is similar to Alternative 2 in that clean fill and a soil cover would be placed throughout the site, but this alternative also includes focused excavation of Zones 1 and 2. These two zones would be excavated to remove contaminated subsurface media in known areas of subsidence and areas where concentrated contamination exceeding recreational PRGs may be relatively close to the ground surface.

This alternative consists of removing subsurface soil material, with contaminant concentrations above recreational PRGs from previously identified risk Zones 1 and 2, treating and disposing the material at an off-site location, backfilling the removal areas with clean fill, placing a minimum 2 feet of soil cover in other areas, establishing a vegetative cover, and implementing institutional controls and monitoring to eliminate or limit human, dermal, and ingestion exposure pathways to the remaining contaminants at the site. Figure 5-2 depicts the areas to be excavated as well as the potential areas requiring soil cover. Actual excavation dimensions may vary according to attainment criteria and areas requiring soil cover may vary based on field surveys at the time the remedy is implemented.

Contaminated soils would be excavated from risk 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. 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 PRGs. Appendix C, Tables 1 through 4, present a range of potentially acceptable PRGs for application under this alternative. After review of the verification sample results, 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 transported and disposed of off site at a non-hazardous waste landfill or permitted TSD facility, 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 RCRA-permitted treatment, storage, or disposal (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 OU-7, TtNUS 1999).

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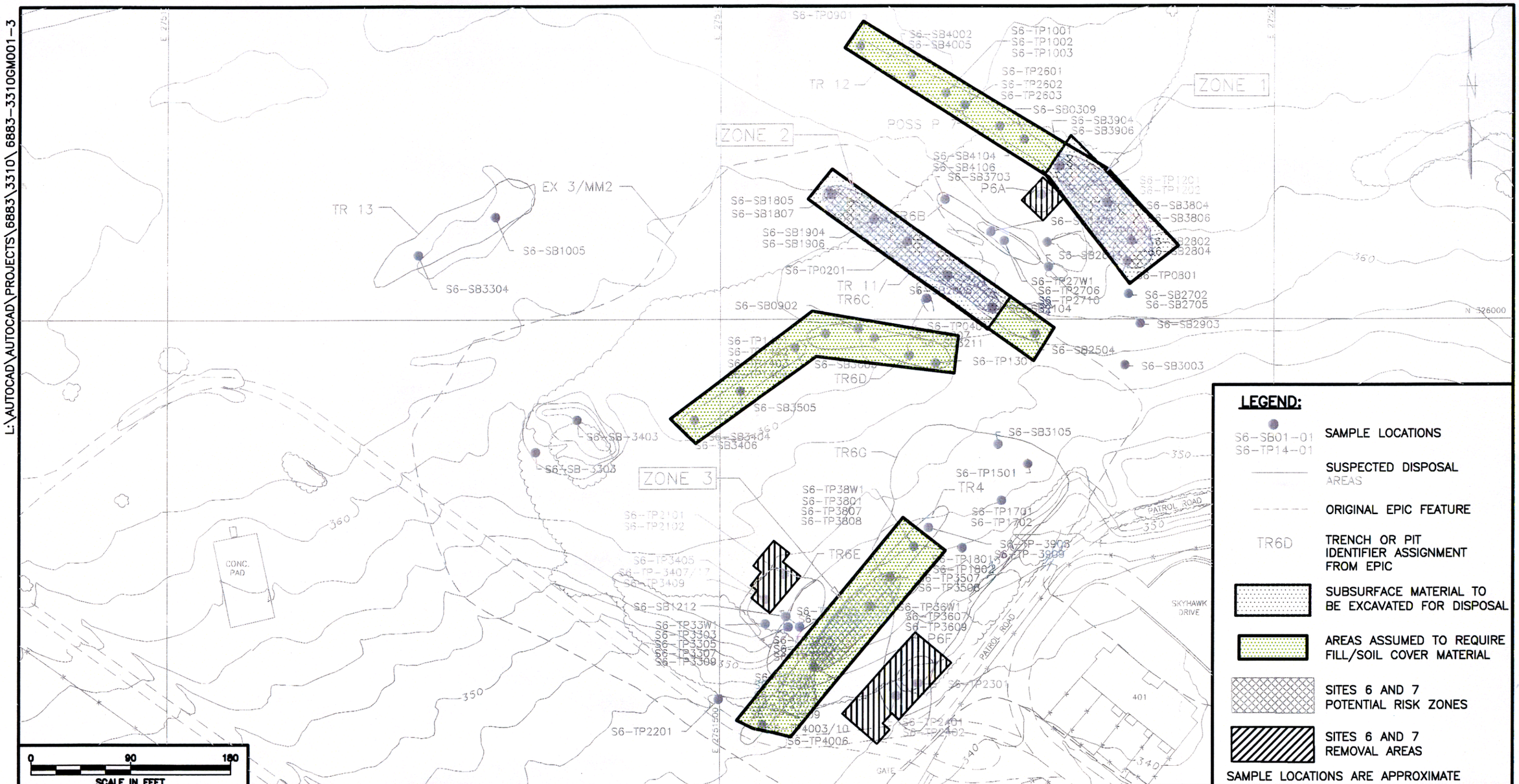

LEGEND:

- S6-SB01-01 / S6-TP14-01 — SAMPLE LOCATIONS
- SUSPECTED DISPOSAL AREAS
- ORIGINAL EPIC FEATURE
- TR6D — TRENCH OR PIT IDENTIFIER ASSIGNMENT FROM EPIC
- SUBSURFACE MATERIAL TO BE EXCAVATED FOR DISPOSAL
- AREAS ASSUMED TO REQUIRE FILL/SOIL COVER MATERIAL
- SITES 6 AND 7 POTENTIAL RISK ZONES
- SITES 6 AND 7 REMOVAL AREAS

SAMPLE LOCATIONS ARE APPROXIMATE

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. 0252
APPROVED BY [signature] DATE 4/30/99
APPROVED BY DATE
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REV. 3

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In addition to the placement of clean fill within the two excavation areas, clean fill would also be placed in areas of subsidence. A minimum 2-foot soil cover would be placed over areas where subsurface contamination exists relatively close to the ground surface and where inadequate cover (less than 2 feet of soil cover exists), and a vegetative cover would be established to protect the soil cover from erosion.

Land use restrictions, (non-residential, recreational use), restrictions on excavation and other intrusive activities, would be imposed by deed restrictions, covenants, or zoning restrictions. Records on the presence, nature, and extent of contaminants would be maintained to ensure that measures are implemented during future activities to minimize exposure to contaminants. Long-term monitoring and maintenance would include periodic inspections of the area(s) of concern and replacement of cover material and vegetation as necessary. Institutional controls for Zones 1 and 2 could be limited to those necessary to protect the integrity of the soil cover in adjacent areas.

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 remain at concentrations that exceed PRGs.

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health by reducing the potential for exposure through the removal of known subsurface soil contamination in Zone 1 and Zone 2, institutional controls and the placement and maintenance of a sitewide soil cover. The removal would address discrete areas of known contamination where the majority of the material of concern is within 6 feet of ground surface. Institutional controls could be limited for these and other areas addressed by the removal. Monitoring and maintenance activities would ensure the restrictions are enforced and the cover maintained.

Compliance with ARARs and TBCs

Alternative 3 would achieve the RAOs as developed and presented in Section 2 of this FS. In addition, the excavation and removal of contamination from Zones 1 and 2 would be directed by achieving contaminant specific PRGs developed for the protection of human health under the designated future use.

Long-Term Effectiveness and Permanence

Alternative 3 could be effective and permanent if implemented as planned. It would prevent or limit exposure to contaminated media by removal of known materials of concern within 6 feet of ground surface, by controlling intrusive activities, and maintaining a cover of clean soil over sitewide subsurface soils. The degree of effectiveness for this alternative would depend on the enforcement of the institutional controls and the maintenance of the cover material (see Implementability). By removing known subsurface materials of concerns from Zones 1 and 2, this Alternative provides an additional degree of permanence over Alternative 2.

Reduction of Toxicity, Mobility, and Volume through Treatment

Excavated materials identified as hazardous waste may be treated prior to disposal as appropriate. Approximately two percent of the total volume to be excavated is estimated to be classified as hazardous waste. Treatment, if required, would result in a reduction of toxicity and mobility but not volume.

Short-Term Effectiveness

Remedial activities are not expected to have an adverse impact on the community, workers, or the environment. Inhalation, dermal, and ingestion risks during excavation would be easily controlled through the use of dust suppression techniques, use of PPE for intrusive activities, and restricted site access. Truck routes for the transportation of the excavated material could be arranged to minimize any impact or potential impact on residential areas

It is estimated that excavation and site restoration activities at Zones 1 and 2 and placement of the soil cover would take approximately 2 months to complete. Deed restrictions and other administrative control measures may take as long as 1 year to implement.

Implementability

Excavation, transportation and disposal services for both hazardous and nonhazardous materials from Zones 1 and 2 are readily available. Landscaping services are also readily available. Institutional controls, monitoring and maintenance could be successfully implemented. Prior to property transfer, the Navy would prepare a deed for the property. Appropriate deed restrictions or covenants, including those necessary to control excavation activities and/or establish subsurface soil excavation and soil handling protocols or requirements, would be addressed at this time during the preparation of the original

document. Similarly, long-term access to the property for the purpose of conducting maintenance and/or monitoring activities could also be addressed. The Navy, through the use of operation and maintenance contracts accessible through existing contracting mechanisms, could perform routine inspections of the area. Long-term maintenance of the vegetated soil cover could be addressed by the Navy through standard contracting means with a local landscaping company. As an alternative, these needs could also be addressed through agreements with the new property owner that would be executed at the time of property transfer. In either case the Navy would be responsible for assuring that these maintenance activities and inspections were performed and documented. The Navy would retain the responsibility to conduct five-year reviews for the property.

Cost

Estimated costs for this alternative are as follows:

- 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

Appendix A presents estimated volume calculations to support this alternative. Appendix B presents a detailed cost estimate for this alternative.

5.3.4 Alternative 4: ExpandedExcavation; Off-Site Treatment/Disposal, Vegetated Soil Cover, and Institutional Controls

Alternative 4 includes removing known materials of concern from three subsurface soil areas, Zones 1, 2, and 3, to meet recreational risk based PRGs in these areas. This alternative also includes establishing a vegetated soil cover over sitewide subsurface soils administering institutional controls, monitoring, and maintenance. The additional removal of materials from Zone 3 could add to the area where the controls could be limited to those necessary to protect the integrity of the cover in adjacent areas.

5.3.4.1 Detailed Description

This alternative is similar to Alternative 3 but also includes the excavation of contaminated media associated with risk Zone 3. The excavation in this area would be expanded beyond that area identified as Zone 3 to include areas where waste material and/or contamination may have been brought close to the surface during previous site disturbances. The assumed excavation area extends from the patrol

road, where evidence suggests the sporadic presence of material close to the surface, to a point to the northwest where test pit excavations did not encounter evidence of waste material.

This alternative consists of removing subsurface material with contaminant concentrations above recreational PRGs from previously identified Zones 1, 2, and 3, treating and disposing the material at an off-site location, backfilling the removal areas with clean fill, placing a minimum of 2 feet of soil cover in other areas, establishing a vegetative cover, and implementing institutional controls and monitoring to eliminate or limit human dermal and ingestion exposure pathways to the remaining contaminants at the site. Figure 5-3 depicts the estimated areas to be excavated, as well as the potential areas requiring soil cover. Actual dimensions may vary according to attainment criteria, and areas requiring soil cover may vary based on field surveys at the time the remedy is implemented.

Contaminated soils would be excavated from Zones 1, 2, and 3, using mechanical equipment such as excavators, bulldozers, and front-end loaders. Excavation would be accomplished in accordance with OSHA requirements. Dust control measures, to be implemented as necessary, would minimize the risk of airborne contamination to the surrounding community and environment. Verification sampling would confirm that materials left in place meet the established PRGs. Appendix C, Tables 1 through 6, present a range of potentially acceptable PRGs for application to each zone. After review of the verification sample results, the excavated area would be backfilled with clean fill, graded, and revegetated. During excavation and materials handling, size separation processes would be implemented to segregate large pieces of concrete, stone, etc. for separate handling and/or disposal.

Excavated material would be transported and disposed off site at a nonhazardous waste landfill or permitted TSD facility, as appropriate. It is estimated that approximately 2 percent of the excavated materials would be classified as hazardous waste, and would require treatment and/or disposal by a RCRA-permitted TSD facility. This estimate is based on actual experience from completed removal actions at this site where two percent of the excavated material required RCRA hazardous material handling (see OU-7 RI report, TtNUS, 1999).

In addition to the placement of clean fill in the three excavation areas, clean fill would also be placed in areas of subsidence. A minimum 2-foot soil cover would be placed over areas where subsurface contamination and/or materials exist relatively close to ground surface and where existing cover is inadequate (less than 2 feet of soil cover). A field survey would be conducted at the time of the remediation to determine which areas require additional cover. A vegetative cover would be established to protect the soil cover from erosion.

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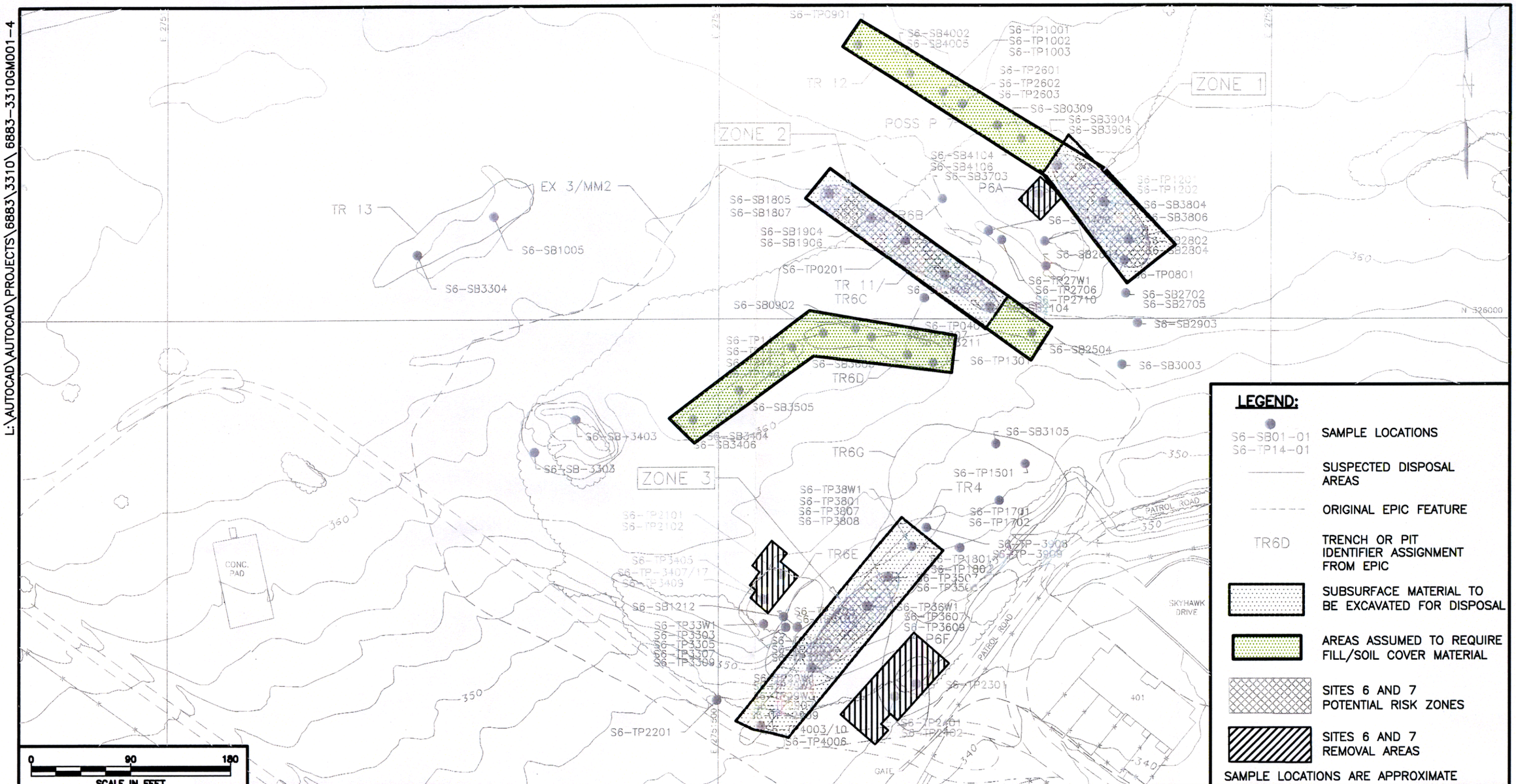

LEGEND:

S6-SB01-01 S6-TP14-01	SAMPLE LOCATIONS
	SUSPECTED DISPOSAL AREAS
	ORIGINAL EPIC FEATURE
TR6D	TRENCH OR PIT IDENTIFIER ASSIGNMENT FROM EPIC
	SUBSURFACE MATERIAL TO BE EXCAVATED FOR DISPOSAL
	AREAS ASSUMED TO REQUIRE FILL/SOIL COVER MATERIAL
	SITES 6 AND 7 POTENTIAL RISK ZONES
	SITES 6 AND 7 REMOVAL AREAS

SAMPLE LOCATIONS ARE APPROXIMATE

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

CONTRACT NO. N62472-90-D-1298
OWNER NO. CTO 0252
APPROVED BY [illegible] DATE 11/30/99
APPROVED BY DATE
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Land use restrictions (non-residential, recreational use), restrictions on excavation and other intrusive activities, would be imposed by deed restrictions, covenants, or zoning restrictions. Records on the presence, nature, and extent of contaminants would be maintained to ensure that adequate measures are implemented to minimize exposure to contaminants. Long-term monitoring and maintenance would include periodic inspections of the area(s) of concern and replacement of cover material and vegetation as necessary.

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 would remain at concentrations that exceed PRGs.

Overall Protection of Human Health and the Environment

Alternative 4 is protective of human health by reducing the potential for exposure through the removal of Zone 1, 2, and 3 subsurface soil and through the placement and maintenance of a soil cover over sidewide subsurface soils. Removal of Zones 1, 2, and 3 eliminates the most likely and highest known potential risk zones associated with future recreational use. This reduces the overall residual risk associated with the site. Land use and excavation restrictions and maintenance of the soil cover would limit exposure to sitewide subsurface soils.

Compliance with ARARs and TBCs

Alternative 4 achieves the RAOs as developed and presented in Section 2 of this FS. In addition, the excavation and removal of contamination in Zones 1, 2, and 3 will be directed by achieving contaminant specific PRGs developed for the protection of human health under the designated future use.

Long-Term Effectiveness and Permanence

Alternative 4 prevents or limits exposure to contaminated media by removal of materials most likely to present an exposure risk, by controlling intrusive activities, and by maintaining a cover of clean soil over the contaminated media remaining in place. The degree of effectiveness for this alternative will depend on the enforcement of the institutional controls and the reliability of soil cover maintenance (see Implementability). By removing known materials of concern from Zones 1, 2 and 3, this Alternative offers an additional degree of permanence over Alternatives 2 and 3.

Reduction of Toxicity, Mobility, and Volume through Treatment

Excavated materials identified as hazardous waste may be treated prior to disposal as appropriate. Approximately two percent of the total volume to be excavated is estimated to be classified as hazardous waste. Treatment, if required, would result in a reduction of toxicity and mobility, but not volume.

Short-Term Effectiveness

Remedial activities are not expected to have an adverse impact on the community, workers, or the environment. Inhalation, dermal, and ingestion risks during excavation are easily controlled through the use of dust suppression techniques, use of PPE for intrusive activities, and restricted site access. Truck routes for the transportation of the excavated material could be arranged to minimize any impact or potential impact on residential areas.

It is estimated that excavation and site restoration activities at Zones 1, 2, and 3 and placement of the soil cover would take approximately 2.5 months to complete. Deed restrictions and other administrative control measures may take as long as 1 one year to implement.

Implementability

Excavation, transportation and disposal services for both hazardous and nonhazardous materials from Zones 1, 2, and 3 are readily available. Landscaping services are also readily available. Institutional controls, monitoring and maintenance could be successfully implemented. Prior to property transfer, the Navy would prepare a deed for the property. Appropriate deed restrictions or covenants, including those necessary to control excavation activities and/or establish subsurface soil excavation and soil handling protocols or requirements, would be addressed at this time during the preparation of the original document. Similarly, long-term access to the property for the purpose of conducting maintenance and/or monitoring activities could also be addressed. The Navy, through the use of operation and maintenance contracts accessible through existing contracting mechanisms, could perform routine inspections of the area. Long-term maintenance of the vegetated soil cover could be addressed by the Navy through standard contracting means with a local landscaping company. As an alternative, these needs could also be addressed through agreements with the new property owner that would be executed at the time of property transfer. In either case the Navy would be responsible for assuring that these maintenance activities and inspections were performed and documented. The Navy would retain the responsibility to conduct five-year reviews for the property.

Cost

Estimated costs for this alternative are as follows:

- 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

Appendix A presents volume calculations to support this alternative. Appendix B presents a detailed cost estimate for this alternative.

Appendix C Tables 9 and 10 present a range of potentially acceptable PRGs for application under the residential land use scenario. Tables 7 and 8 present a similar range for future recreational land use.

5.3.5 Alternative 5: Complete Excavation; Offsite Treatment/Disposal

Alternative 5 is based on removing all surficial and subsurface materials from the area to meet recreational and residential risk based PRGs. This alternative includes no long-term institutional controls, monitoring, or maintenance since all materials would be removed from site.

5.3.5.1 Detailed Description

This alternative consists of removing all surficial and subsurface materials from the site, treating and disposing the material at an off-site location, and backfilling the removal area with clean fill. This alternative was developed to allow for the evaluation of an alternative that did not require the implementation of land use or deed restrictions.

Under this alternative, all surface soils from within the site would be excavated to a depth of 2 feet and transported off site for disposal. Surface soils within the site have been identified as presenting an unacceptable potential risk to residential receptors. Figure 5-4 depicts the area where surface soils associated with site activities exceed residential PRGs. This area is approximate and would be defined through additional sample collection and analysis during and after the removal of soils.

This alternative also includes the excavation and disposal of subsurface soils that exceed residential PRGs. The two areas that are known to contain contamination in excess of PRGs and have been identified as presenting a potential unacceptable risk to residential receptors are shown on Figure 5-4.

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 control measures, if necessary, would minimize the risk of airborne contamination to the surrounding community and environment. Verification sampling will confirm that materials left in place meet the established residential PRGs. After review of the verification sample results, 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.

Excavated material would be transported and disposed off site at a nonhazardous waste landfill or permitted TSD facility, as appropriate. It is estimated that approximately two percent of the excavated materials from Zones 1, 2, and 3 would be classified as hazardous waste and would require treatment and/or disposal by a RCRA-permitted TSD facility. The remainder of the excavated soils would be disposed as nonhazardous materials.

For cost estimating purposes, it is assumed that the areas shown on Figure 5-4 would be excavated. As noted above, the actual areas and volume of material requiring excavation and disposal may vary based on characterization and attainment sample results. Subsurface soils would be excavated to clean soil that does not exceed PRGs or to bedrock, whichever is encountered first. It is assumed, for costing purposes, that these excavations would extend to 12 feet, the average depth to competent bedrock across the site. In addition, the subsurface soil volume estimate includes the removal of the relatively small mounded area within the western portion of the site. Subsurface samples from within this mound indicate the presence of contamination in excess of residential PRGs.

Overall Protection of Human Health and the Environment

Alternative 5 is protective of human health by elimination of the potential for exposure through the removal of all contaminated media. Long-term actions, such as institutional controls, would not be required. This alternative achieves residential reuse criteria, which are more stringent than those that apply to the anticipated recreational reuse of the site.

Compliance with ARARs and TBCs

Alternative 5 would achieve the RAOs as developed and presented in Section 2 of this FS. In addition, the excavation and removal of all contaminated media will be directed by achieving contaminant specific

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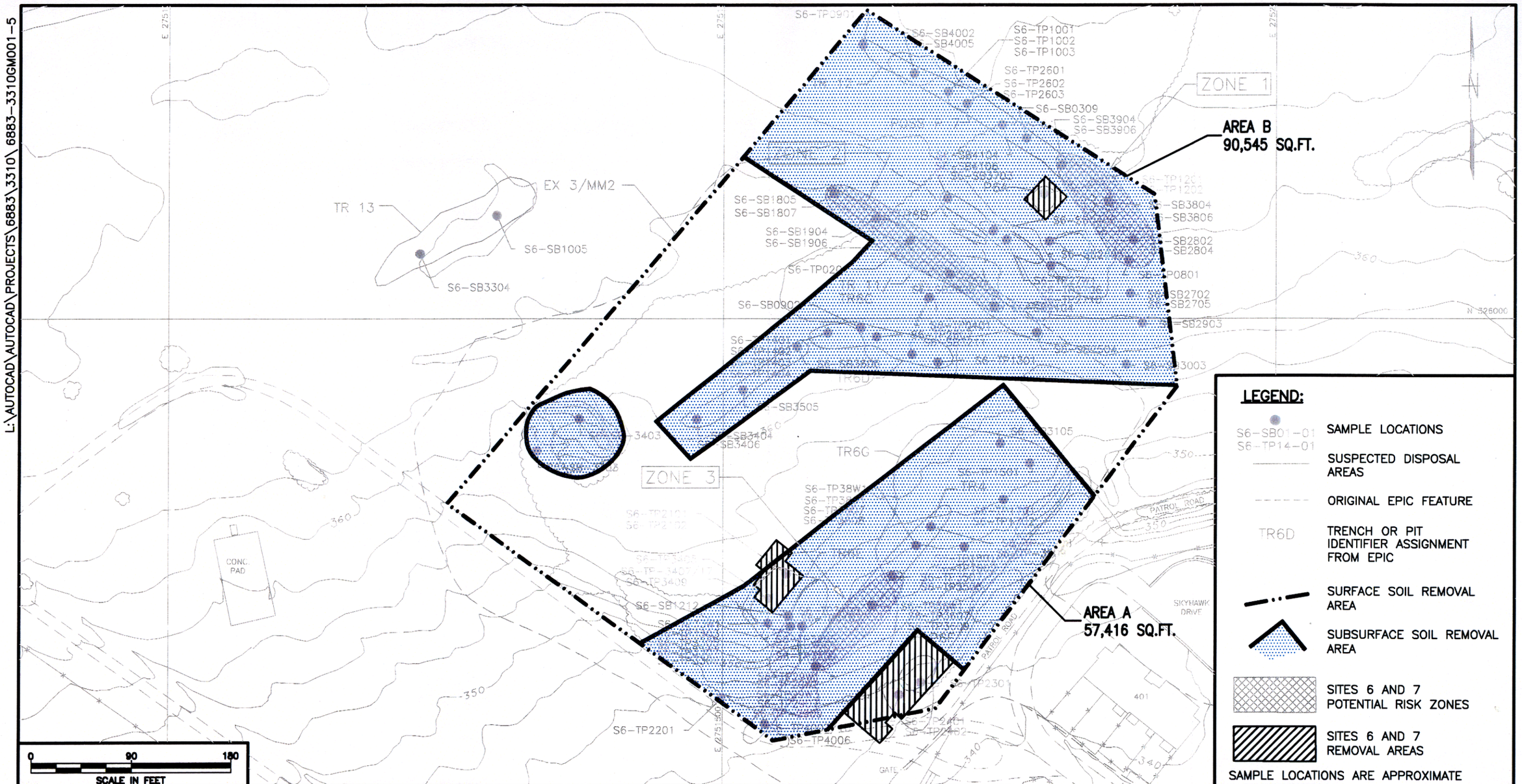

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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 0052
APPROVED BY DATE 11/30/99
APPROVED BY DATE
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PRGs established for the protection of human health under a residential re-use scenario. The level of remediation is more stringent than that required to achieve the RAOs and to support the designated future recreational use.

Long-Term Effectiveness and Permanence

Alternative 5 is effective and permanent. It prevents exposure to contaminated media at Sites 6 and 7 by removal of all contaminated materials.

Reduction of Toxicity, Mobility, and Volume through Treatment

Excavated materials identified as hazardous waste may be treated prior to off-site disposal as appropriate to comply with Federal LDRs. Approximately two percent of the total volume to be excavated is estimated to be classified as hazardous waste. Treatment, if required, would result in a reduction of toxicity and mobility but not volume.

Short-Term Effectiveness

Remedial activities are not expected to have an adverse impact on the remediation workers. Inhalation, dermal, and ingestion risks during excavation would be controlled through dust-suppression techniques, PPE, and restricted site access. Moderate risk to the community would be anticipated from increased truck/vehicle traffic and construction noise.

Complete excavation of Sites 6 and 7 would present significant disruption and destruction to the current environmental setting. The implementation of this alternative would require the destruction of existing wood lots, open fields, and transition zones. The value associated with the presence of these wood lots as buffer zones and potential recreational areas would be lost until the area was able to recover and reestablish comparable growth or cover. It is anticipated that it may take up to 20 to 30 years for the area to recover.

It is estimated that excavation and site restoration activities would take approximately 7 months to complete.

Implementability

Due to the large volume of materials that need to be handled, Alternative 5 is not considered readily implementable. Although excavation, transportation, and disposal services for both hazardous and nonhazardous materials are readily available, several providers may need to be identified for transportation and disposal services. These services from multiple providers would require detailed scheduling and coordination to avoid project impacts. Difficulties may also be encountered locating and obtaining a reliable source for the anticipated required volume of clean fill and topsoil.

Cost

Estimated costs for this alternative are as follow:

- 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

Appendix A presents volume and perimeter calculations to support this alternative. Appendix B presents detailed cost estimates for this alternative.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section provides a review of the alternatives and presents a comparative analysis of the alternatives relative to the specific evaluation criteria. Section 5 details the evaluation of each alternative as to the performance of that alternative under each criterion. This section provides for a comparison to identify the advantages and disadvantages of each alternative relative to one another. Table 6-1 presents summaries of the evaluation for each alternative.

6.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives 2 through 5 all provide protection of human health and the environment and meet the RAOs for the reasonably anticipated land use of recreation. Alternative 5 is protective of residential land use. Alternative 1 is not protective of human health under any long-term land use scenarios.

6.2 COMPLIANCE WITH ARARs

Alternatives 2, 3, 4, and 5 all can be implemented to comply with ARARs. Alternative 5 would require extensive excavation and backfilling, which would require 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. Alternative 1 would not comply with human health protection standards.

6.3 LONG-TERM EFFECTIVENESS AND PERMANANCE

Alternative 5 would result in the permanent removal of all material above human health protection criteria. This alternative would not rely on any additional controls or long-term monitoring. Alternatives 2, 3, and 4 provide a lesser degree of permanence as each alternative relies on institutional controls and regular operation and maintenance to manage residual risks. Under each Alternative, institutional controls would be implemented as necessary to maintain a soil cover over sitewide soils. 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 to recreational receptors. Alternative 4 provides a further degree of permanence, by including the removal of a third area of deeper contamination. However, the likelihood of exposure to most of known contaminated material in Zone 3 is particularly unlikely if controls, monitoring and maintenance are implemented. Alternatives 2, 3 and 4 all provide for the management of risks associated with subsurface soils through the maintenance of a soil cover and institutional controls. The long-term effectiveness of these measures depends on the enforcement of the controls and the maintenance of the cover (see

TABLE 6-1
COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
SITES 6 and 7 FEASIBILITY STUDY
FORMER NAWC WARMINSTER

CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: VEGETATED SOIL COVER, INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 3: FOCUSED EXCAVATION, VEGETATED SOIL COVER, INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 4: EXPANDED EXCAVATION, VEGETATED SOIL COVER, INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 5: COMPLETE EXCAVATION AND OFF-SITE TREATMENT/DISPOSAL
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT					
Prevent Human Exposure to Contaminated Subsurface and Surface Soils.	No action taken to prevent human exposure to contaminated soils. Existing risks would remain.	A vegetated soil cover would be maintained over existing contamination. Land use restrictions would limit potential exposure, thereby eliminating the pathways resulting in excess human health risks.	Limited subsurface soil removal would be protective by removing the potentially more accessible subsurface soils. Soil cover and land use restrictions would limit potential exposure to remaining subsurface soils, thereby eliminating the pathways resulting in excess human health risks.	Removal of additional subsurface soil above PRGs would be protective by eliminating potential human health risks from areas of potential exposure. Soil cover and land use restrictions would limit potential exposure to remaining soils, thereby eliminating the pathways resulting in excess human health risks.	Removal of all subsurface soil above residential use PRGs provides added protection by eliminating all potential excess human health risks from soils. No land use restrictions would be needed to avoid potential human health risks.
COMPLIANCE WITH ARARs					
Compliance with ARARs	No action taken to prevent human exposure to health risks from site soils.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs. Pennsylvania DEP Clean Fill requirements may be limiting factor
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Magnitude of Residual Risk	Existing risks would remain.	Existing subsurface risks would remain but would be managed and controlled.	Residual risk from remaining subsurface soil would remain, but would be managed and controlled.	Residual risk from remaining subsurface soil would remain, but would be managed and controlled.	No site-related risks would remain.
Adequacy and Reliability of Controls	No new controls implemented. Site cover soil thickness is a significant barrier to subsurface soil exposure, but with time subsurface soil could become exposed	Monitoring and maintenance activities would help ensure enforcement of land use controls and integrity of soil cover.	Limited subsurface soil removal in high risk zones would reduce the potential risk from contact with contaminated subsurface soils. Monitoring and maintenance activities would help ensure enforcement of land use controls and the integrity of the soil cover.	Removal of subsurface soil from high risk and potential risk zones would reduce the potential risk from contact with contaminated subsurface soils. Monitoring and maintenance activities would help ensure enforcement of land use controls and the integrity of the soil cover.	Removal of all subsurface soil and surface soil above PRGs permanently eliminates all potential excess human health risks.
Need for 5-Year Review	No review would be planned.	Review would be required since soil contaminants would be left in place.	Review would be required since soil contaminants would be left in place.	Review would be required since soil contaminants would be left in place.	No review would be needed.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	No reduction, since no treatment would be employed.	Off-site treatment of part of the soil removed would result in reduction in toxicity and mobility. Volume would not be reduced.	Off-site treatment of part of the soil removed may result in greater reduction in toxicity and mobility compared to Alternative 3. Volume would not be reduced.	Off-site treatment of part of the soil removed may result in greater reduction in toxicity and mobility compared to Alternative 4. Volume would not be reduced.

TABLE 6-1
COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
SITES 6 and 7 FEASIBILITY STUDY
FORMER NAWC WARMINSTER

CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 3: FOCUSED EXCAVATION ZONES 1 and 2 INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 4: FOCUSED EXCAVATION ZONES 1, 2 and 3 INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 5: COMPLETE EXCAVATION OFFSITE TREATMENT/DISPOSAL
SHORT-TERM EFFECTIVENESS					
Community Protection	No additional risk to community anticipated.	No additional risk to community anticipated.	No significant risk to community anticipated. Engineering controls would be used during implementation to mitigate risks.	No significant risk to community anticipated. Engineering controls would be used during implementation to mitigate risks.	Moderate risk in the form of increased truck traffic and noise is anticipated. Engineering controls and scheduling would be used during implementation to mitigate risks.
Worker Protection	Not applicable.	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No risk to workers anticipated if proper PPE is used during soil removal and long-term monitoring.	No risk to workers anticipated if proper PPE is used during soil removal and long-term monitoring.	No risk to workers anticipated if proper PPE is used during soil removal and long-term monitoring.
Environmental Impacts	Not applicable.	No adverse impacts to the environment anticipated.	No adverse impacts to the environment anticipated.	No adverse impacts to the environment anticipated.	Complete destruction of existing habitat may have a potential impact on area environment. It may take 20-30 years to reach full restoration.
Time Until Action is Complete	Not applicable.	Not applicable.	2 months	2.5 months	9 months.
IMPLEMENTABILITY					
Ability to Construct and Operate	No construction or operation involved.	No construction or operation involved.	No difficulties anticipated. Excavation is a readily implementable technology.	No difficulties anticipated. Excavation is a readily implementable technology.	No difficulties anticipated. Excavation is a readily implementable technology. Requires extensive disposal capabilities and significant source of clean fill material.
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	Additional actions would be easily implemented if required.	Additional soil removal would be easily implemented if required.	Additional soil removal would be easily implemented if required.	Additional soil removal would be easily implemented but unlikely required.
Ability to Monitor Effectiveness	No actions are proposed.	Monitoring would provide assessment of potential exposures, contaminant presence, migration, or changes in site conditions.	Excavation areas could be sampled for PRG attainment and remaining areas monitored the same as Alternative 2.	Same as Alternative 3.	Excavation areas could be sampled for PRG attainment.
Ability to Obtain Approvals and Coordinate with Other Agencies	None required.	Coordination for 5-year reviews may be required and would be obtainable. Would require coordination of institutional controls with local authorities.	Coordination for 5-year reviews may be required and would be obtainable. Would require coordination of institutional controls with local authorities.	Coordination for 5-year reviews may be required and would be obtainable. Would require coordination of institutional controls with local authorities.	Community resistance to the duration and (minor) inconvenience (noise and traffic) resulting from site operations would be anticipated.

TABLE 6-1
COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
SITES 6 and 7 FEASIBILITY STUDY
FORMER NAWC WARMINSTER

CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 3: FOCUSED EXCAVATION ZONES 1 and 2 INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 4: FOCUSED EXCAVATION ZONES 1, 2 and 3 INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 5: COMPLETE EXCAVATION OFFSITE` TREATMENT/DISPOSAL
IMPLEMENTABILITY (Continued)					
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	None required.	Transportation, treatment, and disposal capacity for low level metals-contaminated soils is readily available.	Transportation, treatment, and disposal capacity for low level metals-contaminated soils is readily available.	Transportation, treatment, and disposal capacity for low level metals-contaminated soils is readily available. However multiple sources may be required.
Availability of Equipment, Specialists, and Materials	None required.	Personnel and equipment available for implementation of long-term monitoring and 5- year reviews.	Ample availability of equipment and personnel to perform excavation and perform long-term maintenance, monitoring, and 5-year reviews.	Ample availability of equipment and personnel to perform excavation and perform long-term maintenance, monitoring, and 5-year reviews.	Ample availability of equipment and personnel to perform excavation. Availability of "Clean fill" may be a limiting factor without a waiver of PADEP ARAR.
Availability of Technology	Not required.	Not required.	Common construction techniques required for construction.	Common construction techniques required for construction.	Common construction techniques required for construction.
COST					
Capital Cost	---	$83,000	$1,220,000	$1,831,000	$10,636,544
Annual O&M Cost	---	$8,000	$8,000	$8,000	---
Five Year Reviews	---	$20,000	$20,000	$20,000	---
Estimated 30-Years Net Present Worth Cost*	---	$225,429	$1,362,429	$1,973,429	$10,636,544

* Present worth cost is based on discount rate of 7%.

Implementability) Alternative 1 is neither permanent nor reliable in controlling or managing site risks.

6.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

None of the alternatives contain treatment components as an integral part of the alternative. Alternative 2, 3, 4, and 5 allow for the appropriate treatment of material before final disposition at a licensed facility. None of these alternatives result in the overall reduction of toxicity, mobility or volume through a treatment process. The nature of the site, the waste materials, and the future land use are not conducive to the selection of a treatment alternative.

6.5 SHORT-TERM EFFECTIVENESS

Alternative 2 offers the shortest period to completion of the remedial actions with no additional short-term risks to the community or site workers. Alternative 3 and 4 offer slightly longer periods to completion and operational controls that would limit or manage any short-term potential risks to the community or workers. 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 requires the complete destruction of existing habitat.

6.6 IMPLEMENTABILITY

Since Alternative 1 includes no action, Implementability is not applicable.

Alternative 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, 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 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 Zones 1, 2 and/or 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 somewhat

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 uncertain and complicated.

6.7 COST

Alternative 2 is the lowest compliant cost alternative. This alternative requires minimal initial capital cost to implement and includes an ongoing O&M cost. Alternatives 3 and 4 are also compliant, but require increasing initial capital costs to implement. The annual and long-term O&M costs associated with Alternatives 3 and 4 are anticipated to be the same as Alternative 2. Alternative 5 does not require annual or long-term O&M components, but requires a significant initial cost to implement.

REFERENCES

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United States Environmental Protection Agency, 1989. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A). EPA 540/1-89/002, office of Emergency and Remedial Response, Washington, DC.

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APPENDIX A

Soil Volume Calculations

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT Warminster FS		JOB NUMBER 6883	
SUBJECT Alternative 2			
BASED ON		DRAWING NUMBER	
BY MES	CHECKED BY	APPROVED BY	DATE

Alternative 2 cover replacement
- Assume all areas require 2 ft cover

AREA TR 12 = [45' x 135' (Zone 1 area)] + [36' x 216'] = 13,851 sf

AREA TR 11/TR6C = [45' x 225' (zone 2 area)] + [27' x 45'] = 11,340 sf

ZONE 3 = 45' x 220' = 9900 sf

TR6D = 36' x 135' = 4860 sf

SW of TR6D = 36' x 135' = 4860 sf

Total Area for Cover : 44,811 sf

Cover vol = 2 ft x 44811

= 3,320 cy

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT Warminster		JOB NUMBER 6883	
SUBJECT Alternative 3			
BASED ON		DRAWING NUMBER	
BY MES	CHECKED BY	APPROVED BY GG	DATE

Zone 1

Area 45' x 135' = 6075 sf

Use avg. 12' excavation depths

Volume = 72,900 cf = 2700 cy

Zone 2

Area 45' x 225' = 10125 sf

use avg. 12' excavation depth

Volume = 121,500 cf = 4500 cy

Total Zones 1+2 = 7200 cy

For disposal estimates use 1.5 tons/cy

or 10,800 tons

Assume 2% of total is RCRA-Hazardous Waste.

For Alternative 3 10,584 tons non-haz

216 tons haz

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
Warminster	6883
SUBJECT: Alternative 3	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
MES		GG	

For backfill/restoration

Back fill

Fill excavations (7200 cy) plus cover areas not excavated with 2 ft of clean fill at TR 12, TR11/TR6C, TR6D, SW of TR6D, and zone 3

For alternative 3

Excavations -				=	7220 cy
TR12	36' x 216' x 2'	=	15,552 cf	=	576 cy
TR11/6C	27' x 45' x 2'	=	2430 cf	=	90 cy
TR6D	36' x 135' x 2'	=	9720 cf	=	360 cy
SWTR6D	36' x 135' x 2'	=	9720 cf	=	360 cy
zone 3	45' x 220' x 2'	=	19800	=	733 cy

Total Backfill required = 9339 cy

Area for cover - same as alt 2

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT		JOB NUMBER	
Warminster		6883	
SUBJECT			
Alternative 4			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE
MES		GG	

For alternative 4 add Zone 3 excavation
From previous sheets

Zone 1 + Zone 2 = 7200 cy @ 1.5 ton/cy = 10,800 tons

Zone 3 = 45' x 220' x 12' = 118,800 cf = 4400 cy

@ 1.5 ton/cy = 6600 ton

Alt 4 totals = 7200 cy + 4400 cy = 11600 cy

@ 1.5 ton/cy = 17400 ton

Assume 2% of total is RCRA Hazardous Waste

For alternative 4 17,052 tons NON-Haz

348 tons Haz.

Backfill =	11600 cy	Zones 1,2,3
	576 cy	TR12
	90 cy	TR11/6C
	360 cy	TR 6D
	360 cy	SW of TR6D
Total	12,986	

Area for Restoration cover - Same as alt 2

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT Warminster		JOB NUMBER 6883	
SUBJECT Alt. 5 Removal Areas			
BASED ON		DRAWING NUMBER	
BY MES	CHECKED BY	APPROVED BY GG	DATE

Reference Sheet for Residential Removal Scenarios

From ACAD drawings of removal areas updated 5/7/99.

For Alternative 5

Removal Areas = 90,545 sf + 57,416 sf

= 147961 sf

Perimeters = 1563 ft + 1110 ft

= 2673 ft.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT Warminster		JOB NUMBER 6883	
SUBJECT Alternative 5			
BASED ON		DRAWING NUMBER	
BY MES	CHECKED BY	APPROVED BY GG	DATE

Alternative 5

From ACAD figure for alternative

Removal Areas = 90 545 sf + 57,416 sf

= 147961 sf

Assume 2 ft soil is removed from entire (253,259 sf) area

253259 sf × 2' = 506518 cf = 18760 cy

Assume 10 ft average depth to bedrock for remaining removal areas

147961 sf × 10 ft = 1479610 cf = 54800 cy

Add small "mounded" area at western edge (SB3303)

90' × 90' × 3' = 24300 cf = 900 cy

Total = 74460 cy

@ 1.5 tons/cy = 111690 tons

Assume 2% of material excavated from Zones 1,2,3 is RCRA-Haz.

Haz = 348 tons

NON-HAZ = 111342

CALCULATION WORKSHEET Order No. 19115 (01-91)

CLIENT Warrington		JOB NUMBER 6883	
SUBJECT Verification Sampling			
BASED ON		DRAWING NUMBER	
BY MES	CHECKED BY	APPROVED BY	DATE

Alternative 3

Excavation perimeters = 2(45'+135') + 2(45'+225') = 900 ft

Assume 1 sample/50 ft = 18 samples - add 30%

use 23 samples

Alternative 4

Add perimeter of Zone 3 2(45'+220')/50 + 30% = 14

23 + 14 = 37 samples

Alternative 5A

Perimeters = 2673 ft / 50 + 1.3 = 70 samples

Surface 1 sample @ 50 ft grid spaces

Surficial Area = TOTAL AREA − Excavated area

= 253259 sf − 147961 sf = 105298 sf

105298 / 2500 sf-sample = 42 add 30%

= 55 surface samples

Total 5A = 125

APPENDIX B

Costs

ASSUMPTIONS FOR SITES 6 AND 7 FEASABILITY STUDY REPORT

1. For Alternatives 2, 3, and4, it is assumed that the following areas, if not being excavated, will require 2 foot of soil cover: TR 12, TR 11/TR 6C, Risk Zone 3, TR 6D, and the area identified southwest of TR 6D.
2. All excavation volume calculations assume an average depth to bedrock of 12 feet below ground surface.
3. For soil disposal estimates, a factor of 1.5 tons/cubic yard of soil has been assumed.
4. It is assumed that 2% of all materials excavated from Zones 1, 2, and 3, will be characterized as RCRA-Hazardous wastes. No other excavated soils have been assumed to be RCRA-Hazardous.
5. For excavation perimeter verification sampling, a factor of one sample per 50 linear feet has been used to calculate the number of verification samples required. For surface soil verification sampling, a factor of one sample per 50 foot grid space has been used.

Alternative 2

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	ANNUAL COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	83			83.00
1	0.935		8		7.48
2	0.873		8		6.99
3	0.816		8		6.53
4	0.763		8		6.10
5	0.713		8	20	19.96
6	0.666		8		5.33
7	0.623		8		4.98
8	0.582		8		4.66
9	0.544		8		4.35
10	0.508		8	20	14.23
11	0.475		8		3.80
12	0.444		8		3.55
13	0.415		8		3.32
14	0.388		8		3.10
15	0.362		8	20	10.15
16	0.339		8		2.71
17	0.317		8		2.53
18	0.296		8		2.37
19	0.277		8		2.21
20	0.258		8	20	7.24
21	0.242		8		1.93
22	0.226		8		1.81
23	0.211		8		1.69
24	0.197		8		1.58
25	0.184		8	20	5.16
26	0.172		8		1.38
27	0.161		8		1.29
28	0.150		8		1.20
29	0.141		8		1.12
30	0.131		8	20	3.68

TOTAL PRESENT WORTH = $225,429

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 1993

Alternatives 2, 3, and 4
Institutional Controls, Monitoring and Maintenance

ITEM	CAPITAL ITEMS($)	ANNUAL ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Establish Deed Restrictions Title Search, Posting	$20,000			
2. Ground Cover Inspection and Reporting		$3,000		
3. Ground Cover Maintenance		$5,000		
4. 5-year Site reviews			$20,000	Reviews performed for years 5,10,15, 20, 25, and 30

ALTERNATIVE 2

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
SITE RESTORATION												
Backfill (Common Earth)	3320	CY		4.05	0.23	0.68	0	13,446	764	2,258	16,467	022 216 4020
							0	0	0	0	0	
							0	0	0	0	0	
Lawn & Ground Cover (1000 SF)	44	MSF		340.00	92.50		0	14,960	4,070	0	19,030	12.7-411 1080
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
VERIFICATION SAMPLING												
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SITE STAFFING												
							0	0	0	0	0	
Site Superintendant	2	WK			1180.00		0	0	2,360	0	2,360	010 000 0260
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SUM OF TOTAL DIRECT COSTS							0	28,406	7,194	2,258	37,857	

ALTERNATIVE 2

	Total Cost ($)				Total Direct Cost ($)	Comments
	Sub.	Mat.	Labor	Equip.		
Previous page subtotals	0	28,406	7,194	2,258	37,857	
Burden @ 30% of Labor Cost	0	0	2,158	0	2,158	
Labor @ 10% of Labor Cost	0	0	719	0	719	
Material @ 10% of Material Cost	0	2,841	0	0	2,841	
SubContract @10% of Sub. Cost	0	0	0	0	0	
Total Direct Cost	0	2,841	2,877	0	43,575	
Indirects @ 75% of Direct Labor Cost			2,158		2,158	
Profit @ 10% of Total Direct Cost					4,358	
Total Field Cost					50,091	
Contingency @ 20% of Total Field Cost					10,018	
Engineering @ 6% of Total Field Cost					3,005	
TOTAL COST THIS PAGE					63,114	

Alternative 3

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	ANNUAL COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,220			1220.00
1	0.935		8		7.48
2	0.873		8		6.99
3	0.816		8		6.53
4	0.763		8		6.10
5	0.713		8	20	19.96
6	0.666		8		5.33
7	0.623		8		4.98
8	0.582		8		4.66
9	0.544		8		4.35
10	0.508		8	20	14.23
11	0.475		8		3.80
12	0.444		8		3.55
13	0.415		8		3.32
14	0.388		8		3.10
15	0.362		8	20	10.15
16	0.339		8		2.71
17	0.317		8		2.53
18	0.296		8		2.37
19	0.277		8		2.21
20	0.258		8	20	7.24
21	0.242		8		1.93
22	0.226		8		1.81
23	0.211		8		1.69
24	0.197		8		1.58
25	0.184		8	20	5.16
26	0.172		8		1.38
27	0.161		8		1.29
28	0.150		8		1.20
29	0.141		8		1.12
30	0.131		8	20	3.68

TOTAL PRESENT WORTH = $1,362,429

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 1993

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Alternatives 2, 3, and 4
Institutional Controls, Monitoring and Maintenance

ITEM	CAPITAL ITEMS($)	ANNUAL ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Establish Deed Restrictions Title Search, Posting	$20,000			
2. Ground Cover Inspection and Reporting		$3,000		
3. Ground Cover Maintenance		$5,000		
4. 5-year Site reviews			$20,000	Reviews performed for years 5,10,15, 20, 25, and 30

ALTERNATIVE 3

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
MOBILIZATION/DEMOBILIZATION												
Office Trailer (32' X 8') w/ Air Conditioning	2	MO		250.00			0	500	0	0	500	015 904 0700
Storage Trailer (28' X 10')	2	MO		95.00			0	190	0	0	190	015 904 1200
Construction Survey (2 men)	2	D			390.00		0	0	780	0	780	013 306 1100
Equipment Mob/demob	1	LS	1,000.00				1,000	0	0	0	1,000	
Site Utilities(elec)	2	MO		110.00			0	220	0	0	220	014 104 0650
Site Utitlities (water)	2	MO		53.00			0	106	0	0	106	014 104 0700
Site Utitlities (phone)	2	MO	230.00				460	0	0	0	460	
Utility Hook-ups (elec, phone)	1	LS	1,500.00				1,500	0	0	0	1,500	
Fire Extinguishers (10 lb)	2	EA		60.00			0	120	0	0	120	105 225 1080
Pickup Truck	2	MO				690.00	0	0	0	1,380	1,380	016 420 7200
Dumpster	2	MO	125.00				250	0	0	0	250	
Portable toilets(2)	2	MO		180.00			0	360	0	0	360	016 400 6410
SITE PREPARATION												
Clear & Grub (Cut & Chip light, trees 6" dia.)	1	AC			1,050.00	1,125.00	0	0	933	999	1,932	021 104 0010
Clearing (Heavy density brush)	0	AC			214.00	208.00	0	0	0	0	0	021 108 1080
Silt Fence	1500	LF		0.43	0.20		0	645	300	0	945	022 704 1000
Soil staging area liner(40 ML HDPE) 150ft x 150ft	22500	SF		0.47	0.52	0.08	0	10,575	11,700	1,800	24,075	33 08 0571
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
EQUIPMENT DECONTAMINATION												
Excavate & Grade (15' X 30' X 2')	35	CY			1.69	1.39	0	0	59	49	108	022 238 0310
Sand Base (1')	675	T		8.00			0	5,400	0	0	5,400	033 102 0350
Liner (40 ML HDPE)	600	SF		0.47	0.52	0.08	0	282	312	48	642	33 08 0571
Gravel, 3/4"	25	T		15.50			0	388	0	0	388	033 102 0450
							0	0	0	0	0	
Pressure Washer	2	MO				531.00	0	0	0	1,062	1,062	vendor catalogue
Submersible Pump 1-1/4", 55 gpm	2	MO				300.00	0	0	0	600	600	016 420 4500
Clean Water Tank	2	MO				120.00	0	0	0	240	240	016 420 7660
Spent Water Tank	2	MO				120.00	0	0	0	240	240	016 420 7660
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	

ALTERNATIVE 3

			Unit Cost ($)				Total Cost ($)				Total Direct Cost ($)	Comments
Item	Qty	Unit	Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.		Means® Ref. No.
EXCAVATION												
Excavate 45 CY/Hour	7200	CY			1.13	1.25	0	0	8,136	9,000	17,136	022 238 0360
Dump truck, 12 CY, Haul to stockpile 1 mi. round-trip, 3.	7200	CY			0.55	1.40	0	0	3,960	10,080	14,040	022 266 0320
							0	0	0	0	0	
Load for disposal, 3/4CY Wheel Loader,	7200	CY			0.82	0.65	0	0	5,904	4,680	10,584	022-238-1500
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SOIL DISPOSAL												
Transportation/Disposal (Bulk Soil Waste)	10800	T	50.00				540,000	0	0	0	540,000	Grow
							0	0	0	0	0	
Haz Landfill Transportation/Disposal (ChemWaste))	216	T	145.00				31,320	0	0	0	31,320	Model City
							0	0	0	0	0	
							0	0	0	0	0	
Waste Profile	2	EA	1000.00				2,000	0	0	0	2,000	
							0	0	0	0	0	
							0	0	0	0	0	
(All disposal based on 1.5tons/CY)							0	0	0	0	0	
DECON WATER												
Transportation, 2TRIPS @ 50MI	100	MI	4.02				402	0	0	0	402	33 19 0254
Disposal, NON-HAZ use 50gpd@48 days	2400	GAL	1.54				3,696	0	0	0	3,696	33 19 7302
Waste Profile	1	EA	494.71				495	0	0	0	495	33 19 0317
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	

ALTERNATIVE 3

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
SITE RESTORATION												
Backfill (Common Earth)	7200	CY		4.05	0.23	0.68	0	29,160	1,656	4,896	35,712	022 216 4020
Cover Material (Common Earth)	2139	CY		4.05	0.23	0.68	0	8,663	492	1,455	10,609	022 216 4020
							0	0	0	0	0	
Lawn & Ground Cover (1000 SF)	45	MSF		340.00	92.50		0	15,300	4,163	0	19,463	12.7-411 1080
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
VERIFICATION SAMPLING												
Sample Collection and Laboratory Analysis	23	EA	150.00	3.00	50.00	3.00	3,450	69	1,150	69	4,738	
Reporting	60	Hr		1.00	35.00	1.00	0	60	2,100	60	2,220	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SITE STAFFING												
Site Project Manager	7	WK			1250.00		0	0	8,750	0	8,750	010 000 0200
Site Superintendant	7	WK			1180.00		0	0	8,260	0	8,260	010 000 0260
Field Safety Engineer	7	WK			775.00		0	0	5,425	0	5,425	010 000 0120
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SUM OF TOTAL DIRECT COSTS							584,573	72,037	64,079	36,658	757,347	

ALTERNATIVE 3

	Total Cost ($)				Total Direct Cost ($)	Comments
	Sub.	Mat.	Labor	Equip.		
Previous page Subtotals	584,573	72,037	64,079	36,658	757,347	
Burden @ 30% of Labor Cost	0	0	19,224	0	19,224	
Labor @ 10% of Labor Cost	0	0	6,408	0	6,408	
Material @ 10% of Material Cost	0	7,204	0	0	7,204	
SubContract @10% of Sub. Cost	58,457	0	0	0	58,457	
Total Direct Cost	58,457	7,204	25,632	0	848,640	
Indirects @ 75% of Direct Labor Cost			19,224		19,224	
Profit @ 10% of Total Direct Cost					84,864	
Total Field Cost					952,728	
Contingency @ 20% of Total Field Cost					190,546	
Engineering @ 6% of Total Field Cost					57,164	
TOTAL COST THIS PAGE					1,200,437	

Alternative 4

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	ANNUAL COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,831			1831.00
1	0.935		8		7.48
2	0.873		8		6.99
3	0.816		8		6.53
4	0.763		8		6.10
5	0.713		8	20	19.96
6	0.666		8		5.33
7	0.623		8		4.98
8	0.582		8		4.66
9	0.544		8		4.35
10	0.508		8	20	14.23
11	0.475		8		3.80
12	0.444		8		3.55
13	0.415		8		3.32
14	0.388		8		3.10
15	0.362		8	20	10.15
16	0.339		8		2.71
17	0.317		8		2.53
18	0.296		8		2.37
19	0.277		8		2.21
20	0.258		8	20	7.24
21	0.242		8		1.93
22	0.226		8		1.81
23	0.211		8		1.69
24	0.197		8		1.58
25	0.184		8	20	5.16
26	0.172		8		1.38
27	0.161		8		1.29
28	0.150		8		1.20
29	0.141		8		1.12
30	0.131		8	20	3.68

TOTAL PRESENT WORTH = $1,973,429

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 1993

Alternatives 2, 3, and 4
Institutional Controls, Monitoring and Maintenance

ITEM	CAPITAL ITEMS($)	ANNUAL ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Establish Deed Restrictions Title Search, Posting	$20,000			
2. Ground Cover Inspection and Reporting		$3,000		
3. Ground Cover Maintenance		$5,000		
4. 5-year Site reviews			$20,000	Reviews performed for years 5,10,15, 20, 25, and 30

ALTERNATIVE 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
MOBILIZATION/DEMOBILIZATION												
Office Trailer (32' X 8') w/ Air Conditioning	3	MO		250.00			0	625	0	0	625	015 904 0700
Storage Trailer (28' X 10')	3	MO		95.00			0	238	0	0	238	015 904 1200
Construction Survey (2 men)	2	D			390.00		0	0	780	0	780	013 306 1100
Equipment Mob/demob	1	LS	1,000.00				1,000	0	0	0	1,000	
Site Utilities(elec)	3	MO		110.00			0	275	0	0	275	014 104 0650
Site Utitlities (water)	3	MO		53.00			0	133	0	0	133	014 104 0700
Site Utitlities (phone)	3	MO	230.00				575	0	0	0	575	
Utility Hook-ups (elec, phone)	1	LS	1,500.00				1,500	0	0	0	1,500	
Fire Extinguishers (10 lb)	3	EA		60.00			0	180	0	0	180	105 225 1080
Pickup Truck	3	MO				690.00	0	0	0	1,725	1,725	016 420 7200
Dumpster	3	MO	125.00				313	0	0	0	313	
Portable toilets(2)	3	MO		180.00			0	450	0	0	450	016 400 6410
SITE PREPARATION												
Clear & Grub (Cut & Chip light, trees 6" dia.)	1.0	AC			1,050.00	1,125.00	0	0	1,079	1,156	2,236	021 104 0010
Clearing (Heavy density brush)	0	AC			214.00	208.00	0	0	0	0	0	021 108 1080
Silt Fence	1900	LF		0.43	0.20		0	817	380	0	1,197	022 704 1000
Soil staging area liner(40 ML HDPE) 150ft x 150ft	22500	SF		0.47	0.52	0.08	0	10,575	11,700	1,800	24,075	33 08 0571
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
EQUIPMENT DECONTAMINATION												
Excavate & Grade (15' X 30' X 2')	35	CY			1.69	1.39	0	0	59	49	108	022 238 0310
Sand Base (1')	675	T		8.00			0	5,400	0	0	5,400	033 102 0350
Liner (40 ML HDPE)	600	SF		0.47	0.52	0.08	0	282	312	48	642	33 08 0571
Gravel, 3/4"	25	T		15.50			0	388	0	0	388	033 102 0450
							0	0	0	0	0	
Pressure Washer	3	MO				531.00	0	0	0	1,328	1,328	vendor catalogue
Submersible Pump 1-1/4", 55 gpm	3	MO				300.00	0	0	0	750	750	016 420 4500
Clean Water Tank	3	MO				120.00	0	0	0	300	300	016 420 7660
Spent Water Tank	3	MO				120.00	0	0	0	300	300	016 420 7660
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	

ALTERNATIVE 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
EXCAVATION												
Excavate 45 CY/Hour	11600	CY			1.13	1.25	0	0	13,108	14,500	27,608	022 238 0360
Dump truck, 12 CY, Haul to stockpile 1 mi. round-trip, 3.	11600	CY			0.55	1.40	0	0	6,380	16,240	22,620	022 266 0320
							0	0	0	0	0	
Load for disposal, 3/4CY Wheel Loader.	11600	CY			0.82	0.65	0	0	9,512	7,540	17,052	022-238-1500
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SOIL DISPOSAL												
Transportation/Disposal (Bulk Soil Waste)	17052	T	50.00				852,600	0	0	0	852,600	Waste Mngmnt.
							0	0	0	0	0	
Haz Landfill Disposal (ChemWaste))	348	T	145.00				50,460	0	0	0	50,460	ChemWaste
							0	0	0	0	0	
							0	0	0	0	0	
Waste Profile	6	EA	1000.00				6,000	0	0	0	6,000	
							0	0	0	0	0	
							0	0	0	0	0	
(All disposal based on 1.5tons/CY)							0	0	0	0	0	
DECON WATER												
Transportation, 2TRIPS @ 50MI	100	MI	4.02				402	0	0	0	402	33 19 0254
Disposal, NON-HAZ use 50gpd@66 days	3300	GAL	1.54				5,082	0	0	0	5,082	33 19 7302
Waste Profile	1	EA	494.71				495	0	0	0	495	33 19 0317
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	

ALTERNATIVE 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
SITE RESTORATION												
Backfill (Common Earth)	11600	CY		4.05	0.23	0.68	0	46,980	2,668	7,888	57,536	022 216 4020
							0	0	0	0	0	
							0	0	0	0	0	
Lawn & Ground Cover (1000 SF)	45	MSF		340.00	92.50		0	15,300	4,163	0	19,463	12.7-411 1080
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
VERIFICATION SAMPLING												
Sample Collection and Laboratory Analysis	37	EA	150.00	3.00	50.00	3.00	5,550	111	1,850	111	7,622	
Reporting	100	Hr		1.00	35.00	1.00	0	100	3,500	100	3,700	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SITE STAFFING												
Site Project Manager	10	WK			1250.00		0	0	12,500	0	12,500	010 000 0200
Site Superintendant	10	WK			1180.00		0	0	11,800	0	11,800	010 000 0260
Field Safety Engineer	10	WK			775.00		0	0	7,750	0	7,750	010 000 0120
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SUM OF TOTAL DIRECT COSTS							923,976	81,853	87,541	53,835	1,147,204	

ALTERNATIVE 4

	Total Cost ($)				Total Direct Cost ($)	Comments
	Sub.	Mat.	Labor	Equip.		
Previous page Subtotals	923,976	81,853	87,541	53,835	1,147,204	
Burden @ 30% of Labor Cost	0	0	26,262	0	26,262	
Labor @ 10% of Labor Cost	0	0	8,754	0	8,754	
Material @ 10% of Material Cost	0	8,185	0	0	8,185	
SubContract @10% of Sub. Cost	92,398	0	0	0	92,398	
Total Direct Cost	92,398	8,185	35,016	0	1,282,803	
Indirects @ 75% of Direct Labor Cost			26,262		26,262	
Profit @ 10% of Total Direct Cost					128,280	
Total Field Cost					1,437,346	
Contingency @ 20% of Total Field Cost					287,469	
Engineering @ 6% of Total Field Cost					86,241	
TOTAL COST THIS PAGE					1,811,056	

Alternative 5

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	ANNUAL COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	10,637			10637.00
1	0.935				0.00
2	0.873				0.00
3	0.816				0.00
4	0.763				0.00
5	0.713				0.00
6	0.666				0.00
7	0.623				0.00
8	0.582				0.00
9	0.544				0.00
10	0.508				0.00
11	0.475				0.00
12	0.444				0.00
13	0.415				0.00
14	0.388				0.00
15	0.362				0.00
16	0.339				0.00
17	0.317				0.00
18	0.296				0.00
19	0.277				0.00
20	0.258				0.00
21	0.242				0.00
22	0.226				0.00
23	0.211				0.00
24	0.197				0.00
25	0.184				0.00
26	0.172				0.00
27	0.161				0.00
28	0.150				0.00
29	0.141				0.00
30	0.131				0.00

TOTAL PRESENT WORTH = $10,637,000

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 1993

ALTERNATIVE 5

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
MOBILIZATION/DEMOBILIZATION												
Office Trailer (32' X 8') w/ Air Conditioning	7	MO		250.00			0	1,750	0	0	1,750	015 904 0700
Storage Trailer (28' X 10')	7	MO		95.00			0	665	0	0	665	015 904 1200
Construction Survey (2 men)	4	D			390.00		0	0	1,560	0	1,560	013 306 1100
Equipment Mob/demob	1	LS	1,000.00				1,000	0	0	0	1,000	
Site Utilities(elec)	7	MO		110.00			0	770	0	0	770	014 104 0650
Site Utitlities (water)	7	MO		53.00			0	371	0	0	371	014 104 0700
Site Utitlities (phone)	7	MO	230.00				1,610	0	0	0	1,610	
Utility Hook-ups (elec, phone)	1	LS	1,500.00				1,500	0	0	0	1,500	
Fire Extinguishers (10 lb)	3	EA		60.00			0	180	0	0	180	105 225 1080
Pickup Truck	7	MO				690.00	0	0	0	4,830	4,830	016 420 7200
Dumpster	7	MO	125.00				875	0	0	0	875	
Portable toilets(2)	7	MO		180.00			0	1,260	0	0	1,260	016 400 6410
SITE PREPARATION												
Clear & Grub (Cut & Chip light, trees 6" dia.)	2	AC			1,050.00	1,125.00	0	0	2,100	2,250	4,350	021 104 0010
Heavy density brush mowing	2	AC			214.00	208.00	0	0	428	416	844	021 108 1080
Silt Fence	6000	LF		0.43	0.20		0	2,580	1,200	0	3,780	022 704 1000
Soil staging area liner(40 ML HDPE) 150ft x 150ft	22500	SF		0.47	0.52	0.08	0	10,575	11,700	1,800	24,075	33 08 0571
							0	0	0	0	0	
							0	0	0	0	0	
BACKGROUND STUDY												
Sample Collection and Laboratory Analysis	20	EA	150.00	3.00	50.00	3.00	3,000	60	1,000	60	4,120	
Reporting	250	Hr		1.00	35.00	1.00	0	250	8,750	250	9,250	
							0	0	0	0	0	
EQUIPMENT DECONTAMINATION												
Excavate & Grade (15' X 30' X 2')	35	CY			0.68	0.92	0	0	24	32	56	022 238 0200
Sand Base (1')	675	T		8.00			0	5,400	0	0	5,400	033 102 0350
Liner (20 ML PVC)	600	SF		0.47	0.52	0.08	0	282	312	48	642	33 08 0571
Gravel, 3/4"	25	T		15.50			0	388	0	0	388	033 102 0450
							0	0	0	0	0	
Pressure Washer	7	MO				531.00	0	0	0	3,717	3,717	vendor catalogue
Submersible Pump 1-1/4", 55 gpm	7	MO				300.00	0	0	0	2,100	2,100	016 420 4500
Clean Water Tank	7	MO				120.00	0	0	0	840	840	016 420 7660
Spent Water Tank	7	MO				120.00	0	0	0	840	840	016 420 7660
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	

ALTERNATIVE 5

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
EXCAVATION												
Excavate 130 CY/Hour	78245	CY			0.39	0.94	0	0	30,516	73,550	104,066	022 238 0260
2 Dump trucks, 12 CY, Haul to stockpile 1 mi. round-trip,	3 11600	CY			1.32	3.32	0	0	15,312	38,512	53,824	022 266 0330
(-only material generated from zones 1, 2, and 3)							0	0	0	0	0	
Load for disposal, 3/4CY Wheel Loader,	78245	CY			0.46	0.49	0	0	35,993	38,340	74,333	022-238-1550
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SOIL DISPOSAL												
Transportation/Disposal (Bulk Soil Waste)	117020	T	50.00				5,851,000	0	0	0	5,851,000	Waste Mngmnt.
							0	0	0	0	0	
Haz Landfill Disposal (ChemWaste))	348	T	145.00				50,460	0	0	0	50,460	ChemWaste
							0	0	0	0	0	
							0	0	0	0	0	
Waste Profile	6	EA	1000.00				6,000	0	0	0	6,000	
							0	0	0	0	0	
							0	0	0	0	0	
(All disposal based on 1.5tons/CY)							0	0	0	0	0	
DECON WATER												
Transportation, 2TRIPS @ 50MI	100	MI		4.02			0	402	0	0	402	33 19 0254
Disposal, NON-HAZ use 50gpd@180 days	9000	GAL		1.54			0	13,860	0	0	13,860	33 19 7302
Waste Profile	1	EA		494.71			0	495	0	0	495	33 19 0317
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	

ALTERNATIVE 5

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments Means® Ref. No.
SITE RESTORATION												
Backfill (Common Earth)	78245	CY		4.05	0.23	0.68	0	316,892	17,996	53,207	388,095	022 216 4020
							0	0	0	0	0	
							0	0	0	0	0	
Lawn & Ground Cover (1000 SF)	253	MSF		340.00	92.50		0	86,020	23,403	0	109,423	12.7-411 1080
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
VERIFICATION SAMPLING												
Perimeter Sample Collection and Laboratory Analysis	70	EA	150.00	3.00	50.00	3.00	10,500	210	3,500	210	14,420	
Surface Sample Collection and Laboratory Analysis	55	EA	150.00	3.00	50.00	3.00	8,250	165	2,750	165	11,330	
Reporting	175	Hr		1.00	35.00	1.00	0	175	6,125	175	6,475	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SITE STAFFING												
Site Project Manager	31	WK			1250.00		0	0	38,750	0	38,750	010 000 0200
Site Superintendant	31	WK			1180.00		0	0	36,580	0	36,580	010 000 0260
Field Safety Engineer	31	WK			775.00		0	0	24,025	0	24,025	010 000 0120
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
							0	0	0	0	0	
SUM OF TOTAL DIRECT COSTS							5,934,195	442,749	262,023	221,342	6,860,310	

ALTERNATIVE 5

	Total Cost ($)				Total Direct Cost ($)	Comments
	Sub.	Mat.	Labor	Equip.		
Previous page Subtotals	5,934,195	442,749	262,023	221,342	6,860,310	
Burden @ 30% of Labor Cost	0	0	78,607	0	78,607	
Labor @ 10% of Labor Cost	0	0	26,202	0	26,202	
Material @ 10% of Material Cost	0	44,275	0	0	44,275	
SubContract @10% of Sub. Cost	593,420	0	0	0	593,420	
Total Direct Cost	593,420	44,275	104,809	0	7,602,813	
Indirects @ 75% of Direct Labor Cost			78,607		78,607	
Profit @ 10% of Total Direct Cost					760,281	
Total Field Cost					8,441,701	
Contingency @ 20% of Total Field Cost					1,688,340	
Engineering @ 6% of Total Field Cost					506,502	
TOTAL COST THIS PAGE					10,636,544	

Waste Management℠

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Domenic Argenti
Account Manager
Industrial Services

Waste Management℠

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October 30, 1998

Mr. Mike Snyder
TETRA TECH NUS, INC.
600 Clark Avenue, Suite 3
King of Prussia, PA 19046
610-491-9688
610-491-9645 fax

Dear Mike,

Advanced Environmental Technical Services (AETS) is pleased to provide you with this budgetary estimate for the transportation and disposal of approximately 8500 tons on nonhazardous soil and 2000 tons of hazardous soil. This is a budgetary estimate only and AETS will be able to provide firm numbers when the project work plan is developed.

AETS understands that the project is at the Naval Air Warfare Center in Warminster, PA. It also our understanding that the project is a government directed clean up. The following are the estimated unit prices and the extended values:

	TRANSPORTATION AND DISPOSAL WITH TAXES
NONHAZARDOUS SOIL	$50.00/TON
8500 TONS	ESTIMATED $425,000.00
HAZARDOUS SOIL	$110.00/TON-DIRECT LANDFILL
2000 TONS	ESTIMATED $220,000.00
	$145.00/TON-STABILIZATION
	ESTIMATED $290,000.00

I hope this information is complete and should you have any questions please free to call me at 800-423-2382. Thank you for your continued confidence in AETS and our environmental philosophies.

Sincerely,
ADVANCED ENVIRONMENTAL
TECHNICAL SERVICES

Domenic Argentieri

Domenic Argentieri
Account Manager

Printed on recycled paper

APPENDIX C

Preliminary Remediation Goals Developed For Variable Receptors and Land Uses

Site 6 and 7

NAWC Warminster, Pennsylvania

TABLE 1
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL YOUTH - ZONE 1 EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION IN MG/KG ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS* HAZARD QUOTIENT	
		0.1	1
CHROMIUM	S, K	72	720
THALLIUM	S, K, L, CNS	30.4	304

* - Noncarcinogenic cleanup levels are based on exposures for a recreational youth.
Only COCs are listed which contribute an Hazard Quotient (HQ) of at least 0.1 towards a Hazard Index (HI) of greater than 1.0 for a particular target organ.
Only the HIs for skin and kidney exceeded 1.0 for this exposure scenario.
Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System

TABLE 2
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL CHILD - ZONE 1 EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION IN MG/KG ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS*	
		HAZARD QUOTIENT	
		0.1	1
CHROMIUM	S, K	54.1	541
THALLIUM	S, K, L, CNS	7.43	74.3

* - Noncarcinogenic cleanup levels are based on exposures for a recreational child.
Only COCs are listed which contribute an HQ of at least 0.1 towards
a Hazard Index (HI) of greater than 1.0 for a particular target organ.
Only the HIs for the skin and kidney exceed 1.0 for this exposure scenario.
Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System

TABLE 3
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL YOUTH - ZONE 2 EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION IN MG/KG ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS* HAZARD QUOTIENT	
		0.1	1
ARSENIC	S	80.1	801
CADMIUM	K	66.5	665
CHROMIUM	S, K	72	720
THALLIUM	S, K, L, CNS	30.4	304

* - Noncarcinogenic cleanup levels are based on exposures for a recreational youth.
Only COCs are listed which contribute an Hazard Quotient (HQ) of at least 0.1 towards a Hazard Index (HI) of greater than 1.0 for a particular target organ.
Only the HIs for skin and kidney exceeded 1.0 for this exposure scenario.
Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System

TABLE 4
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL CHILD - ZONE 2 EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION IN MG/KG ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS* HAZARD QUOTIENT	
		0.1	1
ARSENIC	S	27.9	279
CADMIUM	K	40.2	402
CHROMIUM	S, K	54.1	541
THALLIUM	S, K, L, CNS	7.43	74.3

* - Noncarcinogenic cleanup levels are based on exposures for a recreational child.
Only COCs are listed which contribute an HQ of at least 0.1 towards
a Hazard Index (HI) of greater than 1.0 for a particular target organ.
Only the HIs for the skin and kidney exceed 1.0 for this exposure scenario.
Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System

TABLE 5
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL YOUTH - ZONE 3 EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS* HAZARD QUOTIENT	
		0.1	1
CADMIUM	K	66.5	665
CHROMIUM	S, K	72	720
THALLIUM	S, K, L, CNS	30.4	304
AROCLOR-1254	S, L, RS	3620	36200

Metals cleanup levels in mg/kg; Aroclor cleanup level in ug/kg.

* - Noncarcinogenic cleanup levels are based on exposures for a recreational youth.

Only COCs are listed which contribute an Hazard Quotient (HQ) of at least 0.1 towards a Hazard Index (HI) of greater than 1.0 for a particular target organ.

Only the HIs for skin and kidney exceeded 1.0 for this exposure scenario.

Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System, RS = Reproductive System

TABLE 6
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL CHILD - ZONE 3 EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS* HAZARD QUOTIENT	
		0.1	1
ARSENIC	S	27.9	279
CADMIUM	K	40.2	402
CHROMIUM	S, K	54.1	541
THALLIUM	S, K, L, CNS	7.43	74.3
AROCLOR-1254	S, L, RS	1540	15400

Metals Cleanup levels in mg/kg; Aroclor cleanup level in ug/kg.

* - Noncarcinogenic cleanup levels are based on exposures for a recreational child.

Only COCs are listed which contribute an HQ of at least 0.1 towards a Hazard Index (HI) of greater than 1.0 for a particular target organ.

Only the HIs for the skin and kidney exceed 1.0 for this exposure scenario.

Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System, RS = Reproductive System

TABLE 7
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL YOUTH - SITEWIDE EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION IN MG/KG ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS*	
		HAZARD QUOTIENT	
		0.1	1
CHROMIUM	S, K	72	720

* - Noncarcinogenic cleanup levels are based on exposures for a recreational youth.
Only COCs are listed which contribute an Hazard Quotient (HQ) of at least 0.1 towards a Hazard Index (HI) of greater than 1.0 for a particular target organ.
Only the HIs for skin and kidney exceeded 1.0 for this exposure scenario.
Target organs: S = Skin, K = Kidney

TABLE 8
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RECREATIONAL CHILD - SITEWIDE EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION IN MG/KG ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS*	
		HAZARD QUOTIENT	
		0.1	1
CHROMIUM	S, K	54.1	541
THALLIUM	S, K, L, CNS	7.43	74.3

* - Noncarcinogenic cleanup levels are based on exposures for a recreational child.
Only COCs are listed which contribute an HQ of at least 0.1 towards
a Hazard Index (HI) of greater than 1.0 for a particular target organ.
Only the HIs for the skin and kidney exceed 1.0 for this exposure scenario.
Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System

TABLE 9

PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE RESIDENTIAL CHILD - SITEWIDE EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION ASSOCIATED WITH ESTIMATED HAZARD QUOTIENT

NAWC WARMINSTER, PENNSYLVANIA

COC	Target Organ	NONCARCINOGENIC CLEANUP LEVELS* HAZARD QUOTIENT	
		0.1	1
ARSENIC	S	1.77	17.7
CADMIUM	K	2.68	26.8
CHROMIUM	S, K	3.7	37
MANGANESE	CNS	553	5530
MERCURY	K, CNS	0.478	4.78
SILVER	K	35.7	357
THALLIUM	S, K, L, CNS	0.464	4.64
AROCLOR-1254	S, L, RS	99.3	993

Metals cleanup levels in mg/kg; Aroclor cleanup level in ug/kg.

* - Noncarcinogenic cleanup levels are based on exposures for a residential child.

Only COCs are listed which contribute an HQ of at least 0.1 towards a Hazard Index (HI) of greater than 1.0 for a particular target organ.

Only the HIs for the skin and kidney exceed 1.0 for this exposure scenario.

Target organs: S = Skin, K = Kidney, L = Liver, CNS = Central Nervous System, RS = Reproductive System

TABLE 10
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF FUTURE LIFETIME RESIDENT - SITEWIDE EXPOSURE TO SUBSURFACE SOIL - SITE 6 CONCENTRATION ASSOCIATED WITH ESTIMATED CANCER RISK NAWC WARMINSTER, PENNSYLVANIA

COC	CARCINOGENIC CLEANUP LEVELS*		
	CANCER RISK LEVEL		
	1.00E-06	1.00E-05	1.00E-04
ARSENIC	0.269	2.69	26.9
BERYLLIUM	0.008	0.081	0.811
AROCLOR-1254	157	1570	15700
AROCLOR-1260	157	1570	15700
BENZO(A)PYRENE	87.4	874	8740
DIBENZO(A,H)ANTHRACENE	87.3	873	8730

Metals cleanup levels in mg/kg; Organics cleanup levels in ug/kg.

* - Carcinogenic cleanup levels are based on exposures for a lifetime resident.

Only COCs are listed which contribute a cancer risk of at least 1E-06 towards a cumulative cancer risk of greater than 1E-04.