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FEASIBILITY STUDY
for
SITE 13 (OU-5)

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey

Northern Division
Naval Facilities Engineering Command
Contract No. N62472-90-D-1298
Contract Task Order 300

DECEMBER 2000

TETRA TECH NUS, INC.

R-51-11-7-10

FEASIBILITY STUDY
for
SITE 13 (OU-5)

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Department, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

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Contract No. N62472-90-D-1298
Contract Task Order 300

December 2000

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Reference: Contract No. N62472-90-D-1298 (CLEAN)
Contract Task Order (CTO) No. 300

Subject: Submission of Feasibility Study for OU-5 (Final)
NWS Earle - Colts Neck, New Jersey

Dear Mr. Kolicius:

Tetra Tech NUS, Incorporated (TtNUS) is pleased to provide twelve copies of the subject document. Three copies have been sent to Jessica Mollin at EPA, Region II, three copies have been sent to Bob Marcolina at NJDEP, two copies have been sent to Greg Goepfert at NWS Earle, and four copies are enclosed for your use.

Thank you for this opportunity to submit the documents. Do not hesitate to contact me if you have any questions or require revisions.

Sincerely

Russell Turner

Russell E. Turner
Project Manager

RET/vah

c: Greg Goepfert (NWS Earle)
Jessica Mollin (EPA, Region II)
Bob Marcolina (NJDEP)
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EXECUTIVE SUMMARY

Under the Department of Defense's Installation Restoration Program, the Navy, in agreement with the United States Environmental Protection Agency (EPA) and in consultation with the state of New Jersey Department of Environmental Protection (NJDEP), is in the process of completing the remedial investigation and feasibility study (RI/FS) of 27 former known or suspected waste disposal sites at Naval Weapons Station Earle (NWS Earle), which is located in Colts Neck, New Jersey. The RI for the 27 NWS Earle sites was completed in July 1996. Additional remedial investigation activities were performed at seven of the sites to fill data gaps, and these results were presented in the RI Addendum Report, dated February 1997.

This report presents the feasibility study (FS) performed for Site 13, also designated as Operable Unit 5 (OU-5), which is the Defense Property Disposal Office (DPDO) Yard. The FS considered a range of remedial alternatives that address potential risks to human health and the environment posed by site-related contaminants identified previously under the RI. This report addresses the remedial alternatives developed for Site 13.

The remedial options developed in this document will be used by the Navy and regulators to select a preferred remedy for Site 13. A Proposed Plan will then be prepared to present the preferred remedy for public comment. After the public comment period has concluded, all questions and concerns from the public will be addressed in a Responsiveness Summary, and the selected remedy will be documented in a Record of Decision.

NWS Earle Site Summary

NWS Earle is located in Monmouth County, New Jersey, approximately 47 miles southeast of New York City (Figure 1-1). This facility was commissioned in 1943 with the primary responsibility of supplying ammunition to the Naval fleet. This station consists of an inland 10,248-acre Main Base and a 706-acre Waterfront Area connected by a right-of-way controlled by the Navy. NWS Earle was included on the National Priorities List (NPL) in October 1990.

Site 13 - Defense Property Disposal Office Yard

The DPDO yard is an area of fill material extending into a marsh near the rail classification yards (Figure 1-2). Activities at the site included storage of scrap metals and batteries and the burial of material such as cars, trucks, electronic equipment, clothing/shoes, sheet metal, furniture, scrap metal, and batteries. Additionally, batteries were broken open at the site for lead recovery, and acid was drained onto the ground. Obvious fill

material was present at the ground surface at several places across the site. A partial removal of exposed debris was performed by NWS Earle public works employees in the summer of 1997.

Regulatory History

An Initial Assessment Study conducted in 1982 identified 29 waste disposal areas at NWS Earle and led to the further investigation of 11 of those sites. Following the listing of NWS Earle on the NPL in 1990, site investigations were initiated at 16 sites. Two of the remaining sites were not included in these investigations because they were permitted to operate under the Resource Conservation and Recovery Act. In 1992, EPA requested Preliminary Assessments be performed on 17 sites. To date, the following investigations have been completed and are documented:

- Installation Restoration Program (IRP) Phase II Confirmation Study (September 1986)
- Phase II Site Inspection Study (December 1993)
- IRP RI/FS for 11 sites (September 1993)
- IRP RI for 27 sites (July 1996)
- IRP RI Addendum for 7 sites (February 1997)

Summary of Site 13 Risks

The results of the RIs were evaluated using EPA guidance and directives to gauge potential impacts from Site 13 conditions on human health and the environment. The exact procedures used for the estimation of human health risk assessment and ecological risk screening are presented in the RI report (July 1996) and Addendum RI report (January 1998).

The results of the baseline human health risk concluded that reasonable maximum exposure (RME) cancer risks estimated for future residents consuming and exposed to groundwater from beneath the site exceeded the target maximum acceptable risk range. The estimated human health risk for the future industrial (groundwater) exposure scenario was at the upper end of the target maximum acceptable risk range. Arsenic (via ingestion and dermal contact with groundwater) and vinyl chloride (via ingestion and inhalation) were the principal compounds of concern in Site 13 groundwater that contributed to the estimated cancer risks in these exposure scenarios. Noncancer risks estimated for the future residential and future industrial (groundwater) exposure scenarios exceeded 1.0, the cutoff value below which adverse noncarcinogenic effects are not expected to occur. Arsenic, cadmium, and iron were the principal compounds of concern in Site 13 groundwater that contributed to the estimated hazard indices (HIs) greater than 1.0 for this exposure scenario.

Lead concentrations encountered at Site 13 during RIs were below the EPA guideline concentrations and would not be expected to be associated with increased blood-levels based on the results of the IEUBK Lead Model (v. 0.99).

Objective of the FS

The overall objective of this FS is to develop and evaluate remedial alternatives that address contamination at Site 13. The general FS process is described below:

- Develop remedial action objectives (RAOs) that incorporate clean-up goals protective of human health and the environment. The RAOs specify the contaminants, media of interest, exposure pathways, and preliminary remediation goals. The preliminary remediation goals (numeric criteria) are developed based on chemical-specific applicable or relevant and appropriate requirements (ARARs), when available, and site-specific risk-related factors.

- Develop general response actions to address each medium of interest. Each response action may be implemented singly or in combination with other actions to satisfy the RAOs.

- Identify and screen technologies applicable to each general response action. Technologies and process options that are not technically implementable are eliminated. Representative process options for the remaining technologies are then evaluated for their effectiveness, implementability, and cost.

- Assemble and screen remedial alternatives from the retained technologies.

- Prepare a detailed analysis of individual alternatives following the criteria specified in the National Contingency Plan (NCP) and the RI/FS guidance document. Finally, compare and evaluate the alternatives.

Remedial Action Objectives (RAOs)

Based on the baseline human health risk assessment, the ecological risk assessment, and the RI results, RAOs were developed to address contaminated environmental media (soils, groundwater) present at Site 13.

Protection of Human Health RAOs

- Prevent potential human exposure to volatile organic compounds and metals in groundwater.
- Prevent contact with landfill contents.

Protection of the Environment RAO

- Minimize migration of landfill contaminants to the adjacent wetlands.
- Prevent contact with landfill contents.

Because Site 13 is a military landfill, two EPA Office of Solid Waste and Emergency Response (OSWER) directives are to be considered (TBC) guidance documents that were considered in developing remedial alternatives that employ presumptive remedies. These guidance documents are OSWER Directive 9355.0-62FS, Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance - April 1996); and OSWER Directive 93550.0-49FS, Presumptive Remedy for CERCLA Municipal Landfill Sites (September 1993).

Groundwater Fate and Transport Modeling

As part of the FS, computer modeling was performed at Site 13 to assess the fate and transport of the groundwater contaminant plume. Computer modeling was performed to assess the long-term impact of groundwater contamination and to help assess the need for groundwater response actions. The modeling was prepared using the available RI hydrogeologic data, groundwater analytical results, and chemical properties derived through literature.

Alternatives Development

Following the technology screening and detailed evaluation, remedial technologies were assembled into alternatives that address contaminated soils and groundwater and the RAOs. These alternatives provide variable levels of protection to human health and the environment, as well as variable degrees of compliance with ARARs. Remedial alternatives included no action, limited action (institutional controls), and consolidation and capping.

Site 13 Remedial Alternatives

Three remedial alternatives were developed for Site 13. A brief discussion of each alternative is included. A more detailed discussion of each alternative can be found in Section 3.1.2 of the FS.

Alternative 1: No Action

The no-action alternative was developed as a baseline to which other alternatives may be compared, as required by the NCP. No remedial actions would be taken to protect human health or the environment. The purpose of the alternative is to evaluate the overall human health and environmental protection provided by the site in its present state. Periodic reviews of site conditions, typically every 5 years, and long-term monitoring of groundwater, surface water, and sediments would be the only activities conducted under this alternative.

Alternative 2: Institutional Controls and Long-Term Monitoring

Alternative 2 relies on institutional controls to limit exposures to site-related contaminants. This alternative does not employ engineered treatment or containment to address groundwater contamination; however, the groundwater contaminant concentrations are expected to decline naturally over time through physical, biological, and chemical processes.

Institutional controls would be enacted to prohibit use of impacted groundwater. Long-term periodic monitoring would be conducted to assess the ongoing effectiveness of institutional controls to contain potential threats to human health and the environment. Since wastes would be left in place, site conditions and risks would be reviewed every 5 years.

Alternative 3: Capping, Institutional Controls, and Long-Term Monitoring

Alternative 3 relies on containment and institutional controls to limit exposures to hazardous substances and minimize migration of contaminants to groundwater and surface water. Active treatment would not be employed to address site contamination. Over time, the contaminants in groundwater would likely attenuate naturally through physical, biological, and chemical processes. Contaminant concentrations in groundwater would also decrease as a result of reduced infiltration of precipitation through contaminated landfill materials.

A low-permeability cover system that complies with federal and state regulatory requirements would be used to prevent potential human and animal contact with contaminants in landfill materials, limit contaminant leaching to groundwater, and minimize contaminant migration via surface runoff and erosion. The cover system would be installed over all former landfill areas of the site. Impacted surface soils which have been carried off-site by previous runoff or erosion would be brought back under the cover. Access restrictions would be enacted to limit future uses of the site that may result in disturbance of the cover or direct contact with contaminated media.

Long-term, periodic monitoring would be conducted to assess contaminant status and potential threats to human health and the environment. Since wastes would be left in place, site conditions and risks would be reviewed every 5 years.

Individual and Comparative Analysis of Alternatives

Detailed evaluations of remedial alternatives were performed for this FS in accordance with the requirements of the NCP and the EPA RI/FS Guidance Document. As part of the detailed analysis, the remedial alternatives were compared to identify differences and compare how site contaminant threats are addressed. The following seven criteria, as established by the NCP, were used for the detailed analysis of alternatives:

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

A detailed analysis of each alternative with respect to these seven evaluation criteria is provided in Section 4 of the FS. Two other evaluation criteria, state and community acceptance, will be addressed in the Record of Decision following the receipt of comments during the public comment period, after the Proposed Plan has been presented to the public.

1.0 INTRODUCTION AND BACKGROUND INFORMATION

This feasibility study (FS) report presents an executive summary (preceding this section), a summary of previous investigations for the site (Section 1.0), identification and screening of remedial technologies (Section 2.0), development and screening of remedial action alternatives (Section 3.0), and a detailed analysis of the alternatives, including a no-action alternative (Section 4.0).

Section 1.0 consists of an overview of Naval Weapons Station (NWS) Earle operations and regional environmental settings. A summary of previous investigative activities and results and a discussion of human health and ecological risks for the site have also been presented. For a full understanding of site conditions, the Final Remedial Investigation (RI) Report, July 1996, and the Remedial Investigation Addendum (RIA) Report, February 1997, must be reviewed. The RI and RIA reports are essential companion documents to this FS because they were prepared as part of the prescribed CERCLA RI/FS development procedure.

Section 2.0 provides a discussion on potential chemical-specific, location-specific, and action-specific applicable or relevant and appropriate requirements (ARARs) and other guidance to be considered (TBCs). This section also addresses remedial action objectives (RAOs), preliminary remedial goals (PRGs), and general response actions. RAOs and PRGs are addressed on a site-specific basis for the identification, screening, and evaluation of remedial technologies and process options. Selected site-specific remedial options are also presented.

Selected remedial alternatives for the site are addressed in Section 3.0. The rationale for selection of the alternatives and a description of each alternative, including a no-action alternative, are presented.

Section 4.0 provides a detailed analysis and comparison of the alternatives discussed in Section 3.0.

1.1 SITE DESCRIPTION AND SETTING

This FS report includes a discussion of remedial alternatives for Operable Unit 5 (OU-5), which includes Site 13 [Defense Property Disposal Office (DPDO) Yard]. The OU-5 site is located within the Mainside area of NWS Earle.

NWS Earle is located in Monmouth County in east-central New Jersey. It is situated on approximately 11,134 acres and includes a Mainside area, which is approximately 10 miles inland from the Atlantic Ocean at Sandy Hook Bay, and a Waterfront area, which includes an ammunition depot and associated piers. The Mainside and Waterfront areas are linked by a narrow tract of land that serves as a right-of-way for a

government road and railroad. Figure 1-1 shows the Mainside area Installation Restoration (IR) program sites, including Site 13.

The main entrance to NWS Earle is located off State Route 34, and the entrance to the Waterfront area is located adjacent to State Route 36.

An estimated 2,500 people reside and/or work at NWS Earle. The total population of Monmouth County is approximately 550,000. Colts Neck Township, which is the location of the Mainside facility, has a total population of approximately 8,560 people. Middletown Township, which is the location of the Waterfront area, has a total population of approximately 68,200 people (United States Department of Commerce, 1990).

The majority of the land at the Mainside area is undeveloped land associated with ordnance operations, production, and storage facilities; the undeveloped land is encumbered by explosive safety quantity distance (ESQD) arcs. Land use at the Mainside facility includes residences, office buildings, workshops and warehouses, recreational areas, open space, and undeveloped land. The area around the Mainside facility includes agricultural areas, vacant land, and low-density residential land.

NWS Earle is located in the coastal lowlands of Monmouth County, New Jersey, within the Atlantic Coastal Plain Physiographic Province. The Mainside area, which includes the site included in OU-5, lies in the outer Coastal Plain, approximately 10 miles inland from the Atlantic Ocean. The Mainside area is relatively flat, with elevations ranging from approximately 100 to 300 feet above mean sea level (MSL). The most significant topographic relief within the Mainside area is Hominy Hills, a northeast-southwest-trending group of low hills located near the center of the station.

The rivers and streams draining NWS Earle ultimately discharge to the Atlantic Ocean, which is approximately 9 or 10 miles east of the Mainside area. The headwaters and drainage basins of three major Coastal Plain rivers (Swimming, Manasquan, and Shark) originate on the Mainside area. The northern half of the Mainside is in the drainage basin of the Swimming River, and tributaries include Mine Brook, Hockhockson Brook, and Pine Brook. The southwestern portion of the Mainside drains to the Manasquan River via either Marsh Bog Brook or Mingamahone Brook. The southeastern corner of the Mainside drains to the Shark River. Both the Swimming River and the Shark River supply water to reservoirs used for public water supplies. Site-specific hydrology is discussed in Section 1.3.

NWS Earle is situated in the Coastal Plain Physiographic Province of New Jersey. The New Jersey Coastal Plain is a seaward-dipping wedge of unconsolidated Cretaceous to Quaternary sediments that were deposited on a pre-Cretaceous basement-bedrock complex. The Coastal Plain sediments are primarily composed of clay, silt, sand, and gravel and were deposited in continental, coastal, and marine

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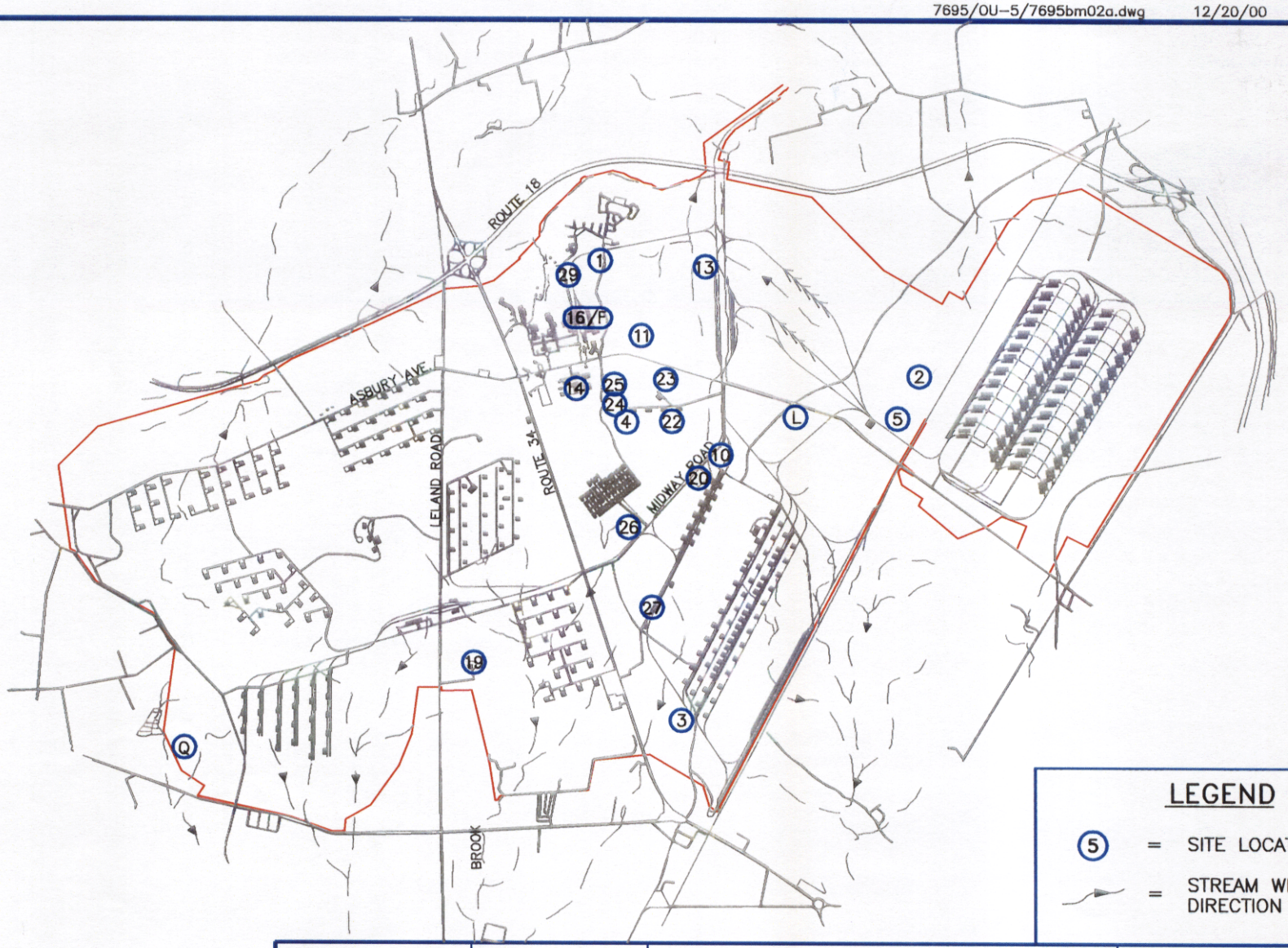

LEGEND

(5) = SITE LOCATION

= STREAM WITH FLOW DIRECTION

0 5,000 10,000

SCALE IN FEET

DRAWN BY LDL	DATE 12/20/00	Tetra Tech NUS, Inc.	MAINSIDE SITE LOCATIONS NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE AS SHOWN			

CONTRACT NO. 7695	
OWNER NO. 0200	
APPROVED BY	DATE
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environments. The sediments generally strike northeast-southwest and dip to the southeast at a rate of 10 to 60 feet per mile. The approximate thickness of these sediments beneath NWS Earle is 900 feet. The pre-Cretaceous complex consists mainly of PreCambrian and lower Paleozoic crystalline rocks and metamorphic schists and gneisses. The Cretaceous to Miocene Coastal Plain Formations are either exposed at the surface or subcrop in a banded pattern that roughly parallels the shoreline. The outcrop pattern is caused by the erosional truncation of the dipping sedimentary wedge. Where these formations are not exposed, they are covered by essentially flat-lying post-Miocene surficial deposits. Site-specific geology and soils are discussed in the site summary section (Section 1.3).

Groundwater classification areas were established in New Jersey under New Jersey Department of Environmental Projection (NJDEP) Water Technical Programs Groundwater Quality Standards in New Jersey Administrative Code (N.J.A.C.) 7:9-6. The Mainside area is located in the Class II-A: Groundwater Supporting Potable Water Supply area. Class II-A includes those areas where groundwater is an existing source of potable water with conventional water supply treatment or is a potential source of potable water. In the Mainside area, in general, the deeper aquifers are used for public water supplies and the shallower aquifers are used for domestic supplies.

The Coastal Plain sediments are the most important source of potable water in the Coastal Plain of New Jersey, with wells supplying greater than 75 percent of the potable water supply. Water-supply problems associated with the increased demand for groundwater in the Coastal Plain include decreased groundwater levels and the induced recharge of fresh, brackish, or saline water from surface water or adjacent aquifers. The five principal Coastal Plain aquifers are the

- Kirkwood-Cohansey aquifer system
- Atlantic City 800-foot sand
- Wenonah-Mount Laurel aquifer system
- Englishtown aquifer
- Potomac-Raritan-Magothy aquifer system

Minor Coastal Plain aquifers include the

- Piney Point aquifer
- Vincentown aquifer
- Red Bank Sand aquifer

The five principal aquifers are capable of yielding large quantities of water for public supply use. The minor aquifers generally yield small to moderate quantities of water in or near their outcrop areas. All the Coastal Plain aquifers except the Kirkwood-Cohansey aquifer system are confined to semi-confined, except where

they crop out or are overlain by permeable surficial deposits. Increased groundwater withdrawals have produced large regional cones of depression in the major artesian aquifers.

The OU-5 site is situated in the recharge area of the Kirkwood-Cohansey aquifer system. The Kirkwood-Cohansey aquifer system is a source of water in Monmouth County and is composed of the generally unconfined sediments of the Cohansey Sand and Kirkwood Formation. The Kirkwood-Cohansey aquifer system has been reported in previous investigations as being used for residential wells in the Mainside area. Along the coast, this aquifer system is underlain by thick diatomaceous clay beds of the Kirkwood Formation.

All facilities located in the Mainside Administration area are connected to a public water supply (New Jersey American Water Company). Water for the public supply network comes from surface water intakes, reservoirs, and deep wells. No public water supply wells or surface water intakes are located on the NWS Earle facility. A combination of private wells and public water supply from the New Jersey American Water Company serves businesses and residences in areas surrounding the Mainside facilities. There are a number of private wells located within a 1-mile radius of NWS Earle and several within the NWS Earle boundaries. The majority of these wells are used for potable supplies; previous testing for drinking water parameters indicates these wells have not been adversely impacted.

There is a rich diversity of ecological systems and habitats at NWS Earle. Knieskern's beaked-rush (Rynchospora knieskernii), a sedge species on the federal and New Jersey State endangered lists, has been seen on the station, and the swamp pink (Helonias bullata), also on the federal and New Jersey State endangered lists, may be present. An osprey has visited Mainside and may nest in another area at NWS Earle. The Mingamahone Brook supports bog turtles downstream of the Mainside area and provides an appropriate habitat for them at the Mainside area.

Resources and habitats of the drainage potentially impacted by sites investigated in the RI were summarized as follows [Source: National Oceanic and Atmospheric Administration (NOAA) in a letter from EPA Region II dated August 19, 1992, signed by Paul G. Ingrisano, project manager]:

- Manasquan River - Mingamahone Brook and East Branch of Mingamahone Brook
  - American eel, alewife, white perch, and blueback herring are likely present in the upper reaches of the Manasquan River and may migrate to Mingamahone Brook.
- Swimming River - Pine Brook and Hockhockson Brook
  - Hockhockson and Pine Brooks originate within NWS Earle. Hockhockson Brook joins Pine Brook north of the facility. Pine Brook discharges to the Swimming River

about 2 kilometers below the Swimming River Reservoir. Swimming River is tidally influenced below its confluence with Pine Brook and flows from there about 4 kilometers to the Navesink River.

- Alewife and blueback herring are known to migrate in the Swimming River and have been sampled in Pine Brook. Their presence in Hockhockson Brook is expected.

- Navesink River

  - The Navesink River is a tidal embayment. NOAA trust species present in the Navesink River include striped bass, alewife, blueback herring, menhaden, bluefish, American eel, blue crab, and sea lamprey. Resource utilization is believed to be limited to foraging activity, with the exception of winter flounder and blue crab spawning.

- McClees Creek

  - McClees Creek flows about 5 kilometers to the Navesink River. The creek has not been studied but is free-flowing and could provide habitat for blueback herring, alewife, American eel, white perch, and blue crab.

An ecological risk assessment was performed for the site; results are discussed in Section 1.3.

1.2 SITE OPERATING HISTORY

NWS Earle was commissioned as a Naval Ammunition Depot on December 13, 1943, with the primary responsibility of furnishing ammunition to the Naval fleet. The station's Ordnance Department coordinates all port services and logistic support for home-ported and visiting ships, conducts safety inspections, supervises ammunition loading for the United States Coast Guard, and provides afloat firefighting capability and standby tug services. Other major active divisions include the Ammunition Distribution and Control Division, responsible for ensuring that a balanced, purified stock of ammunition is maintained in support of Navy, Coast Guard, and Marine Corps programs; the Operations Division, which performs ammunition movement, ship loading, demilitarization of obsolete ammunition, and reclaiming/renovation of various munitions; the Anti-Submarine Warfare (ASW) and Special Weapons Division, which plans and carries out station-level maintenance of air and antisubmarine weapons and provides shore-based support to various commands,

and the Port Services Division, responsible for operating the station fireboat, service craft, and oil pollution containment equipment.

Over 90 percent of the acreage at NWS Earle is dedicated to its primary mission of storage and delivery of ordnance. The actual amount of land used for storage and distribution facilities is much less than this, but ESQD arcs are established around each facility. Any development within these arcs is extremely restricted by safety requirements. The formal disestablishment or reclassification of a facility is required before any development can occur within an ESQD arc.

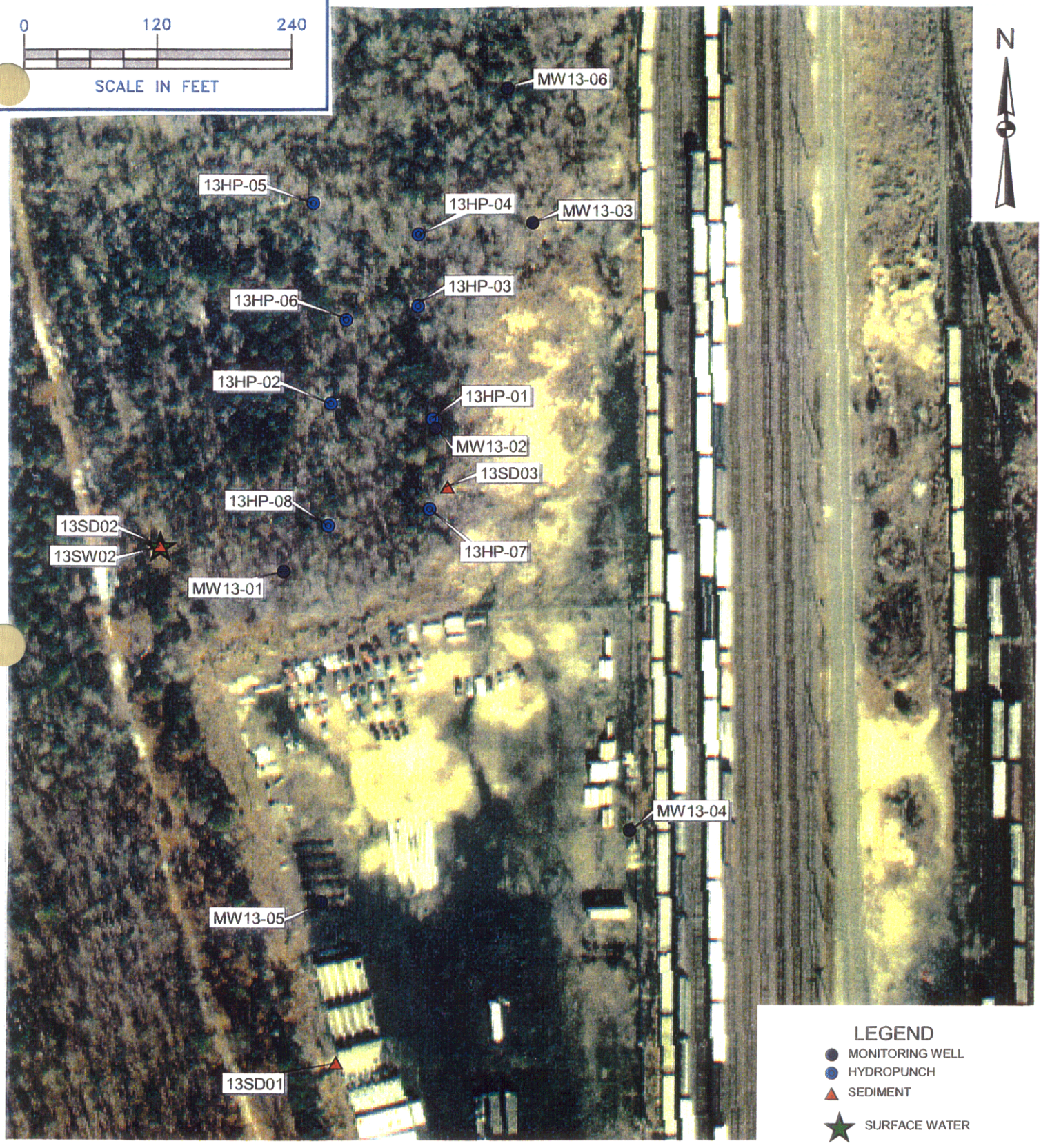
Two areas of NWS Earle, the Mainside Administration and Housing area and the Waterfront Administrative area, are not encumbered by ESQD arcs. These areas are used for offices, base support, housing, and recreational facilities. Any future development would be expected to occur in one of these areas unless the development had an ordnance-specific use. Sites 1, 14, 16, and 29 are within the Mainside Administration and Housing area. Sites 6, 12, 15, and 17 are within the Waterfront Administration area. None of these sites are included in OU-5. Future land use is not expected to vary significantly from current land use unless a major base realignment were to occur. If this were to happen, an Environmental Baseline Survey would be conducted to evaluate the impact of any proposed land-use change.

Site 13 is located at least partially within ESQD arcs. Therefore, future development at this site is severely restricted.

The DPDO yard is an area of fill material extending into a marsh near the rail classification yards (Figure 1-2). Activities at the site included storage of scrap metals and batteries and the burial of material, such as cars, trucks, electronic equipment, clothing/shoes, sheet metal, furniture, scrap metal, and batteries. Additionally, batteries were broken open at the site for lead recovery, and acid was drained onto the ground. Since the primary function of this site was scrap metal storage, it is highly unlikely that any unexploded ordnance (UXO) would be present in the fill material. Ordnance handling only occurs within specifically designated areas of NWS Earle. Obvious fill material is present at the ground surface at several places across the site. A partial removal of exposed debris was performed by NWS Earle public works employees in the summer of 1997.

1.3 SITE INVESTIGATION SUMMARY

Site investigation activities related to areas of potential environmental concern at NWS Earle have been undertaken by the Navy since approximately 1982. Early work included an Initial Assessment Study (IAS) conducted by Fred C. Hart and Associates; the results are included in a report prepared in 1982. Studies and field investigation efforts continued under the Installation Restoration Program (IRP) by Roy F. Weston,



DRAWN BY DL DATE 12/20/00	Tetra Tech NUS, Inc.	SAMPLE LOCATIONS SITE 13 – DPDO YARD NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY	CONTRACT NO. 7695
CKED BY DATE			OWNER NO. 0200
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1–2 REV.

Incorporated. Several documents prepared by Weston were submitted to the Navy, NJDEP, and the United States Environmental Protection Agency (EPA). These documents include the Draft Report for Naval Weapons Station Earle, Colts Neck, New Jersey, IRP Phase II Confirmation Study, dated September 1986; the Draft Report of Current Situation and Draft Plan of Action, dated December 1988; an IRP Phase II Site Inspection Work Plan dated September 1991; a Draft Phase II Site Inspection Study for Naval Weapons Station Earle, Colts Neck, New Jersey, dated February 1993; and a final version of the SI report, dated December 1993. In addition, in September 1993, Weston submitted the Installation Restoration Program Remedial Investigations/Feasibility Study for 11 Sites at NWS Earle, Colts Neck, New Jersey, Volumes 1 to 3.

In 1995-96, Brown & Root Environmental (B&R Environmental) conducted a RI for 27 sites at NWS Earle. The RI included field investigations performed in 1995 and a review of data generated during previous investigations. Field investigations included a determination of base-wide background conditions. The final RI report was prepared in July 1996. Results of the RI indicated that further RI data collection activities were required at seven sites. The results of the additional RI data collection activities are presented in the draft RI Addendum Report, dated February 1997.

Results of the background determination and previous investigations for Site 13 are discussed below.

1.3.1 Background Sampling

In order to determine the background level of chemicals present in and around NWS Earle, B&R Environmental collected samples from media at locations on the station that were selected on the expectation that past or present operations have not impacted site media. The field team collected samples of surface soil, subsurface soil, sediment, surface water, and groundwater from areas throughout the station. The samples were collected in areas hydraulically upgradient and, where possible, upwind of station areas where industrial operations or other potential sources of contaminant accumulation in site media may have occurred. The results of the background sampling were used for comparison with analytical results obtained from the sampling activities at the RI sites. A total of four background samples were collected for each of the five media. The BG-4 suite of sampled background media was split between the Mainside (surface water and sediment) and Waterfront (groundwater and subsurface soils) areas because unimpacted surface water and sediment were not available near the Waterfront BG-4 location.

Three background sampling locations were located on the Mainside (BG-1, BG-2, and BG-4) and two background sampling locations were located at the Waterfront area (BG-3 and BG-4).

1.3.1.1 Background Sample Location 1

Background Sample Location 1 (BG-1) is situated in the northeastern portion of the Mainside. This location is upgradient of operations areas and several thousand feet from an industrial area of the station. A full suite of background samples (surface soil, subsurface soil, sediment, surface water, and groundwater) was collected.

1.3.1.2 Background Sample Location 2

Background Sample Location 2 is situated on the north side of Hominy Hills, approximately 1 mile southwest of the intersection of Guadalcanal Road and Asbury Avenue. A full suite of background samples (surface soil, subsurface soil, sediment, surface water, and groundwater) was collected.

1.3.1.3 Background Sample Location 3

Background Sample Location 3 is situated at the Waterfront area of the station, approximately 1,000 feet northwest of High Point Chapel. This location is upgradient and generally upwind of all industrial operations at the Waterfront portion of the station. Surface soil, subsurface soil, and groundwater samples were collected. Surface water and sediment samples were not collected.

1.3.1.4 Background Sample Location 4

Background Sample Location 4 is situated approximately 250 feet east of Site 15. B&R Environmental installed a monitoring well and collected soil samples at this location to provide data on background conditions near the shoreline. No surface water or sediment samples were collected at this location. The surface water and sediment samples for Background Location 4 were collected from the Mainside, on the south side of Hominy Hills, west of the intersection of Route 34 and Midway Road, due to a lack of available unimpacted surface water/sediment sample locations at the Waterfront area.

1.3.1.5 Background Well Geology

Table 1-1 provides a summary of the characteristics of each background well. Table 1-2 provides a summary of the static water level measurements for each background well.

The four background monitoring wells were completed in distinct geological formations across the facility. The surficial soils outcrop found at the monitoring well location was not necessarily the same geologic unit into which the well screen was installed.

TABLE 1-1

BACKGROUND MONITORING WELL CHARACTERISTICS SUMMARY

OU-5 FEASIBILITY STUDY

NWS EARLE, COLTS NECK, NEW JERSEY

Monitoring Well Number	Total Depth[1] (feet)	Ground Surface Evaluation[2]			Diameter (inches)	Screened Interval Depth[1] (feet)	Filter Pack Interval Depth[1] (feet)	Date Installed
		Top of Concrete Pad[2] (feet)	Top of PVC Riser[2]	Top of Standpipe[2]				
BGMW-01	27	94.16	96.31	96.79	2	17 - 27	15 - 27	6/23/95
BGMW-02	77	231.19	233.70	233.32	2	67 - 77	65 - 77	6/22/95
BGMW-03	69	201.75	203.80	204.20	2	59 - 69	57 - 69	6/26/95
BGMW-04	20	26.82	28.96	29.51	2	10 - 20	8 - 20	6/28/95

Note: All wells are constructed of Schedule 40 polyvinyl chloride (PVC) well casing.

(1) In feet below grade. Reading obtained during monitoring well installation.

(2) In feet above mean sea level.

TABLE 1-2

BACKGROUND STATIC-WATER-LEVEL MEASUREMENT SUMMARY

OU-5 FEASIBILITY STUDY

NWS EARLE, COLTS NECK, NEW JERSEY

Monitoring Well Number	August 7, 1995			October 17, 1995		
	Depth to Water Table(1) (feet)	Top of PVC Riser(2)	Elevation of Water Table(2)	Depth to Water Table(1) (feet)	Top of PVC Riser(2)	Elevation of Water Table(2)
BGMW-01	21.93	96.31	74.38	22.70	96.31	73.61
BGMW-02	70.30	233.70	163.40	71.20	233.70	162.50
BGMW-03	63.38	203.80	140.42	64.89	203.80	138.91
BGMW-04	15.45	28.96	13.51	17.13	28.96	11.83

(1) In feet below top of riser

(2) In feet above mean sea level

Regional mapping places BGMW-01 within the outcrop of the Kirkwood Formation. The Kirkwood Formation ranges between 60 and 100 feet in thickness and the boring is 27 feet deep. The lithology of the sediments encountered in this background boring generally agrees with the published description of the Kirkwood Formation. The well was screened from 17 to 27 feet below grade and is assumed to be screened in the Kirkwood Formation.

Regional mapping places BGMW-02 within the outcrop area of the Cohansey Sand; Quaternary surficial deposits may be present at this location. Quaternary surficial deposits in this area generally are 10 feet or less in thickness, and the Cohansey Sand ranges between 0 and 35 feet in thickness. The lithology of the sediments encountered in the soil boring generally agrees with the published description of the Cohansey Sand. However, because the boring reached a depth of 80 feet, it is likely that the boring also encountered the Kirkwood Formation. The Kirkwood Formation ranges between 60 and 100 feet in thickness. The well was screened to 67 to 77 feet below grade and is therefore assumed to be screened in the Kirkwood Formation.

Regional mapping places BGMW-03 within the outcrop area of the Red Bank Sand and Tinton Sand, which, combined, range between 35 and 135 feet in thickness. The soil boring is 70 feet deep. The lithology of the sediments encountered in the boring generally agrees with the published description of the Red Bank Sand and Navesink Formation. Assuming a portion of the Red Bank Sand was removed by erosion, it is possible that the boring penetrated the underlying Navesink Formation. The well was screened from 59 to 69 feet and is assumed to be screened in the Red Bank Sand and Navesink Formation.

Regional mapping places BGMW-04 within the outcrop area of the Englishtown Formation. The Englishtown Formation ranges between 35 and 150 feet in thickness and the soil boring is 21 feet deep. The lithology of the sediments encountered in the boring generally agrees with the published description of the Englishtown Formation. The well was screened from 10 to 20 feet below grade and is assumed to be screened in the Englishtown Formation.

1.3.1.6 Background Groundwater Statistical Analysis

In order to compare site-related metals concentrations found during RI sampling to facility-wide naturally occurring (background) groundwater concentrations, it was necessary to choose additional facility monitoring wells deemed to have been installed in "background" locations upgradient of RI sites. The Navy proposed a list of existing monitoring wells to be used. After EPA and NJDEP comment and revision, a list of additional monitoring wells to be used for background statistical comparisons was agreed to. Table 1-3 shows the chosen background and upgradient wells grouped by interpreted aquifer.

Formations were grouped according to similarity and intimate association of certain geologic units found across NWS Earle.

TABLE 1-3

BACKGROUND WELLS AND UPGRADIENT WELLS GROUPED BY INTERPRETED AQUIFER

OU-5 FEASIBILITY STUDY

NWS EARLE, COLTS NECK, NEW JERSEY

Interpreted Aquifer[1]	Well No.	Site
Cohansey Sand	MW4-04	4
Cohansey Sand and Kirkwood Formation	BGMW-02	Background 2
Kirkwood Formation	BGMW-01	Background 1
	MW26-03	26
Kirkwood Formation	MW3-06	3
Kirkwood and Vincentown Formations	MW5-02	5
	MW5-03	5
	MW19-01	19
Vincentown Formation	MW1-03	1
	MW5-08	5
	MW11-03	11
Red Bank Sand and Navesink Formation	BGMW-3	Background 3
Red Bank Sand	MW7-03	7
Englishtown Formation	BGMW-04	Background 4
Fill and Englishtown Formation	MW6-01	6
	MW17-01	17

Ref. Remedial Investigation Report, July 1996

Table 1-4 presents a summary of the statistical evaluation of background metals data for monitoring wells completed in the Cohansey Sand, Kirkwood, and Vincentown Formations. Table 1-5 presents a summary of the statistical evaluation of background metals data for monitoring wells completed in the Red Bank Sand and Navesink Formations. Table 1-6 presents a summary of the statistical evaluation of background metals data for monitoring wells completed in fill and the Englishtown Formation at the Waterfront. The 95 percent upper tolerance limits (UTLs) presented in these tables were compared to the individual maximum site-related results for corresponding wells grouped in the same interpreted aquifer.

1.3.1.7 Background Surface Soil Statistical Analysis

In order to compare site-related metals concentrations found during RI sampling to facility-wide naturally occurring (background) surface soil concentrations, a statistical evaluation was performed as described in Section 2.4.6.1 of the RI report. Table 1-7 presents a summary of the statistical evaluation of background surface soil results, showing the UTLs that were compared to individual maximum site-related results.

1.3.1.8 Background Subsurface Soil Statistical Analysis

In order to compare site-related metals concentrations found during RI sampling to facility-wide naturally occurring (background) subsurface soil concentrations, a statistical evaluation was performed as described in Section 2.4.6.1 of the RI report. Table 1-8 presents a summary of the statistical evaluation of background subsurface soil results showing the UTLs that were compared to individual maximum site-related results.

1.3.2 Site 13

1.3.2.1 Initial Assessment and Confirmation Study

The 1983 IAS, which consisted of interviews, concluded minimal impact based on site use as a storage area. The site was not recommended for a confirmation study.

During the 1993 SI, six soil, three sediment, and three surface water samples were collected. The soil samples were collected from 0 to 3 feet below ground surface (bgs) from the area in and around the landfill. The sediment and surface water samples were collected in the drainage west of the site. Soil samples were analyzed for semivolatile organic compounds (SVOCs), polychorinated biphenyls (PCBs), metals, and cyanide. Low levels of metals, pesticides, PCBs, and SVOCs were detected in soil samples. Elevated levels of two semivolatiles were also detected. Sediment samples were analyzed for SVOCs, pesticides, and PCBs. Low levels of pesticides, PCBs, and SVOCs were detected. Surface water samples were analyzed

TABLE 1-4
STATISTICAL EVALUATION OF BACKGROUND GROUNDWATER METALS DATA
COHANSEY SAND, KIRKWOOD, AND VINCENTOWN FORMATIONS
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

Substance	Background Distribution	No. of Detects	No. of Results	Mean or Geometric Mean ug/L	Standard Deviation or Log Standard Deviation	Student's t-Distribution Coefficient	95 % Upper Tolerance Limit - ug/L
Aluminum	Lognormal	11	11	1560	1.14	1.812	13500
Arsenic	Lognormal	1	11	1.85	0.379	1.812	3.79
Barium	Lognormal	11	11	39.5	1.51	1.812	687
Beryllium	Lognormal	4	11	0.111	1.11	1.812	0.914
Cadmium	Lognormal	5	11	0.403	0.919	1.812	2.3
Calcium	Lognormal	11	11	2520	1.03	1.812	17600
Chromium, Total	Lognormal	9	11	5.53	1.71	1.812	141
Cobalt	Lognormal	6	11	0.905	1.28	1.812	10.2
Copper	Lognormal	9	11	1.67	1.18	1.812	15.6
Iron	Lognormal	11	11	1110	1.24	1.812	11500
Lead	Lognormal	3	11	1.03	0.557	1.812	2.97
Magnesium	Lognormal	11	11	1950	1.15	1.812	17100
Manganese	Lognormal	11	11	17	0.888	1.812	91.4
Mercury	Lognormal	11	11	0.034	1.24	1.812	0.355
Nickel	Lognormal	10	11	3.06	1.24	1.812	31.8
Potassium	Lognormal	11	11	1080	0.797	1.812	4900
Selenium	Lognormal	1	11	2.38	0.265	1.812	3.94
Sodium	Lognormal	11	11	3730	0.491	1.812	9460
Thallium	Lognormal	3	11	2.33	0.443	1.812	5.38
Vanadium	Lognormal	10	11	2.92	1.57	1.812	56.5
Zinc	Lognormal	6	9	12.8	2.52	1.86	1780

Notes:

(1) Background statistics are based on the estimated distribution type (normal or lognormal).

(2) The tolerance limit defines the concentration range that, on the average, is estimated to contain 95 % of all data points from the background population.

(3) If a site-related sample exceeds the tolerance limit, statistical evidence suggests the sample comes from a population with a different distribution and higher concentrations than the background data.

TABLE 1-5
STATISTICAL EVALUATION OF BACKGROUND GROUNDWATER METALS DATA
RED BANK SAND AND NAVESINK FORMATIONS
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

Substance	Background Distribution	No. of Detects	No. of Results	Geometric Mean ug/L	Log Standard Deviation	Student's t-Distribution Coefficient	95 % Upper Tolerance Limit - ug/L	
Aluminum	Lognormal	2	2	308	0.343	6.314	4370	
Barium	Lognormal	2	2	46	0.123	6.314	119	
Beryllium	Lognormal	1	2	0.148	1.4	6.314	1.32	*
Calcium	Lognormal	2	2	2930	0.984	6.314	17587	*
Chromium, Total	Lognormal	1	2	2.68	2.42	6.314	52.83	*
Cobalt	Lognormal	2	2	15.4	0.856	6.314	80.81	*
Iron	Lognormal	2	2	459	0.61	6.314	1790	*
Magnesium	Lognormal	2	2	1950	0.116	6.314	4780	
Manganese	Lognormal	2	2	217	0.175	6.314	843	
Mercury	Lognormal	1	2	0.0097	2.23	6.314	0.17	*
Nickel	Lognormal	2	2	6.2	0.849	6.314	32.29	*
Potassium	Lognormal	2	2	1230	0.766	6.314	5819	*
Sodium	Lognormal	2	2	6050	0.353	6.314	92710	
Vanadium	Lognormal	1	2	0.653	1.08	6.314	4.31	*
Zinc	Lognormal	2	2	6.63	0.4	6.314	146	

Notes:

(1) Background statistics are calculated using the EPA default lognormal distribution (too few samples to statistically verify type of distribution).

(2) The tolerance limit defines the concentration range that, on the average, is estimated to contain 95 % of all data points from the background population.

(3) If a site-related sample exceeds the tolerance limit, statistical evidence suggests the sample comes from a population with a different distribution and higher concentrations than the background data.

(*) The EPA Region II test (2X background arithmetic mean) is shown because the tolerance limit is impractical (large uncertainties are caused by too few samples and a high lognormal standard deviation).

TABLE 1-6
STATISTICAL EVALUATION OF BACKGROUND GROUNDWATER METALS DATA
FILL AND ENGLISHTOWN FORMATION
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

Substance	Background Distribution Type Used	No. of Detects	No. of Results	Mean or Geometric Mean ug/L	Standard Deviation or Log Standard Deviation	Student's t-Distribution Coefficient	95 % Upper Tolerance Limit - ug/L
Aluminum	Lognormal	3	3	1660	0.23	2.92	3610
Arsenic	Lognormal	1	3	2.4	0.652	2.92	21.6
Barium	Lognormal	3	3	49	0.472	2.92	241
Beryllium	Lognormal	2	3	0.385	2.25	2.92	5.84 *
Cadmium	Lognormal	3	3	1.15	1.56	2.92	9.00286 *
Calcium	Lognormal	3	3	18000	0.429	2.92	76450
Chromium, Total	Lognormal	1	3	0.637	0.473	2.92	3.14
Cobalt	Lognormal	3	3	8.44	1.03	2.92	30.98 *
Iron	Lognormal	3	3	7880	2.21	2.92	123637 *
Magnesium	Normal	3	3	13500	4440	2.92	28430
Manganese	Normal	3	3	1860	1160	2.92	5770
Mercury	Lognormal	1	3	0.0056	1.78	2.92	0.06 *
Nickel	Lognormal	3	3	11.9	1.23	2.92	54.73 *
Potassium	Normal	3	3	3390	340	2.92	4530
Sodium	Normal	3	3	63800	41800	2.92	204850
Vanadium	Lognormal	1	3	0.468	0.741	2.92	5.68
Zinc	Lognormal	2	2	24.2	0.348	6.314	355

Notes:
(1) Background statistics are calculated assuming the EPA default lognormal distribution, except where this assumption is statistically improbable in cases where a normal distribution assumption is not improbable (based on the W-test using a P level of 0.05).
(2) The tolerance limit defines the concentration range that, on the average, is estimated to contain 95 % of all data points from the background population.
(3) If a site-related sample exceeds the tolerance limit, statistical evidence suggests the sample comes from a population with a different distribution and higher concentrations than the background data.
(*) The EPA Region II test (2X background arithmetic mean) is presented for this metal because the tolerance limit is impractical (large uncertainties are caused by too few sampling points along with a moderate to high lognormal standard deviation).

TABLE 1-7
STATISTICAL EVALUATION OF BACKGROUND SURFACE SOIL METALS DATA
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

Metal	Background Distribution Type Used	No. of Detects	No. of Results	Mean or Geometric Mean mg/kg	Standard Deviation or Log Standard Deviation	Student's t-Distribution Coefficient	95 % Upper Tolerance Limit - mg/kg
Aluminum	Lognormal	4	4	2760	0.538	2.353	11300
Antimony	---	0	4	---	---	---	---
Arsenic	Lognormal	4	4	4.38	1.13	2.353	86.6
Barium	Lognormal	4	4	6.15	1.29	2.353	184
Beryllium	Normal	1	4	0.194	0.161	2.353	0.617 *
Cadmium	Lognormal	1	4	0.31	0.412	2.353	0.916
Calcium	Normal	4	4	276	272	2.353	992 *
Chromium	Lognormal	4	4	24.4	1.03	2.353	368
Cobalt	Lognormal	2	4	0.733	1.36	2.353	26.5
Copper	Lognormal	4	4	3.61	1.04	2.353	55.5
Iron	Lognormal	4	4	16000	1.23	2.353	409600
Lead	Normal	4	4	18.7	16.4	2.353	61.9 *
Magnesium	Lognormal	4	4	222	0.882	2.353	2260
Manganese	Lognormal	4	4	20.5	1.81	2.353	2420
Mercury	Normal	4	4	0.0909	0.0658	2.353	0.264
Nickel	Lognormal	2	4	1.56	1.12	2.353	29.7
Potassium	Normal	4	4	456	287	2.353	1210
Selenium	Lognormal	2	4	0.453	0.587	2.353	2.12
Silver	Lognormal	2	4	0.29	0.672	2.353	1.7
Sodium	Lognormal	4	4	31.7	0.715	2.353	208
Thallium	Lognormal	2	4	0.625	0.818	2.353	5.38
Vanadium	Normal	4	4	35.1	22	2.353	92.8
Zinc	Normal	3	4	11.4	12.9	2.353	45.3 *

Notes:
(1) Background statistics are calculated assuming the EPA default lognormal distribution, except where this assumption is statistically improbable in cases where a normal distribution assumption is not improbable (based on the W-test using a P level of 0.05).
(2) The tolerance limit defines the concentration range that, on the average, is estimated to contain 95 % of all data points from the background population.
(3) If a site-related sample exceeds the tolerance limit, statistical evidence suggests the sample comes from a population with a different distribution and higher concentrations than the background data.
(*) The EPA Region II test (2X background arithmetic mean) is presented for this metal because the tolerance limit is impractical (large uncertainties are caused by too few sampling points along with a moderate to high lognormal standard deviation).

TABLE 1-8
STATISTICAL EVALUATION OF BACKGROUND SUBSURFACE SOIL METALS DATA
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

Metal	Background Distribution Type Used	No. of Detects	No. of Results	Mean or Geometric Mean mg/kg	Standard Deviation or Log Standard Deviation	Student's t-Distribution Coefficient	95 % Upper Tolerance Limit - mg/kg
Aluminum	Lognormal	8	8	2260	0.656	1.895	8470
Arsenic	Lognormal	8	8	4.62	0.971	1.895	32.5
Barium	Lognormal	8	8	4.75	1.27	1.895	60.5
Beryllium	Normal	2	8	0.141	0.134	1.895	0.41
Cadmium	Lognormal	1	8	0.274	0.303	1.895	0.505
Calcium	Lognormal	8	8	155	1.32	1.895	2200
Chromium	Lognormal	8	8	19	0.958	1.895	130
Cobalt	Lognormal	4	8	0.753	1.17	1.895	7.89
Copper	Lognormal	8	8	3.15	0.881	1.895	18.5
Iron	Lognormal	8	8	13800	0.978	1.895	98400
Lead	Lognormal	8	8	6.22	1.31	1.895	87.1
Magnesium	Normal	8	8	252	191	1.895	636
Manganese	Lognormal	8	8	16.7	1.59	1.895	410
Mercury	Lognormal	8	8	0.0516	0.675	1.895	0.201
Nickel	Lognormal	4	8	1.54	0.977	1.895	10.9
Potassium	Normal	7	8	397	246	1.895	891
Selenium	Lognormal	2	8	0.354	0.469	1.895	0.908
Silver	Lognormal	2	8	0.219	0.535	1.895	0.643
Sodium	Lognormal	8	8	31.7	0.67	1.895	122
Thallium	Lognormal	4	8	0.566	0.625	1.895	1.99
Vanadium	Normal	8	8	32.4	18.1	1.895	68.7
Zinc	Lognormal	6	8	7.18	1.53	1.895	155

Notes:
(1) Background statistics are calculated assuming the EPA default lognormal distribution, except where this assumption is statistically improbable in cases where a normal distribution assumption is not improbable (based on the W-test using a P level of 0.05).
(2) The tolerance limit defines the concentration range that, on the average, is estimated to contain 95 % of all data points from the background population.
(3) If a site-related sample exceeds the tolerance limit, statistical evidence suggests the sample comes from a population with a different distribution and higher concentrations than the background data.

for SVOCs, PCBs, pesticides, metals, and cyanide. Elevated levels of several metals were present in samples. No SVOCs, pesticides, or PCBs were detected in surface water.

1.3.2.2 Remedial Investigation

Between June and October 1995, B&R Environmental conducted the following field investigation activities at Site 13:

- Excavation of 12 test pits
- Sampling and analysis of surface water
- Sampling and analysis of sediment
- Drilling and installation of five shallow permanent monitoring wells
- Sampling and analysis of groundwater from the wells
- Measurement of static water levels in the wells
- Performance of slug tests in two of the wells

B&R Environmental conducted a survey to establish the horizontal locations and vertical elevations of the test pit locations, surface water and sediment sample locations, and the permanent monitoring wells.

1.3.2.3 Summary of Results

The top of the site is flat, and there is little topographic relief. Runoff from the site drains to the marsh to the north and west to a perennial drainage that flows to Hockhockson Brook. A fence surrounds the DPDO Yard, although this fence is not located at the edge of the landfill. The extent of fill material was not clearly defined by previous investigations. The toe of the landfill extends into the marsh area and is clearly defined by an abrupt decrease in elevation of several feet between the top of the landfill slope and the marsh. Groundwater flow is generally to the north-northwest, based on groundwater-level measurements.

1.3.2.3.1 Site Geology, Hydrogeology, and Hydrology

Geology

Regional mapping places Site 13 within the outcrop area of the Vincentown Formation. The Vincentown Formation ranges between 10 and 130 feet in thickness; the soil borings are no more than 19 feet deep. The lithology of the sediments encountered in the on-site borings generally agrees with the published description of the Vincentown Formation. In general, the borings encountered alternating beds of yellowish-brown to brown, micaceous, silty, fine- to medium-grained sand and olive, glauconitic, silty sand and sand.

Hydrogeology

Groundwater in the Vincentown aquifer beneath the site occurs under unconfined conditions. Static-water-level measurements and water-table elevations are summarized in Table 1-9. Groundwater elevations for August 1995 and October 1995 are contoured on Figures 1-3 and 1-4, respectively. The direction of shallow groundwater flow in the aquifer, as indicated by both the August and October groundwater contour maps, is north-northwest. There does not appear to be a significant seasonal variation in groundwater flow direction. The hydraulic conductivity calculated for MW13-04 is 2.64×10^{-5} cm/sec (0.75 ft/day).

1.3.2.3.2 Nature and Extent of Contamination

This section evaluates the occurrence and distribution of samples from the 1995 RI and 1996 RI Addendum field activities. Tables 1-10 through 1-14 compare the results of background samples to samples collected at Site 13. Figure 1-5 shows sample locations and concentrations of compounds that exceed ARARs and TBCs.

Sediment

Concentrations of most metals in site-related sediment samples were similar to background ranges. Antimony, cadmium, and silver were detected at low levels in site-related sediment samples (the highest levels were in 13 SD 03) but were not found in background sediments. Lead was detected in 13 SD 03 at a level slightly greater than the ranges found in background samples.

The following polycyclic aromatic hydrocarbons (PAHs), phthalates, and pesticides were detected in site-related sediment samples at levels generally within background concentration range: benzo(b)fluoranthene (48 ug/kg), chrysene (56 ug/kg), fluoranthene (81 ug/kg), pyrene (67.5 ug/kg), and diethyl phthalate (51 ug/kg) were each detected in one site- related sediment sample. Gamma-chlordane (0.16 ug/kg), 4,4'-DDE (2.45 ug/kg), and 4,4'-DDT (6.4 ug/kg) were each detected in one site-related sediment sample.

Several compounds were detected in site-related sediment samples that were not found in background sediment samples. Aroclor 1254 (58 ug/kg to 3,900 ug/kg) was detected in all three site-related sediment samples and Aroclor 1260 (33 ug/kg to 1,200 ug/kg) was detected in two sediment samples. Alpha-chlordane (11 ug/kg to 20 ug/kg) and endrin aldehyde (31 ug/kg to 90 ug/kg) were each detected in two site-related sediment samples, and endosulfan sulfate (0.3 ug/kg) was detected in one site-related sediment sample.

TABLE 1-9

STATIC-WATER-LEVEL MEASUREMENT SUMMARY

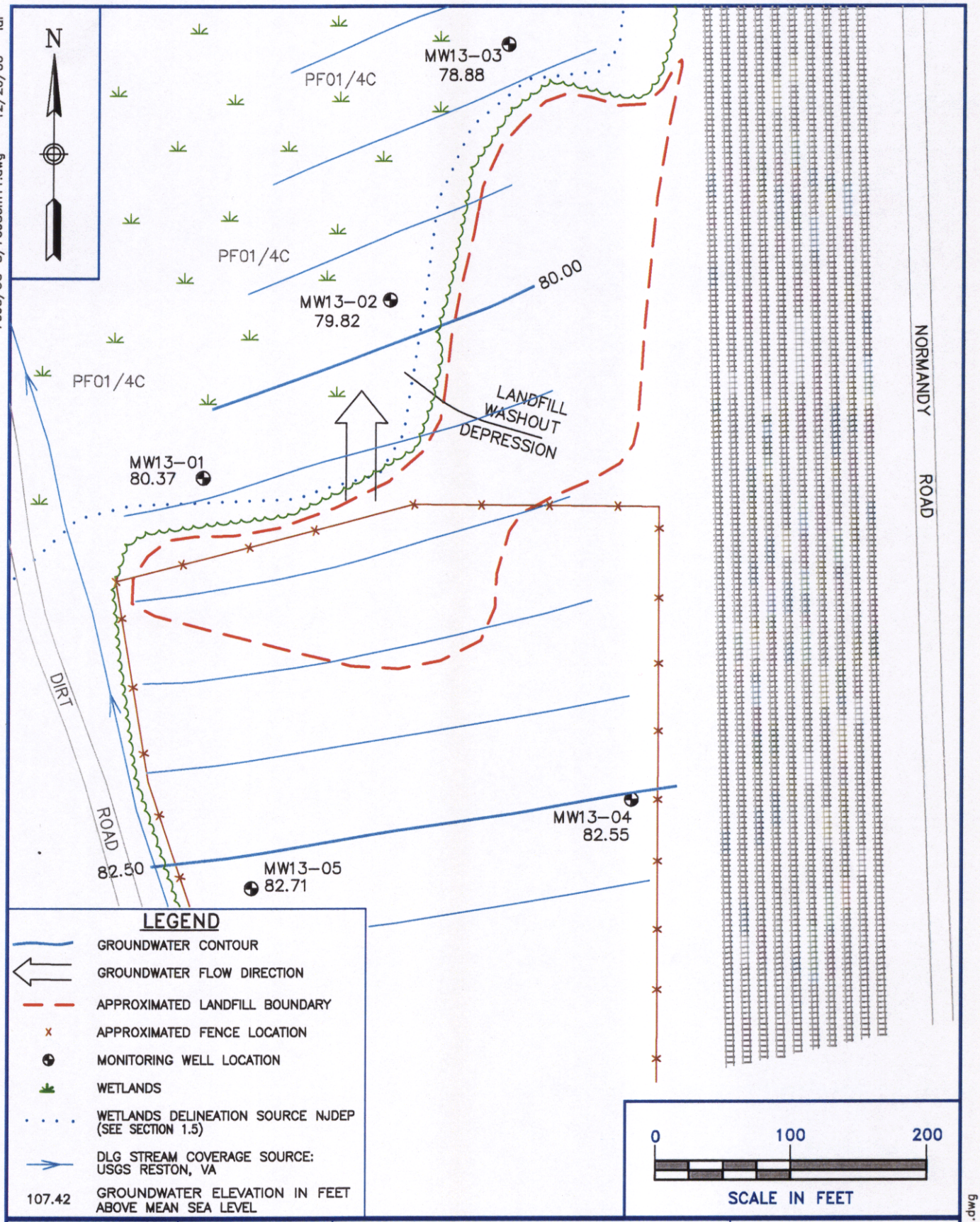
OU-5 FEASIBILITY STUDY

NWS EARLE, COLTS NECK, NEW JERSEY

Monitoring Well Number	August 7, 1995			October 17, 1995		
	Depth to Water Table[1] (feet)	Top of PVC Riser[2]	Elevation of Water Table[2]	Depth to Water Table[1] (feet)	Top of PVC Riser[2]	Elevation of Water Table[2]
MW-01	5.62	86.04	80.42	5.67	86.04	80.37
MW-02	5.28	85.09	79.81	5.27	85.09	79.82
MW-03	4.40	83.26	78.86	4.38	83.26	78.88
MW-04	11.16	93.85	82.69	11.30	93.85	82.55
MW-05	12.88	95.54	82.66	12.83	95.54	82.71

(1) In feet below top of PVC riser

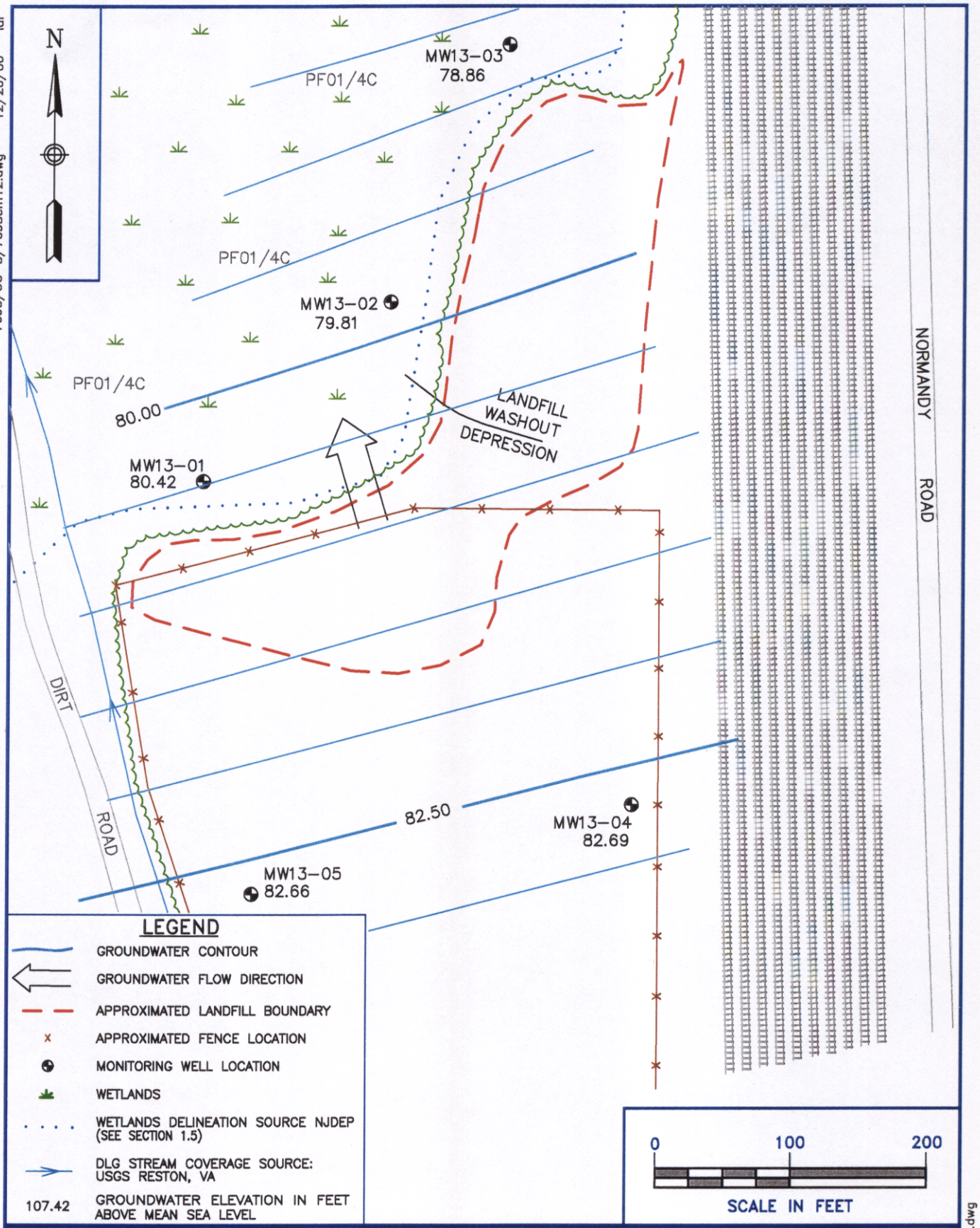
(2) In feet above mean sea level



DRAWN BY	DATE	Tetra Tech NUS, Inc.	GROUNDWATER CONTOUR MAP OCTOBER 17, 1995 SITE 13 – DRMO YARD NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY	CONTRACT NO. 7695	
LDL	12/20/00			OWNER NO. 0200	
CHECKED BY	DATE			APPROVED BY	DATE
REVISED BY	DATE			DRAWING NO. FIGURE 1-3	REV.
SCALE AS NOTED					

7695/OU-5/7695cm11.dwg 12/20/00 ldl

7695/OU-5/7695cm11.dwg



DRAWN BY LDL DATE 12/21/00	Tetra Tech NUS, Inc.	GROUNDWATER CONTOUR MAP AUGUST 7, 1995 SITE 13 – DRMO YARD NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY	CONTRACT NO. 7695
CHECKED BY DATE			OWNER NO. 0200
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-4 REV.

7695/OU-5/7695cm12.dwg 12/20/00 ldl

7695/OU-5/7695cm12.dwg

TABLE 1-10
OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SEDIMENT AT SITE 13
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND***				SITE-RELATED					
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	UTL**	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	MEAN > ACK UTL	REPRESENTATIVE CONCENTRATION
ALUMINUM	6 / 6	839 - 3940	8.1E+07	5459.67	3 / 3	1150 - 2170	1728.33	NO	NO	2170.00
ANTIMONY *	0 / 6	-	1.4E+01	-	2 / 3	0.56 - 2.5	2.12	YES	-	2.50
ARSENIC *	5 / 6	2.4 - 9.9	2.9E+02	11.23	3 / 3	2.3 - 4.2	3.53	NO	NO	4.20
BARIUM	6 / 6	3.2 - 15.8	2.9E+02	16.80	3 / 3	5.6 - 9.3	7.27	NO	NO	9.30
BERYLLIUM	4 / 6	0.34 0.57	3.3E-01	0.72	2 / 3	0.12 - 0.32	0.18	NO	NO	0.32
CADMIUM	2 6	0.44 - 0.46	1.1E+00	0.93	2 / 3	0.35 - 0.47	0.40	NO	NO	0.47
CALCIUM	6 / 6	179 - 518	6.7E+05	690.83	3 / 3	81.1 - 347.25	201.45	NO	NO	347.25
CHROMIUM	6 / 6	4.3 - 56	2.6E+03	40.42	3 / 3	23.2 - 72.5	42.97	YES	NO	72.50
COBALT	4 / 6	0.51 2.1	6.4E+00	2.85	2 / 3	0.43 - 0.57	0.58	NO	NO	0.57
COPPER	6 / 6	1 - 13	1.9E+01	9.08	3 / 3	2.9 - 32.7	14.40	YES	NO	32.70
IRON	6 / 6	228 - 21400	7.2E+09	23589.33	3 / 3	4355 - 9180	6921.67	NO	NO	9180.00
LEAD	6 / 6	4 - 34.3	4.8E+01	21.07	3 / 3	10.1 - 94.3	45.57	YES	NO	94.30
MAGNESIUM	6 / 6	60.7 - 880	2.0E+06	809.90	3 / 3	156 - 441	253.00	NO	NO	441.00
MANGANESE	6 / 6	3.9 - 63.1	8.9E+01	36.22	3 / 3	10.9 - 21.9	14.78	NO	NO	21.90
MERCURY *	1 / 6	0.068 0.068	8.5E-03	0.09	3 / 3	0.0295 - 0.19	0.10	YES	YES	0.19
NICKEL	5 / 6	1.6 - 6	3.4E+01	6.90	2 / 3	2.4 - 3	2.22	NO	NO	3.00
POTASSIUM	5 / 6	86.1 - 2900	1.4E+07	1892.03	3 / 3	308 - 1530	763.00	NO	NO	1530.00
SILVER *	2 / 6	0.1125 0.15	2.8E+00	1.13	2 / 3	2.4 - 22.7	8.58	YES	YES	22.70
SODIUM	4 / 6	26.6 - 2280	2.9E+03	876.80	3 / 3	18.1 - 39.45	27.02	NO	NO	39.45
VANADIUM	6 / 6	5.9 - 42.7	2.1E+03	39.42	3 / 3	19.1 - 37.9	25.67	NO	NO	37.90
ZINC	6 / 6	12.5 - 34.7	1.5E+03	41.23	3 / 3	8.75 - 54.7	31.32	NO	NO	54.70

* - Selected as a COPC

** - Upper Tolerance Limit = UTL is the concentration that is estimated to contain a designated portion (95%) of all possible sample measurements.

*** - Background samples are as follows: BGSD01, BGSD02, BGSD04 through BGSD07

TABLE 1-11
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SEDIMENT AT SITE 13
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/kg)

SUBSTANCE	BACKGROUND**			SITE-RELATED		
	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
4,4'-DDE *	1 / 6	1.7 - 1.7	1.7	1 / 3	2.45 - 2.45	2.45
4,4'-DDT *	1 / 6	19 - 19	10.63992	1 / 3	6.4 - 6.4	6.4
ALPHA-CHLORDANE *	NOT DETECTED	-	-	2 / 3	11 - 20	20
AROCLOR-1254 *	NOT DETECTED	-	-	3 / 3	58 - 3900	3900
AROCLOR-1260 *	NOT DETECTED	-	-	2 / 3	33 - 1200	1200
BENZO(B)FLUORANTHENE	3 / 6	150 - 490	346.54105	1 / 1	48 - 48	48
CHRYSENE *	3 / 6	130 - 940	577.8735	1 / 1	56 - 56	56
DIETHYLPHTHALATE *	1 / 3	44 - 44	44	1 / 1	51 - 51	51
ENDOSULFAN SULFATE *	NOT DETECTED	-	-	1 / 3	0.3 - 0.3	0.3
ENDRIN ALDEHYDE *	NOT DETECTED	-	-	2 / 3	31 - 90	90
FLUORANTHENE *	3 / 6	240 - 1800	1024.31285	1 / 1	81 - 81	81
GAMMA-CHLORDANE *	1 / 6	0.095 - 0.095	0.095	1 / 3	0.16 - 0.16	0.16
PYRENE *	3 / 6	200 - 1900	1076.74355	1 / 1	67.5 - 67.5	67.5

* - Selected as a COPC
** - *Background samples are as follows: BGSD01, BGSD02, BGSD04 through BGSD07*

TABLE1-12
OCCURRENCE AND DISTRIBUTION OF INORGANICS IN GROUNDWATER AT SITE 13
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND***				SITE-RELATED					
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	UTL**	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	MEAN > ACK UTL	REPRESENTATIVE CONCENTRATION
ALUMINUM	11 / 11	287 - 7870	9.6E+06	5097.82	5 / 5	1420 - 15800	8682.00	YES	NO	15800.00
ANTIMONY *	NOT DETECTED	-	-	-	1 / 5	9.7 9.7	3.02	YES	-	9.70
ARSENIC *	1 / 11	5.8 - 5.8	6.6E+00	4.05	3 / 5	15.2 - 39.2	15.14	YES	YES	39.20
BARIUM	11 / 11	2.6 - 518	5.8E+02	229.60	5 / 5	10 - 285	102.84	NO	NO	285.00
BERYLLIUM	4 / 11	0.21 - 1.6	1.3E+00	0.49	4 / 5	0.67 - 1.6	0.87	YES	NO	1.60
CADMIUM *	5 / 11	0.6 - 1.9	2.3E+00	1.21	5 / 5	1 - 63.9	14.50	YES	YES	40.87
CALCIUM	11 / 11	506 - 17200	1.7E+04	8306.55	5 / 5	3170 - 11900	6570.00	NO	NO	11900.00
CHROMIUM*	9 11	1.3 - 43.5	6.0E+01	29.36	5 / 5	26.3 - 296	176.34	YES	YES	296.00
COBALT	6 / 11	0.7 - 10.1	9.6E+00	4.06	5 / 5	2.1 - 8.4	4.96	YES	NO	8.40
COPPER	9 / 11	0.79 - 13.5	1.4E+01	6.53	5 / 5	2.6 - 14.2	6.32	NO	NO	14.20
IRON *	11 / 11	153 - 7690	8.5E+03	4197.09	5 / 5	866 - 57900	33033.20	YES	YES	57900.00
LEAD *	3 / 11	2.1 - 3	3.1E+00	2.44	5 / 5	3.4 - 18.8	10.58	YES	YES	18.80
MAGNESIUM	11 / 11	273 - 27400	2.3E+04	8449.64	5 / 5	2120 - 4040	2888.00	NO	NO	3950.12
MANGANESE	11 / 11	3.3 - 65	1.2E+03	46.18	5 / 5	58.3 - 138	102.50	YES	NO	138.00
MERCURY	11 / 11	0.005 - 0.12	2.0E-01	0.12	5 / 5	0.047 - 0.11	0.06	NO	NO	0.09
NICKEL	10 / 11	0.81 - 25.5	2.6E+01	11.98	4 / 5	11.5 - 35.7	14.90	YES	NO	35.70
POTASSIUM	11 / 11	350 - 3245	2.5E+06	2810.55	5 / 5	2620 - 9330	6288.00	YES	NO	9330.00
SILVER *	1 11	5.3 - 5.3	8.6E+00	4.96	3 / 5	4.6 39.9	10.84	YES	YES	26.39
SODIUM	NOT DETECTED	-	-	-	1 / 5	1 - 1	0.58	YES	-	0.88
THALLIUM	11 / 11	1850 - 11650	1.3E+04	8449.09	5 / 5	3520 - 9780	6966.00	NO	NO	9780.00
VANADIUM	3 / 11	4 - 5.1	1.1E+01	5.15	2 / 5	10.4 - 23.8	7.92	YES	NO	17.10
ZINC *	10 / 11	0.69 - 42.25	4.0E+01	16.48	5 / 5	2.6 - 152	89.44	YES	YES	152.00

* - Selected as a COPC
** - Upper Tolerance Limit = UTL is the concentration that is estimated to contain a designated portion (95%) of all possible sample measurements.
*** - Background samples are as follows: MW4-04, BGMW-02, BGMW-01, MW26-03, MW3-06, MW5-02, MW5-03, MW19-01, MW1-03, MW5-08, MW11-03

TABLE 1-13
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN GROUNDWATER AT SITE 13
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND**			SITE-RELATED		
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
4,4'-DDT *	NOT DETECTED	-	-	2 / 5	0.029 - 0.051	0.051
DIELDRIN *	NOT DETECTED	-	-	1 / 5	0.022 - 0.022	0.02
ENDOSULFAN I *	NOT DETECTED	-	-	1 / 5	0.028 - 0.028	0.03
HEPTACHLOR *	NOT DETECTED	-	-	2 / 5	0.0052 - 0.011	0.01
4-METHYLPHENOL *	NOT DETECTED	-	-	1 / 5	2 - 2	2.00
VOLATILE HYDROCARBONS *	NOT DETECTED	-	-	16 20	2 1300	210.46
1,1,1-TRICHLOROETHANE *	NOT DETECTED	-	-	4 / 28	0.02 - 5	2.68
1,1-DICHLOROETHENE *	NOT DETECTED	-	-	6 / 28	0.01 - 2	2.00
1,2-DICHLOROETHENE (TOTAL)	NOT DETECTED	-	-	6 / 28	0.1 - 120	14.4758
CARBON DISULFIDE *	NOT DETECTED	-	-	1 / 14	1 - 1	1
CARBON TETRACHLORIDE *	NOT DETECTED	-	-	1 / 28	0.001 - 0.001	0.001
CHLOROFORM *	1 / 11	2 - 2	2	11 / 28	0.01 - 9	2.73609
METHYLENE CHLORIDE *	1 / 11	1 - 1	1	9 / 28	0.5 - 35	8.54
TETRACHLOROETHENE *	NOT DETECTED	-	-	17 / 28	0.004 - 70	9.51804
TRICHLOROETHENE *	NOT DETECTED	-	-	7 / 28	0.2 - 180	23.13233
VINYL CHLORIDE *	NOT DETECTED	-	-	2 / 14	10 - 11	6.63

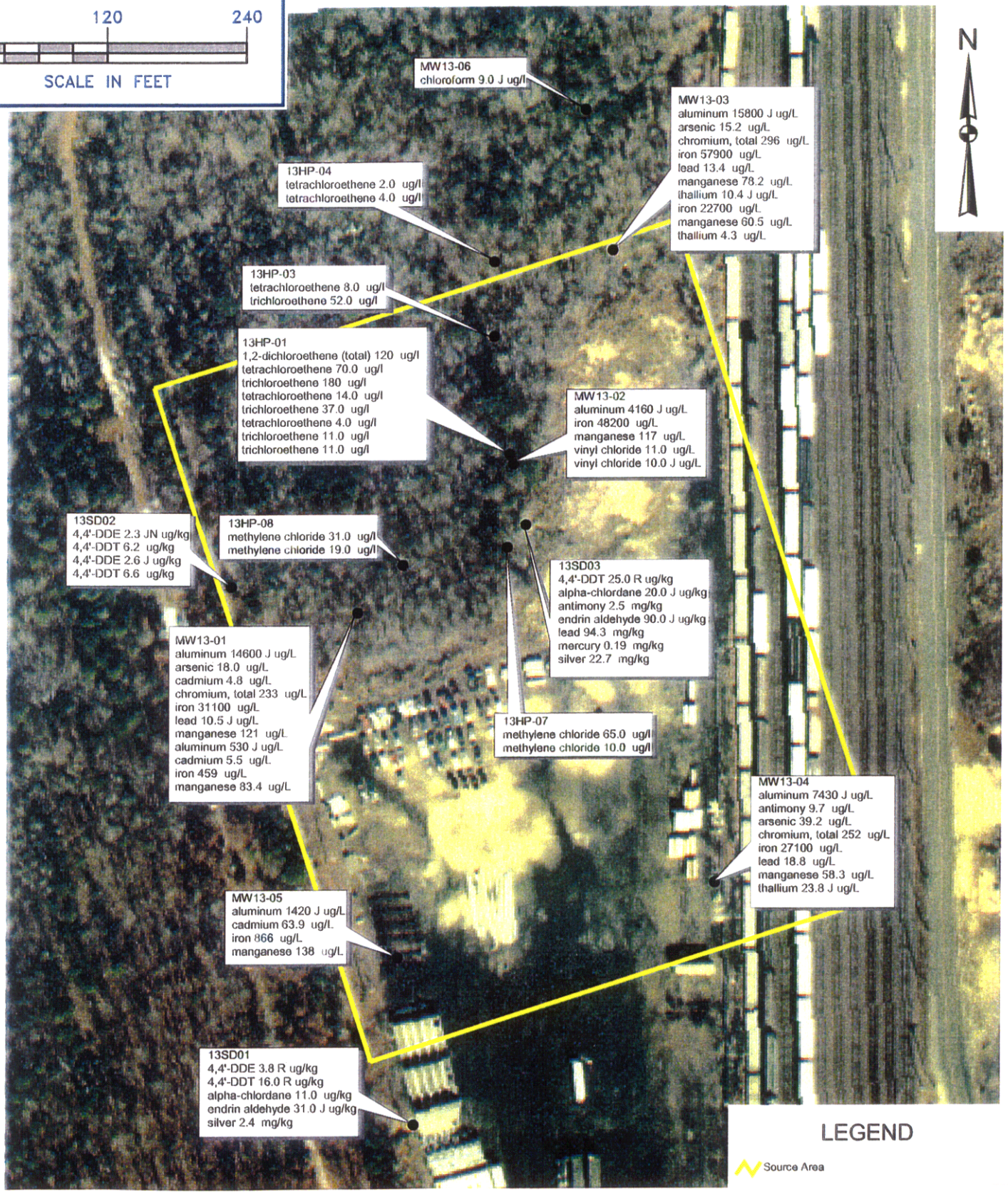
* - Selected as a COPC

** - Background samples are as follows: MW4-04, BGMW-02, BGMW-01, MW26-03, MW3-06, MW5-02, MW5-03, MW19-01, MW1-03, MW5-08, MW11-03

TABLE 1-14
OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SURFACE WATER AT SITE 13
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND***				SITE-RELATED					
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	UTL **	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	MEAN > ACK UTL	REPRESENTATIVE CONCENTRATION
ALUMINUM	5 / 6	102 - 1540	2.2E+03	904.20	1 / 1	932 - 932	932.00	YES	NO	932.00
BARIUM	6 / 6	16.3 - 36.4	2.4E+03	55.05	1 / 1	28.45 - 28.45	28.45	NO	NO	28.45
BERYLLIUM	3 / 6	0.22 - 1.2	1.7E+00	0.70	1 / 1	0.28 - 0.28	0.28	NO	NO	0.28
CADMIUM *	1 / 6	0.18 0.18	3.2E-01	0.23	1 / 1	0.555 - 0.555	0.56	YES	YES	0.56
CALCIUM	6 / 6	462 - 177000	2.3E+05	71114.00	1 / 1	3010 - 3010	3010.00	NO	NO	3010.00
CHROMIUM *	3 / 5	0.72 - 2.6	4.4E+00	1.78	1 / 1	11 - 11	11.00	YES	YES	11.00
COBALT	6 / 6	0.81 - 2	5.2E+00	3.10	1 / 1	2.55 - 2.55	2.55	NO	NO	2.55
COPPER	5 / 6	1.1 - 17.8	3.0E+02	11.92	1 / 1	1.2 - 1.2	1.20	NO	NO	1.20
IRON	6 / 6	160 - 23100	3.0E+04	9576.67	1 / 1	1695 - 1695	1695.00	NO	NO	1695.00
LEAD	2 / 6	4.4 - 16	2.2E+01	7.31	1 / 1	1.85 - 1.85	1.85	NO	NO	1.85
MAGNESIUM	6 / 6	369 - 559000	7.0E+05	190702.67	1 / 1	1940 - 1940	1940.00	NO	NO	1940.00
MANGANESE	6 / 6	14 - 203	3.8E+02	172.43	1 / 1	41.3 - 41.3	41.30	NO	NO	41.30
NICKEL	6 / 6	2.1 - 7.9	8.2E+01	10.23	1 / 1	8.95 - 8.95	8.95	NO	NO	8.95
POTASSIUM	5 / 6	251 - 259000	3.2E+05	88922.83	1 / 1	1720 - 1720	1720.00	NO	NO	1720.00
SILVER *	1 / 6	0.86 - 0.86	1.3E+00	0.75	1 / 1	1.4 - 1.4	1.40	YES	YES	1.40
SODIUM	3 / 3	11150 - 4340000	1.3E+07	2912233.33	1 / 1	4405 - 4405	4405.00	NO	NO	4405.00
VANADIUM	4 / 6	0.225 - 9	1.2E+01	3.79	1 / 1	0.405 - 0.405	0.41	NO	NO	0.41

* - Selected as a COPC
** - Upper Tolerance Limit = UTL is the concentration that is estimated to contain a designated portion (95%) of all possible sample measurements.
*** - Background samples are as follows: BGSW01, BGSW02, BGSW04 through BGSW07



DRAWN BY DL DATE 12/20/00	Tetra Tech NUS, Inc.	CONCENTRATIONS ABOVE SCREENING LEVELS SITE 13 – DPDO YARD NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY	CONTRACT NO. 7695
CHECKED BY DATE			OWNER NO. 0200
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1–5 REV.

Miscellaneous parameter analyses of sediment samples at Site 13 consisted of percent solids, percent moisture, pH, and total organic carbon (TOC). All results were within typical background range.

Groundwater

Five groundwater samples were collected at Site 13 (13 GW 01 through 13 GW 05) during the 1995 RI. An additional monitoring well was installed and sampled (13 GW 06) during the 1996 RI Addendum field work. Also, as part of the RI Addendum activities, groundwater at eight locations at Site 13 (13 HP 01 through 13 HP 08) was sampled using hydropunch or direct-push techniques. A total of 20 samples, plus two duplicates, were obtained at various depths from these eight locations. Explosives were analyzed for but were not detected in Site 13 groundwater.

Metals that significantly exceeded background levels were aluminum, antimony, arsenic, barium, beryllium, cadmium, total chromium, copper, iron, lead, nickel, silver, thallium, vanadium, and zinc. Filtered and unfiltered samples were collected from two monitoring wells where the turbidity endpoint goal could not be achieved (13 GW 03, 13 GW 03F and 13 GW 01, 13 GW 01F).

Monitoring Well Samples

4,4'-DDT (0.029 ug/L to 0.051 ug/L) and heptachlor (0.0052 ug/L to 0.011 ug/L) were each detected in two groundwater samples (13 GW 01 and 13 GW 02). Compounds detected in only one groundwater sample at Site 13 include 4-methylphenol (2 ug/L in 13 GW 03), carbon disulfide (1 ug/L in 13 GW 04), chloroform (9 ug/L in 13 GW 06), dieldrin (0.022 ug/L in 13 GW 01), endosulfan I (0.028 ug/L in 13 GW 01), 1,1,1-trichloroethane (5 ug/L in 13 GW 01), and vinyl chloride (11 ug/L in 13 GW 02). None of these compounds were detected in background groundwater samples.

Hydropunch/Direct-Push Samples

Groundwater samples obtained by direct-push and hydropunch sampling techniques showed elevated levels of VOCs, including tetrachloroethene (PCE) (0.004 to 70 ug/L) in 16 samples, chloroform (0.01 to 0.4 ug/L) in 10 samples, methylene chloride (0.5 to 65 ug/L) in nine samples, trichloroethene (TCE) (0.2 to 180 ug/L) in seven samples, 1,1 dichloroethene (1,1-DCE) (0.02 to 2 ug/L) in six samples, 1,2-DCE (0.1 to 120 ug/L) in four samples, 1,1,1-trichlorethane (0.02 to 0.2 ug/L) in three samples, and carbon tetrachloride (0.001 ug/L) in one sample. The highest levels of VOCs were detected in location 13 HP 01-15; however, the samples obtained from 30 and 45 feet below the ground surface at this location also showed significant levels of VOCs. The concentrations of contaminants at this location decrease with depth. The significant VOCs detected at this location include PCE, TCE, and 1,2- DCE. Other locations where PCE and/or TCE

were detected at significant levels are 13 HP 03-45, 13 HP 04-17, and 13 HP 04-48. Methylene chloride was detected at elevated levels at locations 13 HP 07 and 13 HP 08.

Miscellaneous parameter analyses of groundwater samples at Site 13 consisted of ammonia, biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorides, nitrates, sulfates, TOC, phosphates, and turbidity. Most indicator parameters revealed lower concentrations in upgradient wells than in downgradient wells (MW13-01 through MW13-03). TOC levels were greater than maximum background groundwater levels in all samples. MW13-02 and MW13-03 exhibited ammonia and BOD concentrations above maximum background levels. Downgradient concentrations were greater than upgradient levels and above background ranges for sulfate in MW13-01 and MW13-02. MW13-05 exhibited levels exceeding background levels for nitrate nitrogen. Concentrations of phosphate exceeded ranges for sulfate in MW13-01 and MW13-02. None of the indicator parameters in upgradient or downgradient wells were high enough to be within a range typically associated with concentrated landfill leachate (Chian and DeWalle, 1976; ASCE, 1976; Brunner and Keller, 1972).

Surface Water

One surface water sample, 13 SW 02, was collected. No organic compounds were detected in the site-related surface water sample. Explosives were analyzed for but were not detected in surface water. Concentrations of most metals in the sample were similar to background ranges. Cadmium was detected at levels near the detection limit and slightly greater than the range of background samples.

Miscellaneous parameter analyses consisted of BOD, COD, chlorides, nitrates, TOC, phosphates, and turbidity. A low level of total petroleum hydrocarbon (TPH) (0.100 mg/L) was detected in sample 13 SW 02. No TPH result greater than the detection limit (0.300 mg/L) was reported in the associated background surface water samples. Concentrations of chloride, nitrate nitrogen, and phosphate were detected above maximum surface water background levels.

1.3.2.3.3 Contaminant Fate and Transport

A wide variety of metals, volatile, semivolatile, and pesticide compounds were detected in Site 13 groundwater. PCBs, metals, semivolatiles, and pesticides were found in sediment, and limited metals were detected in surface water.

Migration of impacted sediments from the landfill through runoff and erosional dispersion may be the cause of the detected PCBs and metals in sediments downstream of the landfill. The landfill appears to be the source of the elevated levels of Aroclor 1260, lead, and silver in the drainage ditch leading from the toe of

the landfill. Aroclor 1260, lead, and silver were detected in the landfill during a previous investigation (1992), and historical information indicates that PCB transformers and batteries were stored on site.

Chemical constituents detected in the sediment at Site 13 have low potential for impacts to groundwater. Detected chemicals in the groundwater indicate the possibility of limited groundwater impacts by certain metals and pesticides. Cadmium was detected at an elevated level in upgradient sample 13 GW 04, and zinc was detected at an elevated level in upgradient sample 13 GW 05, which suggests that the lower levels of these metals detected in a downgradient sample might not be site related.

VOCs detected in groundwater (hydropunch and direct push) indicate a significant source area of VOCs, particularly PCE, TCE, and their degradation products. Results indicate that migration of VOCs in groundwater has occurred.

1.3.2.3.4 Baseline Human Health Risk Assessment

Sediment, groundwater, and surface water were sampled at Site 13. The potential receptors considered for this site were future industrial, residential, and recreational receptors.

The reasonable maximum exposure (RME) cancer risks associated with future residential and future industrial (groundwater) exposure scenarios exceeded 1E-04, the upper end of the target risk range. In addition, central tendency exposure (CTE) cancer risks also for the future residential receptor exceeded 1E-04. Arsenic (via ingestion of and dermal contact with groundwater) and vinyl chloride (via ingestion and inhalation) were the principal chemicals of potential concern (COPCs) that contributed to the cancer risks for these exposure scenarios.

RME estimates for noncarcinogenic hazard indices (HIs) associated with future industrial and future residential (groundwater) exposure scenario exceeded 1.0, the cutoff point below which adverse noncarcinogenic effects are not expected to occur. Arsenic, cadmium, and iron were the COPCs that exceeded 1.0 for these exposure scenarios. In addition, CTE risk estimates for future residential exposure to groundwater yielded an HI greater than 1.0. The target organs included cardiovascular system, skin, kidney, and liver.

The estimated RME cancer risk for the future industrial employee and the future residential receptor exceeds 1E-04, based mainly on ingestion of groundwater. The estimated CTE cancer risk for the future residential receptor exceeds 1E-04, based mainly on ingestion of groundwater. The estimated RME noncancer HI for the future residential receptor exceeds 1.0, based mainly on ingestion of groundwater.

The estimated CTE cancer risk for the future residential receptor exceeds 1.0, based mainly on ingestion of groundwater.

Lead concentrations detected at the site during this RI were below the EPA guidelines and are not expected to be associated with a significant increase in blood-lead levels based on the results of the integrated exposure and uptake biokinetic model (IEUBK) Lead Model (v. 0.99).

1.3.2.3.5 Ecological Risk Assessment

Most of the former landfill is covered by grasses and bare areas with exposed landfill debris (now removed). Abandoned automobiles (now removed) and various other equipment and machinery have been stored on the southern portion of the landfill, inside the fenced area. A large railroad bed and Normandy Road are located east of the site. A channelized stream runs along the western boundary of the fenced area between the road and the fence, and drainage flows to the north. This drainageway eventually empties into Hockhockson Brook approximately 2,500 feet north of the site. Another branch of Hockhockson Brook is located approximately 800 feet east of the site. Therefore, the site is located within the Hockhockson Brook watershed. Forested wetland areas are located north and west of the landfill and are dominated by Atlantic white cedar, black gum, and red maple. The forested wetlands are a few feet lower in elevation than the landfill; the edge of the landfill slopes down into the forested area, and runoff from the landfill flows into the forested area and stream. Standing water in the wetlands is ephemeral and is present only after periods of heavy rainfall. As a result, an aquatic community is not present in these areas, except where the channelized stream runs through the forested area. Most of the debris that was present in the forested area adjacent to the landfill was removed in the summer of 1997. RI Site 11 is located 1,000 feet west of the site, and several other RI sites are located in an area between 2,000 and 3,000 feet southwest of Site 13.

Although habitat on the landfill is limited, the forested wetland areas north and west of the landfill provide excellent habitat, primarily for terrestrial receptors. The channelized stream contains marginal aquatic habitat, although it connects with Hockhockson Brook several hundred feet north of the site. Runoff from the landfill drains to the wetlands and stream, and groundwater at the site flows toward the stream and wetlands, indicating potential groundwater to surface water contaminant migration.

Surface water, sediment, and surface soil samples were taken as part of site inspection (SI) activities at Site 13. Low levels of several metals were detected in surface water, and no organics were detected. In sediments, SVOCs were detected (including low levels of phenanthrene, pyrene, and one phthalate). In addition, PCBs and one pesticide, 4,4'-DDE, were detected at low concentrations. In SI surface soil samples taken on the landfill, several PAHs were detected at low concentrations, some pesticides were detected at low concentrations, and some elevated metals concentrations were present. RI groundwater samples taken

in 1995 indicated the presence of elevated concentrations of several inorganics and low levels of several organics, including some pesticides. No PCBs were detected in groundwater.

One surface water and three sediment samples were taken in the drainage ditch and forested wetlands as part of 1995 RI activities to investigate off-site migration and were used for quantitative assessment. Hazard quotients (HQ) values for inorganics in surface water were indicative of low potential risk, with the exception of silver, which had a relatively high HQ. Nonetheless, silver was only detected slightly above background, and the elevated HQ may be due to the only ecotox thresholds (ET) available for this inorganic, which may be excessively conservative. No organics were detected in the surface water sample. HQ values for inorganics in sediments were indicative of low potential risk, with the exception of silver, which slightly exceeded a less conservative ET value. Aluminum and vanadium were conservatively retained as final COPCs since no suitable ET values were available, but these metals were less than background. HQs for organics were indicative of low potential risk, with the exception of the two PCB compounds detected, Aroclor 1254 and 1260. Both these mixtures exceeded less conservative ET values.

In summary, HQ values for metals in both surface water and sediment were indicative of low potential risk, with the exception of silver in both media. No organics were detected in surface waters and HQs for organics in sediments were indicative of low potential risk, except for PCBs. Silver was not detected in SI surface water samples. PCBs were detected at low levels in SI sediment samples, but silver was not analyzed for. Slightly elevated levels of silver were detected in three of six SI surface soil samples taken on the landfill, though this inorganic was detected in only one 1995 RI groundwater sample. In addition, low levels of PCBs were detected in five of six SI surface soils samples but were not detected in RI groundwater samples. For these reasons, overland runoff appears to be the dominant migration pathway to the wetlands and stream. These compounds are highly lipophilic and tend to bioaccumulate and biomagnify. Nonetheless, all PCB congeners have strong affinities for organic carbon in surface soils and sediments and do not migrate significantly. Both of the detected PCB compounds are characterized by higher-chlorinated PCB congeners, which have a greater affinity for organic carbon than lower-chlorinated PCB congeners. As a result, downstream migration of PCBs into Hockhockson Brook is highly unlikely. Although silver and two Aroclors may pose moderate potential risk to aquatic and semi-aquatic receptors near the landfill, aquatic habitat is limited in the area since the channelized stream is small and the wetlands are forested with ephemeral standing water. In addition, it does not appear that silver is migrating or PCBs have the potential to migrate to better habitats downstream in Hockhockson Brook.

1.4 GROUNDWATER FATE AND TRANSPORT MODELING

As part of the FS, computer modeling of the contaminant plume associated with Site 13 was prepared to help assess the fate and transport of contaminants. The purpose of this modeling was to estimate the

time period required for contaminant concentrations to diminish to background or state groundwater quality criteria as well as estimate the maximum anticipated contaminant levels within a specified compliance point.

The modeling was prepared using the available RI hydrogeologic data, groundwater analytical results, and chemical properties derived through literature. Computer modeling was performed to assess the long-term impact of groundwater contamination and to assess the need for groundwater response actions. Modeling was performed using available data only. No site-specific equilibrium values were developed. Where site-specific data were not available, literature values were used for model input.

Available metals data were used to develop estimates for Site 13. The representative metals and organics, together with their associated concentrations, which were developed for use in the risk assessment, were employed as the input values for modeling at Site 13. The modeling results are presented in Appendix A and are discussed in Section 2.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Remedial alternatives are developed by assembling combinations of technologies and the media to which they would be applied into an appropriate range of alternatives that address site contamination, risks, or threats. This section presents the preliminary phase of the remedial alternatives development process, which consists of the identification and screening of remedial technologies and includes the following:

- Developing RAOs that are protective of human health and the environment with regard to the contaminants and media of concern, exposure pathways, and the PRGs and that permit a range of treatment and containment alternatives to be developed.

- Developing general response actions for each medium of interest that define measures that may be taken singly or in combination to satisfy the RAOs for the site.

- Identifying the numbers, volumes, or areas of media to which the general response actions might be applied.

- Identifying and screening the technologies applicable to each general response action.

Section 2.1 presents a preliminary listing of ARARs and TBCs in the development of RAOs for the NWS Earle OU-5 Site. Section 2.2 briefly presents the overall approach used to develop RAOs. Section 2.3 summarizes the overall approach used in development of PRGs. Section 2.4 identifies the general response actions that may be implemented at NWS Earle. Section 2.5 discusses the methods used for identification, screening, and evaluation of remedial alternatives. The site-specific development of RAOs, PRGs, general response actions, and screening of remedial technologies and process options for Site 13 is presented in Section 2.6.

2.1 POTENTIAL 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 clean-up 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. For example, if a new municipal landfill is being considered, then regulatory requirements that specifically govern its construction, operation, and closure are applicable.

- **Relevant and Appropriate Requirements** - Section 300.5 of the NCP defines relevant and appropriate requirements as those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "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. For example, a municipal landfill that was constructed and operated prior to the promulgation of landfill regulations may be closed in accordance with the "relevant and appropriate" requirements of those regulations that identify activities needed to close the landfill.

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.

ARARs and TBCs are divided into three categories: chemical specific, location specific, and action specific. In Sections 2.1.1 through 2.1.3, these categories are briefly described and general types of potential ARARs and TBCs that may be applied to the site are identified. The detailed discussions of the potential ARARs and TBCs for specific remedial alternatives are provided in Section 4.0.

2.1.1 Potential Chemical-Specific ARARs and TBCs

Chemical-specific ARARs and TBCs are usually health- or risk-based numerical values that are used to establish the acceptable amount or concentration of a chemical that may remain in or be discharged to the environment. In general, chemical-specific requirements are set for a single chemical or a closely related group of chemicals. These requirements do not consider the mixture of chemicals. Typical

chemical-specific ARARs are federal and state drinking water standards. Summaries of the potential federal and state chemical-specific ARARs and TBCs and their consideration in the FS are provided in Tables 2-1 and 2-2, respectively.

The aquifer underlying NWS Earle is classified as Class II-A, a potential source of potable water under New Jersey regulations [N.J.A.C. 7:9-6]. Groundwater at Site 13 is not currently used for drinking water and potable water is provided by a public water supply. Federal chemical-specific ARARs such as the Safe Drinking Water Act (SDWA) Maximum Containment Levels (MCLs) [40 CFR 141] and the Resource Conservation and Recovery Act (RCRA) MCLs and Alternate Concentration Limits (ACLs) [40 CFR 264.94] may be relevant and appropriate requirements in establishing groundwater clean-up levels or may be used to help derive potential soil remediation levels. Non-zero MCL Goals (MCLGs) are non-promulgated health-based drinking water supply limits that are to be considered during the development of groundwater clean-up goals. EPA reference doses, carcinogen potency factors, and health advisories, when available, are all factors used to assess potential risks and can be used to derive risk-based clean-up limits. The disposal of contaminated soils may be restricted by the RCRA Land Disposal Restrictions [40 CFR 268], which may potentially be applicable.

Chemical-specific ARARs for the NWS Earle Sites include the New Jersey Ground Water Quality Standards (GWQSs) [N.J.A.C. 7:9-6] that regulate groundwater quality. Potential chemical-specific ARARs include the Surface Water Quality Standards [N.J.A.C. 7:9B] that provide guidelines for surface water quality. These state ARARs may potentially be relevant and appropriate and may be used to establish clean-up levels that are protective of human health and the environment.

While there are no specific promulgated soil clean-up standards, Office of Solid Waste and Emergency Response (OSWER) Directive No. 9355.4-12, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, and the New Jersey Soil Cleanup Criteria may be considered in developing site-specific clean-up levels.

2.1.2 Potential Location-Specific ARARs and TBCs

Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because the substances or activities are in specific areas. The general types of location-specific ARARs that may be applied to the sites are briefly described below. Summaries of the potential federal and state location-specific ARARs and TBCs and their consideration in this FS are provided in Tables 2-3 and 2-4, respectively.

TABLE 2-1
POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Safe Drinking Water Act (SDWA) - Maximum Contaminant Levels (MCLs) (40 CFR 141.11-141.16)	Potentially Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants to regulate the concentration of contaminants in public drinking water supply systems. MCLs may be relevant and appropriate for groundwater because the aquifer beneath the site is a potential drinking water supply.	MCLs may be used to establish clean-up levels for the portion of the aquifer underlying Site 13. MCLs can be used to derive potential soil clean-up levels.
Resource Conservation and Recovery Act (RCRA) - Groundwater Protection Standard (40 CFR 264.94)	Potentially Relevant and Appropriate	The RCRA groundwater protection standard is established for groundwater monitoring of RCRA-permitted treatment, storage, or disposal facilities. The standard is set at either an existing or proposed RCRA MCL, background concentration, or an alternate concentration limit (ACL) protective of human health and the environment.	RCRA MCLs may be used or ACLs may be developed to identify levels of contamination in the aquifer above which human health and the environment are at risk and to provide an indicator when corrective action is necessary.
RCRA Land Disposal Restrictions (40 CFR 268)	Potentially Applicable	These regulations identify hazardous wastes that are restricted from land disposal and establish waste analysis and recordkeeping requirements and "treatment standards" (concentration levels or methods of treatment) that wastes must meet in order to be eligible for land disposal.	Contaminated soil must be analyzed and disposed in accordance with the requirements of these regulations. If necessary, soils will be treated to attain applicable "treatment standards" prior to placement in a landfill or other land disposal facility. This requirement would be considered for alternatives involving land disposal.
Clean Water Act - Ambient Water Quality Criteria (AWQCs)	To Be Considered	AWQC are non-promulgated health-based surface water quality criteria that have been developed for carcinogenic and non-carcinogenic compounds for the protection of human health. AWQCs have also been developed for the protection of aquatic organisms.	AWQC may be used to assess need for remediation of discharges to surface water or to use as benchmarks during long-term monitoring.

TABLE 2-1
POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
SDWA Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 and 141.51)	To Be Considered	MCLGs are health-based limits for contaminant concentrations in drinking water. MCLGs are established at levels at which no known or anticipated adverse effects on human health are anticipated and that allow for an adequate margin of safety. MCLGs are set without regard for cost or feasibility.	Non-zero MCLGs may be used as clean-up levels if conditions at the site justify setting clean-up levels lower than MCLs.
Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (OSWER Directive No. 9355.4-12) (Jul 1994)	To Be Considered	This OSWER Directive recommends a lead soil screening level of 400 ppm for residential land use based on the IEUBK model. The screening value may be used to determine whether sites or portions of sites warrant further evaluation and evaluations of risks.	If any of Site 13 is to be considered for eventual residential use, then the screening value may be used to assess whether site-specific lead levels require further evaluation and possible remediation.
EPA Groundwater Protection Strategy	To Be Considered	Provides classification and restoration goals for groundwater based on its vulnerability, use, and value.	This strategy was considered in conjunction with the federal SDWA and state Groundwater Protection Rules in order to determine groundwater clean-up levels.
EPA Risk Reference Doses (RfDs)	To Be Considered	RfDs are dose levels developed by EPA for use in estimating the non-carcinogenic risk resulting from exposure to toxic substances.	RfDs were used to assess health risks due to exposure to non-carcinogenic contaminants present at the site. RfDs may also be used in the development of acceptable contaminant concentrations.
EPA Carcinogen Assessment Group Potency Factors (CPFs)	To Be Considered	EPA CPFs are used to compute the individual incremental cancer risk resulting from exposure to carcinogens.	CPFs were used to assess health risks from carcinogens present at the site. These factors may also be used in the development of acceptable contaminant concentrations.

TABLE 2-1
POTENTIAL STATE CHEMICAL-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
EPA Health Advisories and Acceptable Intake Health Assessment Documents	To Be Considered	Intended for use in qualitative human health evaluation of remedial alternatives.	These advisories and health assessment documents were used in assessing health risks from contaminants present at the site.
Clean Air Act - Standards for Air Emissions from Municipal Solid Waste Landfills (40 CFR 60.752 and 60.753)	Potentially Relevant and Appropriate	Active landfills with design capacities equal to or greater than 2.5 million cubic meters are required to have landfill gas collection and control systems if greater than 50 megagrams of non-methane organic compounds are expected to be emitted. The collection system shall be operated so that the methane concentration is less than 500 ppm above background at the surface of the landfill.	The Site 13 landfill is estimated to be much less than 2 million cubic feet in capacity. However, soil gas studies and measurement of methane concentrations at the landfill surfaces need to be conducted during the pre-design phase to determine whether landfill gas controls need to be included as part of the control systems.

TABLE 2-2
POTENTIAL STATE CHEMICAL-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
New Jersey Ground Water Quality Standards (GWQS) (N.J.A.C. 7:9-6)	Applicable	This regulation establishes the rules to protect ambient groundwater quality through establishing groundwater protection and clean-up standards and setting numerical criteria limits for discharges to groundwater. The Groundwater Quality Criteria (GWQC) (N.J.A.C. 7:9-6.7) are the maximum allowable pollutant concentrations in groundwater that are protective of human health. This regulation also prohibits the discharges to groundwater that subsequently discharges to surface water do not comply with the Surface Water Quality Standards (SWQS).	Because contaminated groundwater is present underneath Site 13 in excess of GWQS, these regulations will be considered in determining groundwater action levels. Application for Classification Exception Area (CEA) may be required if GWQS will not be met during the term of proposed remediation. The CEA procedure ensures that designated groundwater uses at remediation sites are suspended for the term of the CEA.
New Jersey Surface Water Quality Standards (SWQS) (N.J.A.C. 7:9B)	Applicable	These standards establish rules to protect and enhance surface water resources, define surface water classifications and uses, and establish water-quality-based criteria, and effluent discharge limitations. The Surface Water Quality Criteria (SWQC) (N.J.A.C. 7:9B-14) are the maximum allowable pollutant concentrations in surface water for the designated use.	For alternatives where surface water may be affected, remedial measures may be needed so that the SWQC are attained in the long term. Remedial alternatives shall consider action to mitigate the continued contamination of surface waters.
New Jersey Safe Drinking Water Act (N.J.A.C. 7:10)	Potentially Relevant and Appropriate	These regulations were promulgated to assure the provision of safe drinking water to consumers in public community water systems. Maximum Contaminant Levels (MCLs) (N.J.A.C. 7:10-16) have been established to regulate the concentration of organic and metal contaminants in water supplies. MCLs may be relevant and appropriate for groundwater because the aquifer beneath the site is a potential drinking water supply.	MCLs may be used to establish clean-up levels for groundwater underlying Site 13. MCLs can be used to derive potential soil clean-up levels.

TABLE 2-2
POTENTIAL STATE CHEMICAL-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
New Jersey Soil Cleanup Criteria	To Be Considered	These are non-promulgated soils clean-up criteria for residential direct contact, non-residential direct contact, and impact to groundwater (through leaching).	These criteria will be considered in the development of soil clean-up goals.

TABLE 2-3
POTENTIAL FEDERAL LOCATION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Wetlands Executive Order (E.O. 11990) & 40 CFR 6, App. A (Policy on Implementing E.O. 11990)	Potentially Applicable	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and preserve and enhance natural and beneficial values of wetlands.	Remedial alternatives that involve excavation or deposition of materials will include all practicable means of minimizing harm to the wetlands adjacent to Site 13. Wetlands protection consideration will be incorporated into the planning, decision making, and implementation of remedial alternatives.
Floodplains Executive Order (E.O. 11988) & 40 CFR 6, App. A (Policy on Implementing E.O. 11988)	Potentially Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial value of floodplains.	The potential effects on floodplains will be considered during the development and evaluation of remedial alternatives. All practicable measures will be taken to minimize adverse effects on floodplains.
Resource Conservation and Recovery Act (RCRA) Location Standards, Floodplains (40 CFR 264.18 (a))	Potentially Applicable	Any RCRA facility that treats, stores, or disposes of hazardous waste, if situated in a 100-year floodplain, must be designed, constructed, operated, and maintained to avoid washout.	Where possible, remedial alternatives that include construction of a treatment, storage, or disposal facility will be sited outside a 100-year floodplain.
Endangered Species Act of 1973 (16 USC 1531 et seq.); (50 CFR Part 200)	Potentially Applicable, if present	Actions shall be taken to conserve endangered or threatened species or to protect critical habitats. Consultation with the Department of the Interior is required.	The RI determined that there were no sensitive habitats (except for wetlands) or endangered or threatened species present at Site 13.
Fish and Wildlife Coordination Act Of 1958 (16 U.S.C. 661) Protection of Wildlife Habitats	Potentially Applicable	This regulation requires that any federal agency that proposes to modify a body of water must consult with the U.S. Fish and Wildlife Service and requires that actions be taken to avoid adverse effects, minimize potential harm to fish or wildlife, and preserve natural and beneficial uses of the land.	During the evaluation of alternatives, potential remediation effects on the wetlands and floodplains are evaluated. If it is determined that an impact may occur, then the Fish and Wildlife Service, NJDEP, and EPA would be consulted.

TABLE 2-3
POTENTIAL FEDERAL LOCATION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
National Historic Preservation Act of 1966 Section 106 (16 USC 470 et. seq.)	Potentially Applicable, if present	Action will be taken to recover and to preserve historic artifacts that may be threatened as the result of terrain alteration.	Potential ARAR if artifacts are encountered during active site remediation (e.g., excavation, consolidation, grading). To date, no such artifacts have been encountered at Site 13.
National Archeological and Historic Preservation Act of 1974 (132 CFR 229)	Potentially Applicable, if present	Action will be taken to recover and to preserve scientific, prehistoric, historic, or archaeologic artifacts that may be threatened as the result of terrain alteration.	Potential ARAR if artifacts are encountered during active site remediation (e.g., excavation, consolidation, grading). To date, no such artifacts have been encountered at Site 13.

TABLE 2-4
POTENTIAL STATE LOCATION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
New Jersey Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A)	Potentially Applicable	Regulate activities that result in the disturbance in and around freshwater wetland areas including removing or dredging wetland soils, disturbing the water level or water table, driving piles, placing obstructions, destroying plant life, and discharging dredged or fill materials into open water.	Remedial alternatives will be developed to avoid activities that would be detrimental to the wetlands located adjacent to Site 13.
New Jersey Freshwater Wetlands Protection Act Rules, Mitigation (N.J.A.C. 7:7A-14)	Potentially Applicable	This regulation requires mitigation of the disturbed wetlands or filled open water. Generally requires the restoration, creation, or enhancement of area, or donations to the Mitigation Bank, of equal ecological value.	If a remedial alternative action results in the loss of wetlands through dredging, filling, or construction activities, then mitigation measures will need to be incorporated into the alternative's design.
New Jersey Flood Hazard Area Control (N.J.A.C. 7:14)	Potentially Applicable	These regulations control development in floodplains and water courses that may adversely affect the flood-carrying capacity of these features, subject new facilities to flooding, increase storm water runoff, degrade water quality, or result in increased sedimentation, erosion, or environmental damage.	This requirement is applicable to remedial alternative actions that may adversely affect floodplains adjacent to Site 13.
New Jersey Siting Criteria for New Major Commercial Hazardous Waste Facilities (N.J.A.C. 7:26-13)	Potentially Relevant and Appropriate	These regulations specify siting requirements and limitations for commercial hazardous waste facilities including protection of nearby residents, surface water, groundwater, air, and environmentally sensitive areas.	No on-site or on-base treatment schemes are anticipated for Site 13. However, if remedial alternatives employs an on-site or on-base treatment scheme, then remediation activities will need to be consistent with these requirements.

Several federal and state regulations govern activities in wetlands and floodplains that may result in their degradation or impairment of their functions. Potential location-specific ARARs include Executive Orders 11990 and 11988 for wetlands and floodplains, respectively; the RCRA Location Standards governing the siting of treatment, storage, and disposal facilities in a 100-year floodplain; the New Jersey Freshwater Wetlands Protection Act Rules; the New Jersey Flood Hazard Area Control regulations; and the State Siting Criteria for New Major Commercial Hazardous Waste Facilities (no on-base treatment of contaminated materials is anticipated).

The Federal Fish and Wildlife Coordination Act and the Endangered Species Act are potential ARARs that are promulgated protect wildlife and endangered species (if present or encountered) during remediation.

If historic or archeological artifacts are encountered during remediation, then the National Historic Preservation Act of 1966 and the National Archeological and Historic Preservation Act of 1974 may be potential ARARs that would be invoked to prevent their loss.

2.1.3 Potential Action-Specific ARARs and TBCs

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are generally focused on actions taken to remediate, handle, treat, transport, or dispose of hazardous wastes. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved. Summaries of the potential action-specific federal and state ARARs and TBCs and their consideration in the FS are provided in Tables 2-5 and 2-6, respectively.

If site soils, sediments, or landfill materials are determined to be hazardous by characteristic or are listed wastes (per RCRA Identification and Listing of Hazardous Waste [40 CFR 261]), then these action-specific ARARs may potentially be applicable to the how they are treated, stored, or disposed or to the treatment processes considered. These ARARs include federal regulations governing the off-site transport of hazardous wastes [40 CFR 262 and 263], general facility standards [40 CFR 265 Subpart B], preparedness and prevention [40 CFR 265 Subpart C], contingency plan and emergency procedures [40 CFR 265 Subpart D], manifesting and recordkeeping [40 CFR 265 Subpart E], closure and post-closure of municipal landfills [40 CFR 258 Subpart F], land treatment [40 CFR 265 Subpart P], thermal treatment [40 CFR 265 Subpart X], and miscellaneous treatment units [40 CFR 264 Subpart X].

State ARAR regulations that may be applicable to remedial actions for hazardous wastes include off-site transport of hazardous wastes [N.J.A.C. 7:26-7]; general facility standards, preparedness and prevention, contingency, and emergency procedures, record keeping and closure and post-closure requirements

TABLE 2-5
POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Resource Conservation and Recovery Act (RCRA) - Hazardous Waste Generator and Transporter Requirements (40 CFR parts 262 and 263)	Potentially Applicable	These regulations establish the responsibilities of generators and transporters of hazardous waste in the handling, transportation, and management of waste. The regulations specify the packaging, labeling, recordkeeping, and manifest requirements.	Activities performed in connection with off-site transport of hazardous wastes will comply with the requirements of these regulations.
RCRA - General Facility Standards (40 CFR 265 Subpart B)	Potentially Applicable	General facility requirements outline general waste analysis, security measures, inspections, and training requirements.	If a remedial alternative includes the establishment of an on-base treatment facility for hazardous wastes (characterisitic or listed), then this regulation will be considered. This regulation specifies TSD facilities construction, fencing, postings, and operations. All workers will be properly trained. Process wastes will be evaluated for the characteristics of hazardous wastes to assess further handling requirements.
RCRA - Preparedness and Prevention (40 CFR 265 Subpart C)	Potentially Applicable	Outlines requirements for safety equipment and spill control.	If a remedial alternative includes treatment, storage, or disposal of hazardous wastes, then this regulation will be considered. Safety and communication equipment will be maintained at the site. Local authorities will be familiarized with the site operations.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 265 Subpart D)	Potentially Applicable	Outlines requirements for emergency procedures to be used following explosions, fires, etc.	If the alternative includes treatment, storage, or disposal of hazardous wastes, then contingency plans will be developed. Copies of the plans will be kept on site.
RCRA - Manifesting Recordkeeping, and Reporting (40 CFR 265 Subpart E)	Potentially Applicable	Specifies the recordkeeping and reporting requirements for RCRA facilities.	If the alternative includes treatment, storage, or disposal of hazardous wastes, then records of facility activities will be developed and maintained during remedial actions.

TABLE 2-5
POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
RCRA - Closure and Post-Closure (40 CFR 258, Subpart F)	Potentially Relevant and Appropriate	Details specific requirements for closure and pos-closure of municipal solid waste landfills. Final cover requirements that address minimizing infiltration and erosion are identified in this regulation. Following closure, post-closure requirements include preparing a post-closure plan, maintaining integrity and effectiveness of the final cover, groundwater monitoring, and maintaining and operating a gas collection system.	If an alternative includes closure of a solid waste landfill, then these requirements will be considered in formulating the alternative.
RCRA - Land Treatment (40 CFR 265 Subpart M)	Potentially Applicable	These regulations detail the requirements for conducting land treatment of RCRA hazardous waste.	Alternatives that involve on-site treatment of hazardous wastes (contaminated soil or sediments) will comply with these regulations.
RCRA - Thermal Treatment (40 CFR 265 Subpart P)	Potentially Applicable	This regulation details operating requirements and performance standards for thermal treatment of hazardous wastes.	Alternatives that include thermal or catalytic oxidation of offgases would be designed and operated in compliance with this regulation.
RCRA - Miscellaneous Treatment Units (40 CFR 264 Subpart X)	Potentially Applicable	This regulation details design and operating standards for units in which hazardous waste is treated.	Hazardous waste treatment units used for on-site or on-base treatment of contaminated media must meet these requirements.
RCRA - Air Emission Standards for Process Vents (40 CFR 265 Subpart AA)	Potentially Applicable	This regulation contains air pollutant emission standards for process vents, closed-vent systems, and control devices at hazardous waste TSD facilities. This subpart applies to equipment associated with solvent extraction or air/steam stripping operations that treat wastes that are identified or listed RCRA hazardous wastes and have a total organics concentration of 10 ppm or greater.	These standards will be considered during the development and design of alternatives that include treatment of VOC-contaminated soils. Air emissions from treatment units will be monitored to ensure compliance with this ARAR.

TABLE 2-5
POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
OSWER Directive 9355.0-62FS Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance) (April 1996)	To Be Considered	This EPA directive provides guidance in evaluating military landfill sites and determining whether presumptive remedies can be applied.	The procedures and suggested remedial actions will be considered in formulating remedial alternatives for Sites 13.
OSWER Directive 9355.0-49FS Presumptive Remedy for CERCLA Municipal Landfill Sites (Sep 1993)	To Be Considered	This EPA directive provides guidance in evaluating CERCLA municipal landfill sites and determining if presumptive remedies can be applied.	The procedures and suggested remedial actions will be considered in formulating remedial alternatives for Sites 13.

TABLE 2-6
POTENTIAL STATE ACTION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	COMMENTS
New Jersey Labeling, Records, and Transportation Requirements (N.J.A.C. 7:26-7)	Potentially Applicable	These regulations establish the responsibilities of generators and transporters of hazardous waste in the handling, transportation, and management of waste. The regulations specify the packaging, labeling, recordkeeping, and manifest requirements.	Activities performed in connection with off-site transport of hazardous wastes will comply with the requirements of these regulations.
New Jersey Requirements for Hazardous Waste Facilities (N.J.A.C. 7:26-9)	Potentially Applicable	These regulations identify requirements for facilities in general, groundwater monitoring, preparedness and prevention, contingency and emergency procedures, and general closure and post-closure.	If a remedial alternative includes the establishment of an on-base treatment facility for contaminated soils and materials, then this regulation will be complied with during implementation.
New Jersey Closure and Post-Closure Care of Sanitary Landfills Regulations (N.J.A.C. 7:26-2A.9)	Potentially Relevant and Appropriate	Details specific requirements for closure and post-closure of municipal solid waste landfills. Final cover requirements that address minimizing infiltration and erosion are identified in this regulation. Following closure, post-closure requirements include preparing a post-closure plan, maintaining integrity and effectiveness of final cover, groundwater monitoring, and maintaining and operating a gas collection system.	If an alternative includes closure of a solid waste landfill, then these requirements will be considered in formulating the alternative.
New Jersey Thermal Treatment Regulations (N.J.A.C. 7:26-11.6)	Potentially Applicable	These regulations detail operating requirements, waste analyses and monitoring of treatment conditions, performance standards, and closure of existing facilities that thermally treat hazardous wastes.	Alternatives that include thermal treatment of contaminated soils, sediments, and materials would be designed and operated consistent with this regulation.

TABLE 2-6
POTENTIAL STATE ACTION-SPECIFIC ARARs AND TBCs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	COMMENTS
New Jersey Chemical, Physical, and Biological Treatment Regulations (N.J.A.C. 7:26-11.7)	Potentially Applicable	These regulations detail operating requirements, waste analyses and monitoring of treatment conditions, and closure of existing facilities that physically, chemically, or biologically treat hazardous wastes. Also governs handling and compatibility of wastes in treatment processes.	Alternatives that include physical, chemical, or biological treatment of contaminated soils, sediments, and materials would be designed and operated consistent with this regulation.
New Jersey Control and Prohibition of Air Pollution by Toxic Substances (N.J.A.C. 7:27-17)	Potentially Applicable if emissions greater than 45.4 g/hr (0.1 lb/hr)	These regulations govern the emission of Group I and Group II toxic volatile organic compounds (TXS) to the ambient air. Group I TXS would be addressed through adequate stack height or prevention of aerodynamic downwash. Group II TXS would be addressed through reasonably available control technology.	Alternatives that may result in the release of Group I or Group II TXS to the ambient air, exceeding 0.1 lb/hr, would incorporate appropriate vapor control measure to comply with these requirements.

[N.J.A.C. 7:26-9]; closure and post-closure of sanitary landfills [N.J.A.C. 7:26-2A.9]; thermal treatment [N.J.A.C. 7:26-11.6]; and physical, chemical, and biological treatment [N.J.A.C. 7:26-11.7].

Because Site 13 is a military landfill, two OSWER directives are TBC guidance documents that may be considered in developing remedial alternatives that employ presumptive remedies. These guidance documents are OSWER Directive 9355.0-62FS, Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance) (April 1996); and OSWER Directive 93550.0-49FS, Presumptive Remedy for CERCLA Municipal Landfill Sites (September 1993).

2.2 METHOD USED FOR DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The development of the medium-specific RAOs for a site is typically based on the risks posed by site-related contaminants to human and ecological receptors, threats or continued degradation of environmental media (groundwater, surface water, and wetlands), and comparison of detected contaminant levels with available regulatory standards.

Generally, human health RAOs are formulated to prevent exposures to site-related contaminants that result in excess carcinogenic and non-carcinogenic health risks or to contaminants that exceed regulatory requirements (e.g., MCLs in potable water).

Ecological RAOs are formulated to reduce or prevent the detrimental effects of site-related contaminants on environmental media (e.g., degradation of groundwater quality) or to address contaminant concentrations that exceed regulatory standards (e.g., New Jersey GWQSs).

RAO development for Sites 13 is presented in Sections 2.6.

2.3 METHOD USED FOR DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

The determination of numerical remediation goals is an iterative process beginning with the development of a range of medium- and chemical-specific contaminant levels that would be protective of human health or the environment if present in site soils and groundwater. Remediation goals that establish acceptable contaminant levels or ranges of levels that must be achieved under the remedial action are ultimately chosen from the range of PRGs when the remedy is selected.

A range of PRGs for each site was developed for soil and groundwater COCs based on the results of the RI, human health risk assessment, and chemical-specific ARARs. Additionally, background concentrations of COCs and analytical detection limits were identified as potential PRGs to ensure selection of clean-up goals that are reasonably attainable and measurable. Each type of PRG is briefly discussed below. A set of PRGs was developed and the basis for selection is presented.

Typically, a promulgated regulated ARAR is selected as the proposed PRG unless background levels or the analytical detection limit is higher. If no ARAR is available, then the higher of either the risk-based value or the maximum background value (inorganic) was selected, assuming that value was higher than the detection limit.

Each type of PRG is briefly discussed below. PRGs developed for each site are presented in Section 2.6.

2.3.1 ARAR/TBCs Basis

There are no promulgated chemical-specific federal or state ARARs for soils. However, the state has established a set of non-promulgated soil clean-up criteria (TBCs) for residential direct contact, non-residential direct contact, and impact to groundwater. The Interim Soil Lead Guidance (EPA, 1994) is a TBC for lead in soils. Although the screening criterion presented in the guidance is not intended for use as a PRG, the guidance will be considered in the development of PRGs.

There are chemical-specific federal and state groundwater ARARs. The state GWQSs are promulgated under the New Jersey Administrative Code Title 7, Chapter 9-6 (N.J.A.C. 7:9-6) and establish allowable contaminant concentrations in groundwater. The New Jersey surface water quality criteria (SWQCs) are promulgated under N.J.A.C. 7:9B and establish allowable contaminant concentrations in surface water.

2.3.2 Human Health Risk Basis

Human-health-risk-based PRGs were developed for the future industrial worker and resident exposure scenarios, based on carcinogenic risks of 10^{-6} and an HI of 0.1. Risk-based concentrations (RBCs) will be considered in the PRGs development. It should be noted that there are no plans to use the site for residential purposes.

2.3.3 Ecological Risk Basis

ET values were used for screening potential risks to ecological receptors from contaminants detected in the site-related samples. The ecological risk assessment endpoint was the protection of plants/animals inhabiting the wetland area and the Hockhockson Brook Watershed.

2.3.4 Protection of Groundwater Basis

The PRGs for protection of groundwater represent soil contaminant concentrations that, when leached into groundwater, would be protective of groundwater. The New Jersey Soil Clean-up Criteria identified a set of non-promulgated soil organic chemical concentrations that would be protective of groundwater if leaching of contaminants occurred.

2.3.5 Background Concentrations Basis

Some inorganic compounds of concern (COCs) (natural components of soil) are present in site soils and in the background locations (areas deemed not to be affected by the sites) at concentrations higher than the risk-based or groundwater protection-based PRGs calculated for the sites. Section 31 of the RI report presents background results. Because it is not reasonable and may not be possible to remediate site soils to concentrations lower than are present naturally in area soils, background concentrations may be considered as reasonable PRGs for inorganics. Under the RI, eight representative background soil samples were collected and the mean and 95 percent UTL (upper tolerance limit) values were calculated and are presented in Tables 1-7 and 1-8 of this FS report. Representative background groundwater concentration values for formations underlying NWS Earle are presented in Tables 1-4, 1-5, and 1-6. These values are also presented in the site-specific PRG tables of this FS.

2.4 METHOD USED FOR DEVELOPMENT OF GENERAL RESPONSE ACTIONS

The RAOs were used to develop general response actions that describe medium-specific measures that will satisfy the RAOs. 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 each site's 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 and landfill materials at the site 13 include the following:

- No Action
- Limited Action (Institutional Controls)
- Containment
- Excavation and Treatment Actions
- Excavation, Treatment, and Disposal Actions

The soil general response actions can also be applied to sites where contaminated sediments need to be

addressed.

General response actions that may be applicable to the contaminated groundwater include the following:

- No Action
- Limited Action (Institutional Controls)
- Containment Actions
- Collection and Discharge (clean groundwater only)
- Collection, Treatment, and Discharge Actions
- In-Situ Treatment

General response actions specific to Site 13 are presented in Sections 2.6 of this FS.

2.5 METHOD USED FOR IDENTIFICATION, SCREENING, AND EVALUATION OF REMEDIAL TECHNOLOGIES

During this phase of alternatives 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 at each site, 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 (technical implementability) to the media (soils, groundwater, etc.), primary contaminants of concern (metals, volatile organic compounds), and conditions present at each of the sites, including heterogeneous soils, landfill materials, leaching of contaminants to underlying groundwater, erosion and runoff of contaminated materials, vertical hydraulic gradients, etc.

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 Investigations and Feasibility Studies under CERCLA (Interim Final) (EPA, 1988) suggests that this evaluation focus on the effectiveness criterion, with less emphasis directed at the implementability and relative cost criteria. Brief definitions of effectiveness, implementability, and relative

cost, as they apply to the evaluation process, follow:

- Effectiveness - This criterion focuses on the potential effectiveness of process options in handling the estimated volume of media and meeting the remediation goals; the potential impacts to human health and the environment during construction and implementation; and how proven and reliable the process is with respect to the contaminants and conditions at the site.

- Implementability - The implementability evaluation encompasses both the technical and institutional feasibility of implementing a process. Technical implementability was used in developing general response actions as an initial screen of technology types and process options, to eliminate those that are clearly ineffective or unworkable at a site. Therefore, this subsequent, more detailed evaluation of process options places greater emphasis on the institutional aspects of implementability, such as the ability to obtain permits, availability of treatment, storage, and disposal services, and availability of necessary equipment and resources.

- Cost - Cost plays a limited role in this screening. The cost analysis is based on engineering judgment, and each process is evaluated as to whether costs are high, low, or medium relative to the other options in the same technology type. If there is only one process option, costs are compared to other candidate technologies.

The screening and detailed evaluation of technology types and process options are presented in summary tables.

2.6 SITE 13 TECHNOLOGY SCREENING

The selection of viable remedial technologies and process options for assemblage into remedial alternatives for Site 13 is presented in this section.

2.6.1 Site 13 Remedial Action Objectives

The results of the RI, previous investigations, and the human health and ecological risk assessments for Site 13 were evaluated to determine the remedial action objectives that may be needed to protect human health and the environment.

Human Health Protection Considerations

Sediment, groundwater, and surface water were sampled at Site 13. The potential receptors considered for

this site were future industrial, residential, and recreational receptors.

The RME cancer risks associated with future residential and future industrial (groundwater) exposure scenarios exceeded 1E-04, the upper end of the target risk range, based mainly on ingestion of groundwater. In addition, CTE cancer risks for the future residential receptor exceeded 1E-04, also based mainly on ingestion of groundwater. Arsenic (via ingestion of and dermal contact with groundwater) and vinyl chloride (via ingestion and inhalation) were the principal (COPCs) that contributed to the cancer risks for these exposure scenarios.

RME estimates for noncarcinogenic HIs associated with future industrial and future residential (groundwater) exposure scenario exceeded 1.0, the cutoff point below which adverse noncarcinogenic effects are not expected to occur, based mainly on ingestion of groundwater. Arsenic, cadmium, and iron were the COPCs that exceeded 1.0 for these exposure scenarios. In addition, CTE risk estimates for future residential exposure to groundwater yielded an HI greater than 1.0, based mainly on ingestion of groundwater. The target organs included cardiovascular system, skin, kidney, and liver.

Lead concentrations detected at the site during this RI were below the EPA guidelines and are not expected to be associated with a significant increase in blood-lead levels based on the results of the IEUBK Lead Model (v. 0.99).

The underlying groundwater is not used as a potable water supply, and there are no plans for base closure or realignment that would result in Site 13 being considered for future residential land use.

Ecological Receptors Risk Considerations

Although habitat on the landfill is limited, the forested wetland areas north and west of the landfill provide excellent habitat, primarily for terrestrial receptors. The channelized stream contains marginal aquatic habitat, although it connects with Hockhockson Brook several hundred feet north of the site. Runoff from the landfill drains to the wetlands and stream, and groundwater at the site flows toward the stream and wetlands, indicating potential groundwater to surface water contaminant migration.

HQ values for metals in both surface water and sediment were indicative of low potential risk, with the exception of silver in both media. No organics were detected in surface waters and HQs for organics in sediments were indicative of low potential risk, except for PCBs. Silver was not detected in SI surface water samples. PCBs were detected in low levels in SI sediment samples but silver was not analyzed for. Slightly elevated levels of silver were detected in three of six SI surface soil samples taken on the landfill, though this inorganic was detected in only one 1995 RI groundwater sample. In addition, low levels of PCBs were detected in five of six SI surface soils samples but were not detected in RI groundwater samples. For these reasons, overland runoff appears to be the dominant migration pathway to the wetlands and stream. A

Hockhockson Brook watershed surface water and sediment sample (WSSW/SD14) was taken north of Site 13 as part of 1995 RI activities. Silver was only detected slightly above background in the surface water sample and was not detected in sediments. PCBs were not analyzed for in those samples. These compounds are highly lipophilic and tend to bioaccumulate and biomagnify. Nonetheless, all PCB congeners have strong affinities for organic carbon in surface soils and sediments and do not migrate significantly in the dissolved form. Both of the PCB compounds detected are characterized by higher-chlorinated PCB congeners, which have a greater affinity for organic carbon than lower-chlorinated PCB congeners. As a result, downstream migration of PCBs into Hockhockson Brook is highly unlikely. Although silver and two Aroclors may pose moderate potential risk to aquatic and semi-aquatic receptors near the landfill, aquatic habitat is limited in the area since the channelized stream is small and the wetlands are forested with ephemeral standing water. In addition, it does not appear that silver is migrating or PCBs have the potential to migrate to better habitats downstream in Hockhockson Brook. Additional sediment samples taken farther downstream may further delineate the extent of potential downstream migration of silver and PCBs. Since no evidence suggests that downstream migration of PCBs or silver has occurred, sampling and analysis to confirm PCB and silver migration extent can be addressed as a part of any selected remedy. Most of the exposed debris that was present in the forested area adjacent to the landfill was removed in 1997.

Environmental Media Protection Considerations

The RI determined that groundwater adjacent to the landfill contained contaminants at concentrations in excess of the state GWQSs (see Table 2-7). Review of the RI data revealed that aluminum, antimony, arsenic, cadmium, chromium, iron, lead, manganese, and thallium levels exceeded the GWQSs. Final sample turbidities from well sampling were high, resulting in exaggerated metals results in groundwater samples. Organic compounds found in groundwater at concentrations above regulatory guidelines include vinyl chloride, DDE, and DDT.

TABLE 2-7
SITE 13 GROUNDWATER CONTAMINANTS OF CONCERN
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Exceeds NJ GWQS	Exceeds SDWA MCLs	Poses Human Health Risk
Antimony	X	X	X (2)
Arsenic	X	--	X (2,3)
Cadmium	X	X	X (2)
Chromium	X	X	--
Iron	X	(1)	X (2)
Lead	X	X	--
1,2-dichloroethene (total)	X	X	X (3)
Trichloroethene	X	X	X (2)
Tetrachloroethene	X	X	X (3)
Vinyl Chloride	X	X	X (3)

Notes:

- X indicates the basis for selection of the compound or element as a COC.
- New Jersey state groundwater quality standards (GWQS) [N.J.A.C. 7:9-6] are ARARs.
- Safe Drinking Water Act (SDWA) maximum contaminant levels regulate organic and inorganic constituents in public drinking water supplies and are included for comparison purposes.

(1) No SDWA MCL for this analyte.
(2) COC contributes to HI greater than 1.0 for future residential child under RME and CT exposures.
(3) COC contributes to excess carcinogenic risks for the future residential adult through RME ingestion, dermal, and inhalation exposures.
(4) COC contributes to HI greater than 1.0 for future residential child under CT exposures.

Ecological risk assessment concluded that no evidence suggests that downstream migration of PCBs and silver has occurred and that additional sampling does not appear to be necessary. Sampling to date has been sufficient for the purposes of ecological risk assessment, but additional samples of surface soil and sediments may be specified as part of the selected remedy, to confirm the extent of PCB and silver migration. Concentrations of metals found in site surface soils were generally in the range of background. The material in the landfill is not well covered. Material is protruding from the toe and at the surface.

If source control measures are implemented, then a reduction in groundwater contaminant concentrations to below GWQS or to background levels can be expected in the long term, based on a qualitative understanding of the contaminant migration mechanisms and based on a quantitative computer modeling calculations. Source (landfill materials) control measures would likely result in a significant reduction of leachate generation and subsequent migration into the underlying aquifer, thus reducing groundwater contamination in the long term. Current groundwater VOC and metals contamination would be attenuated through a combination of degradation and attenuation processes. Physical processes may include: advection, convection, dispersion, volatilization (of VOCs to unsaturated pore spaces), adsorption, and absorption. Chemical processes may include partitioning, oxidation/reduction, hydrolysis, and acid/base reactions. Biological processes may include aerobic and anaerobic degradation.

The computer model estimated that Site 13 groundwater metal concentrations would gradually diminish over a long period of time (see Appendix A), assuming a source control measure, such as capping, would be implemented. The model indicated that metals concentration at the nearest discharge point, a stream located approximately 500 feet downgradient of Site 13, would be well below the state GWQS (Table 1, Appendix A). These results indicate that the site contaminants (VOCs and metals) are unlikely to migrate very far from Site 13, and their concentrations would be below either GWQSs or background levels within a relatively short distance of Site 13.

Based on the available information, the low anticipated risk levels, the limited extent of observed groundwater contamination, likely implementation of source control measures under a presumptive remedy approach (thus minimizing further contaminant leaching), the fact that the underlying groundwater is not used as a potable water supply, and computer modeling results, no active groundwater response actions, other than long-term monitoring, are anticipated at this time. This FS proposes the use of long-term monitoring to assess actual groundwater conditions following source control. If the revised model or observation of actual site conditions indicates potential problems associated with further plume migration, then the viability and effectiveness of active groundwater response actions (i.e., hydraulic containment, physical containment, or passive or active aquifer remediation) would be assessed.

Based on the information developed to date, remedial actions may be warranted to minimize or mitigate the continued discharge of landfill contaminants to groundwater, surface water, and sediments. Considering the presence of metals and organics in groundwater, the establishment of a classification exception area (CEA) according to state regulations, would need to be considered. This would include future monitoring of groundwater quality.

RAOs Selection

For the reasons provided above, the following remedial action objectives have been selected for Site 3:

Protection of Human Health RAOs

- Prevent potential human exposure to metals and VOCs in groundwater.
- Prevent contact with landfill contents.

Protection of the Environment RAO

- Minimize migration of landfill contaminants to the adjacent wetlands.
- Prevent contact with landfill contents.

2.6.2 Site 13 Preliminary Remediation Goals

Data from the RI human health risk assessment and ARARs were reviewed to identify COCs for Site 13. A summary and the basis for selecting the COCs are provided in Table 2-7.

Because Site 13 is an inactive landfill used for the disposal of material, such as cars, trucks, electronic equipment, clothing/shoes, sheet metal, furniture, scrap metal, and batteries, the presumptive remedy for CERCLA municipal landfill will be applied. The metal contaminants in groundwater that would contribute to excess human health carcinogenic risk (greater than 1E-04 total) or an HI greater than 1.0 were selected as human health risk-based COCs, which are presented in Table 2-8.

Because several metal contaminants in groundwater underlying and adjacent to the site exceed the state GWQSs, these COCs were selected and the GWQS were selected as the ARAR-based PRGs. Table 2-8 lists the metal contaminants whose concentration ranges exceeded those of the maximum detected background groundwater concentrations. Potential PRGs based on ARARs/TBCs and the maximum detected background concentrations are presented in Table 2-8.

TABLE 2-8
SITE 13 GROUNDWATER PRELIMINARY REMEDIATION GOALS (μg/L)
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	ARARS NJ GWQS	SDWA MCLs	PRG(2) Based on Risk = 1E-6 [carcinogen]	PRG(2) Based on HI = 0.1 [non-carcinogen]	Maximum Background Conc.	Maximum Detected Site Conc.
Antimony	20	6.0		0.60	BDL	9.7
Arsenic	8.0	50	0.044	0.46	5.8	39.2
Cadmium	4.0	5.0		0.77	1.9	63.9
Chromium (total)	100	100		7.1	43.5	296
Iron	300	(1)		452	7,690	57,900
Lead	10	15			3.0	18.8
1,2-dichloroethene (total)	70	70	--	12	BDL	120
Trichloroethene	1.0	5.0	3.6	8.4	BDL	180
Tetrachloroethene	1.0	5.0	0.82	11	BDL	70
Vinyl Chloride	5.0	2.0	0.028	--	BDL	11

Notes:
- NJ GWQSs are the state ground water quality standards, which are ARARs
- Safe Drinking Water Act (SDWA) maximum contaminant levels regulate organic and inorganic constituents in public drinking water supplies and are presented for comparison purposes.
- -- not a COC under this parameter.
- BDL - Below detection limit.

(1) No MCL established for this constituent.
(2) PRG numerical values for carcinogens and non-carcinogens are based on exposure scenarios and factors applied in the NWS Earle human health risk assessment and are calculated using the equation - PRG concentration @1E-6 risk = representative concentration of COPC X (1E-6)/calculated cancer risk for COPC from the RI report.

A set of proposed groundwater PRGs for Site 13 is presented on Table 2-9, along with the basis for selection. These proposed PRGs may be used to assist in the delineation of the volume of contaminated groundwater that may need to be evaluated for potential remedial action and may also be used in establishing CEAs as defined under the N.J.A.C. 7:9-6.

2.6.3 Site 13 General Response Actions

General response actions were selected based on the RAOs for Site 13 and the consideration that the site is an inactive military landfill, therefore incorporating the application of a presumptive remedy. Treatment of landfill soils and materials is considered technically impracticable. The general response actions for Site 13 that address potential human exposures to potential contaminant migration into groundwater and the wetlands include

- No action
- Institutional controls (limited action)
- Containment
- Removal and disposal

General response actions that address potential human exposure to groundwater contaminants associated with the landfill materials include

- No action
- Institutional controls (limited action)
- Collection and discharge (clean groundwater only)
- Collection, treatment, and discharge actions
- In-situ treatment

2.6.4 Identification, Screening, and Evaluation of Technologies and Process Options for Site 13

Table 2-10 presents a summary of potential remedial technologies and process options that apply to the Site 13 RAOs and general response actions. Screening of the remedial technologies considered their overall applicability to the media of concern (soil and landfill materials, groundwater), primary contaminants (metals and organics), and current site conditions. During the screening step, process options and entire technology types were eliminated from further consideration on the basis of technical implementability.

TABLE 2-9
SITE 13 PROPOSED GROUNDWATER PRGs
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Proposed PRG	Basis of Selection
Antimony	20	NJ GWQS
Arsenic	8.0	NJ GWQS
Cadmium	4.0	NJ GWQS
Chromium	100	NJ GWQS
Iron	7,690	Background
Lead	10	NJ GWQS
1,2-Dichloroethene (total)	70	NJ GWQS
Trichloroethene	1.0	NJ GWQS
Tetrachloroethene	1.0	NJ GWQS
Vinyl Chloride	5.0	NJ GWQS

Notes:

- All units in ug/L
- New Jersey state GWQS [N.J.A.C. 7:9-6] are ARARs.

TABLE 2-10
SITE 13 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Environmental Medium	Remedial Action Objectives (from site characterization)	General Response Action (for all RAOs)	Remedial Technology Type (for general response actions)	Process Options
Landfill Materials	**Protection of Human Health** Prevent human exposure to landfill materials.	No Action	No Action	Not Applicable
		Limited Action	Institutional Controls	- Deed restrictions - Local ordinances
			Access Restrictions	- Fencing
			Monitoring	- Monitoring of groundwater (to assess contaminant status)
	Protection of the Environment Minimize contaminant migration into groundwater.	Containment	Surface Controls	- Grading - Revegetation
			Cap	- Soil cover - Single barrier - Double barrier
		Removal and Disposal	Excavation	- Mechanical excavation
			Disposal On Site	- Consolidation (into existing landfill) - New landfill
			Disposal Off Site	- RCRA Landfill
Groundwater	**Protection of Human Health** Prevent human exposure to metal contaminants in groundwater.	No Action	No Action	- Not applicable
		Natural Attenuation	Natural Attenuation	- Biological processes - Chemical processes - Physical processes
		Limited Action	Limited Action Technologies - Institutional Controls - Long-Term Monitoring	- Deed restrictions - Groundwater monitoring

Site conditions that were considered include fill materials consisting of heterogeneous municipal-type waste possibly mixed with minor quantities of military waste materials, the location of the landfill adjacent to a wetlands area, relatively sparse top cover of the landfilled materials, and erosion and runoff from landfill soils and materials into the adjacent wetlands.

The preliminary screening of soils and landfill material remedial technologies is presented and summarized in Table 2-11, and the screening of groundwater response remedial technologies is summarized in Table 2-12. Detailed evaluations of the remedial technologies and process options for contaminated soils/landfill materials and groundwater are presented in Tables 2-13 and 2-14, respectively.

2.6.5 Summary of Site 13 Selected Remedial Technologies and Process Options

Tables 2-13 and 2-14 identify the remedial technologies that were retained after the detailed evaluation process. The technologies and process options that are not likely to be implementable and effective or that would result in higher implementation costs were eliminated from further consideration.

For the contaminated soils and landfill materials options, local ordinances were eliminated from further consideration because this action may be difficult to implement and would not offer any greater protection than other institutional controls. The composite cap was eliminated since it did not offer substantially greater protectiveness than the single barrier cap, and the current leaching of landfill contaminants does not appear to constitute a major problem.

All candidate technologies and process options to address contaminated groundwater were retained after the screening phase.

TABLE 2-11
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	No Action	No Action	No remedial actions taken.	Retained as baseline for comparison, in accordance with the NCP.
Limited Action	Institutional Controls	Deed Restrictions	Administrative action used to restrict future site activities on NWS Earle within potentially contaminated area. Activities such as excavation, installation of drinking water supply wells (without treatment), or residential development could be restricted or prohibited.	Potentially viable. Retained.
		Local Ordinances	Administrative actions, such as zoning by-laws and Board of Health regulations, used to limit property use and activities such as well installation.	Not viable, local ordinances may not be applicable to military bases. Eliminated.
	Access Restrictions	Fencing	Security fence installed around contaminated areas to restrict access.	Potentially viable. Retained.
	Monitoring	Groundwater Monitoring	Periodic monitoring of groundwater to evaluate contaminant presence and migration from the landfill.	Potentially viable. Retained.
Containment	Surface Controls	Grading	Reshaping of topography to manage precipitation infiltration and surface runoff.	Grading of current cover material of varied thickness may not be effective in promoting precipitation infiltration management. Grading would be potentially viable if additional cover materials added. Retained.
		Revegetation	Seeding and maintaining site surface to establish vegetation to minimize erosion and to promote evapotranspiration of precipitation, thus reducing infiltration.	Potentially viable. Retained.

TABLE 2-11
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (continued)	Cap	Soil (Permeable) Cover	Soil with a vegetative cover to prevent direct contact and minimize erosion and surface migration of contaminated soils.	Potentially viable if direct contact and erosion are the prime threats. Offers limited effectiveness for reducing infiltration. Retained.
		Single Barrier	Cap constructed with one low-permeability layer (clay or synthetic membrane) over the site to prevent direct contact, to minimize erosion, and to reduce leaching of contaminants from the landfill into groundwater. Additional layers would be required to protect the barrier.	Potentially viable to prevent direct contact and to reduce erosion and infiltration. 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 and reduce leaching of landfill contaminants into groundwater. Provides greater reduction in infiltration and better protection against failure than a single-barrier cap.	Potentially viable to prevent direct contact and to reduce erosion and infiltration. Retained.
Removal and Disposal	Excavation	Mechanical Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers, excavators, and front-end loaders.	Potentially viable for hot spot areas if encountered during remediation. However, no hot spots were identified at Site 13. Retained.
		Drum Removal	Removal of buried drums or containers using mechanical equipment such as a drum grappler, a drum cradle, a sling attached to a backhoe, or a front-end loader.	Potentially viable if drums or containers are encountered during remediation. Retained.

TABLE 2-11
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
PAGE 3 of 3

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal and Disposal (continued)	Disposal Off Base	RCRA Landfill	Transport and disposal of excavated materials in a RCRA-permitted landfill.	Technically impracticable to excavate and dispose of entire landfill, the bulk of which is construction debris. Eliminated. Retained for hot spots and drums, if encountered.
	Disposal On Site	New RCRA-Type Landfill	Disposal of untreated bulk landfill materials in a specially constructed on-base landfill.	Technically impracticable to excavate and dispose of entire landfill, the bulk of which is construction debris. Eliminated.
		Consolidation (into existing landfill)	Relocation of landfill materials into another on-base landfill. Or relocation of small, isolated quantities of contaminated materials into an existing on-base landfill so that one closure action can accommodate both.	Technically impracticable to excavate and relocate landfill. Eliminated. Retained for consolidating small quantities of contaminated materials into existing on-base landfill.

TABLE 2-12
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 13 CONTAMINATED GROUNDWATER
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	No Action	No Action	No active remediation would be conducted to address contamination.	Retained for baseline comparison purposes in accordance with NCP.
	Natural Attenuation	Natural Attenuation	Natural subsurface biological, chemical, or physical processes would attenuate dissolved organics and inorganics and limit migration of the contaminants.	Potentially applicable.
Limited Action	Institutional Controls	Deed Restrictions	Administrative action used to restrict future activities on base properties. Installation of drinking water wells without treatment would be prohibited under property deeds.	Potentially applicable.
	Long-Term Monitoring	Groundwater Monitoring	Periodic sampling and analysis of media to assess groundwater contaminant status and potential migration downgradient.	Potentially applicable.

TABLE 2-13
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

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: Low	Retained.
Limited Action	Institutional Controls	Deed Restrictions	Effectiveness dependent on continued future enforcement to prevent use of underlying groundwater or use of landfill for development. No contaminant reduction anticipated.	Can be added to property deed (or Base Master Plan) and is implementable.	Capital: Low O & M: Low	Retained.
	Access Restrictions	Fencing	Would limit access to contaminated soils. No contamination reduction.	Readily implementable; numerous companies available to perform construction.	Capital: Low O & M: Low	Retained.
	Monitoring	Groundwater Monitoring	Would allow assessment of landfill contaminant status and leaching/migration in groundwater. Would enable action to be taken to reduce continuing groundwater contamination. No contaminant reduction.	Readily implementable; numerous companies with personnel and equipment to perform sampling.	Capital: Low O & M: Low	Retained.
Containment	Surface Controls	Grading	Would be effective in promoting precipitation runoff, thus decreasing infiltration and subsequent contaminant leaching. Would be applicable to top layer of cap system.	Implementable, numerous companies with personnel and heavy equipment to perform earth moving and grading.	Capital: Low O & M: None	Retained.

TABLE 2-13
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
Containment (continued)	Surface Controls	Revegetation	Would be effective in reducing precipitation infiltration through promotion of evapotranspiration and reduction of surface erosion.	Implementable; numerous companies with personnel and equipment available to perform revegetation.	Capital: Low O & M: Low	Retained.
	Cap	Soil (Permeable) Cover	Would prevent direct exposure to contaminated soils. Would reduce precipitation infiltration and contaminant leaching to groundwater and would reduce erosion of landfill materials to adjacent wetlands. No contaminant reduction.	Implementable using standard methods and readily available equipment.	Capital: Low O & M: Low	Retained.
		Single Barrier	Would limit infiltration and significantly reduce contaminant leaching to groundwater. Would prevent exposure to contaminated soils and surface migration of contaminated soils. No contaminant reduction.	Implementable by standard construction techniques; would require specialized, but readily available, equipment and materials to install synthetic cap.	Capital: Moderate O & M: Low	Retained.

TABLE 2-13
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSIONS
		Composite (Double) Barrier	Same as single barrier. Second impermeable barrier would provide greater assurance against cover failure. Level of protection offered by composite barrier cap not required at Site 13 since groundwater contamination is low and groundwater is not used.	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.
Removal and Disposal	Excavation	Mechanical Excavation	Effective method for removing highly contaminated soils and hot spots, if encountered during remediation.	Implementable with standard construction equipment. Equipment and resources are readily available from various contractors.	Capital: Low O & M: None	Retained.
		Drum Removal	Effective for drum removal, if encountered during remediation.	Equipment and resources are readily available from various contractors.	Capital: Low O & M: None	Retained.

TABLE 2-13
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 LANDFILL MATERIALS
OU-5 FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSIONS
	Disposal Offbase	RCRA Landfill (for hot spot removals only)	Effectively controls release of hot spot contaminants to environment, if encountered during remedial actions. Would probably handle volume of hot spot materials encountered. Landfill materials may require treatment prior to disposal to meet land disposal requirements.	Implementable. Commercial landfill facilities are available. Implementation becomes more difficult if excavated materials require segregation or treatment prior to disposal.	Capital: Moderate O & M: None	Retained.
	Disposal On Base	Consolidation	Allows small volumes of material from other isolated locations to be consolidated and addressed with the majority of landfill materials.	Readily implementable for small or moderate soil volumes. No implementability concerns.	Capital: Low O & M: Low	Retained.

TABLE 2-14
EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 13 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
No Action	No Action	No Action	Does not achieve remedial action objectives.	Implementable	Capital: None O&M: Low	Retained.
Natural Attenuation	Natural Attenuation	Natural Attenuation	Effectiveness dependent on subsurface biological, chemical, and physical conditions. Attenuation of organics and metals is anticipated to be gradual.	Implementable. Would require monitoring to determine whether attenuation is ongoing.	Capital: None O&M: Low	Retained.
Limited Action	Institutional Controls	Deed Restrictions	Effectiveness depends on future enforcement. Does not reduce contamination.	Can be added to property deeds (or Base Master Plan) and is implementable.	Capital: Low O&M: Low	Retained.
	Long-Term Monitoring	Groundwater Monitoring	Effective method for observing contaminant extent and potential migration and for assessing effectiveness of remedial action.	Readily implementable; numerous companies available with resources to perform monitoring.	Capital: Low O&M: Low	Retained.

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ACTION ALTERNATIVES

The purpose of the alternative development and screening process is to assemble an appropriate range of possible remedial options to achieve the RAOs identified for the site. In this process, technically feasible technologies retained for further evaluation in Section 2, are combined to form remedial alternatives that provide varying levels of risk reduction.

3.1 SITE 13 - DEVELOPMENT AND SCREENING OF ALTERNATIVES

Section 3.1.1 presents the rationale for development of remedial action alternatives for Site 13, Section 3.1.2 describes the assembled alternatives, Section 3.1.3 presents the screening of alternatives. Detailed evaluations and costing of the retained alternatives are presented in Section 4.0.

3.1.1 Site 13 - Rationale for Development of Alternatives

Factors considered in formulating the remedial alternatives to address the RAOs for Site 13 are discussed below:

Protection of Human Health Considerations - The RAO for protection of human health specifies preventing human exposure to landfill contents and to contaminated groundwater. These objectives have been addressed in the formulation of remedial alternatives.

Protection of the Environment Considerations - The RAO for protection of the environment specifies mitigating migration of VOC contaminants in groundwater to areas with potential receptors. This objective has 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, alternatives development for Site 13 was 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), 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.

EPA established containment as the presumptive remedy for municipal landfills based on the expectation that containment would generally be appropriate for municipal landfill waste because the volume and heterogeneity of the waste generally make treatment impracticable (OSWER Directive No. 9355.0-49FS). Further, EPA established that the municipal landfill presumptive remedy should also be applied to all appropriate military sites (OSWER Directive No. 9355.0-62FS). Based on the criteria presented in that directive, the Site 13 landfill is an appropriate site for the application of the presumptive remedy for CERCLA municipal landfills. As such, alternatives were developed and screened in accordance with the presumptive remedy directives noted above and the guidance Conducting Remedial Investigations/ Feasibility Studies for CERCLA Municipal Landfill Sites. The resulting alternatives development process was streamlined to focus on containment alternatives rather than treatment.

3.1.2 Site 13 - Remedial Alternatives Descriptions

This section presents detailed descriptions of the remedial alternatives for Site 13. The key components of Alternatives 1 through 3 are identified on Table 3-1.

3.1.2.1 Site 13 - Alternative 1: No Action

The no-action alternative is developed as a baseline case, as required by the NCP. The only activities conducted under this alternative are monitoring to evaluate contaminant migration and a review of site conditions and risks every 5 years.

The purpose of the no-action alternative is to evaluate the overall human health and environmental protection provided by the site in its present state. Under this alternative, no remedial actions would be taken to protect human health or the environment. No measures would be implemented to prevent potential human exposure to site groundwater or to mitigate contaminant migration in the environment. Key components of Alternative 1 are identified on Table 3-1 and described below.

Existing Features - Currently, site features offer limited protection of human health and the environment. The primary protective feature is that groundwater underlying Site 13 is not used as a potable water supply. There is currently no pathway for human exposure to VOC-contaminated groundwater.

TABLE 3-1

SITE 13 - REMEDIAL ALTERNATIVE COMPONENTS
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	KEY COMPONENTS OF ALTERNATIVE
1	No Action	• Long-term periodic groundwater, surface water, and sediment monitoring • Five-year reviews
2	Limited Action	• Fencing • Institutional controls (land use restrictions, CEA*) • Long-term periodic groundwater, surface water, and sediment monitoring • Five-year reviews
3	Capping, Institutional Controls, and Long-Term Monitoring	• Pre-design investigations • Site preparation • Site grading • Single-barrier cover system • Fencing • Institutional controls (land use restrictions, CEA*) • Long-term operation and maintenance • Long-term periodic groundwater, surface water, and sediment monitoring • Five-year reviews

Notes:
* Classification Exception Area pursuant to the New Jersey Groundwater Quality Standards (N.J. A.C 7:9-6) would be established for groundwater that does not meet state groundwater quality standards.

However, potable water supply wells are situated elsewhere on the base and site groundwater could conceivably be used as a potable water supply in the future, posing a potential human health risk. Part of the landfill is covered by hard-packed gravel and is within the fenced DPDO storage yard.

Long-Term Monitoring - Under Alternative 1, three new wells would be installed downgradient and groundwater would be sampled periodically to monitor the migration of contaminants from Site 13 and assess the potential impacts to downgradient receptors. The data collected would be evaluated during the 5-year review period.

For the purpose of costing, it is assumed that groundwater samples would be collected from the six existing monitoring wells and three new downgradient wells, three surface water locations, and three sediment locations. A total of 12 groundwater, six sediment, and six surface water samples, including QA/QC samples, would be collected annually. All samples would be analyzed for site-specific contaminants (VOCs and metals). The sampling results would be evaluated to assess whether there have been changes in contaminant status and to determine whether additional response actions are warranted.

Five-Year Reviews - Since contaminants remain on the site, a review of site conditions and risks would be conducted every 5 years, as required by CERCLA. The reviews would consist of evaluating analytical and hydrogeologic data, assessing whether contaminant migration has increased, and determining whether human or biological receptors or natural resources are potentially at risk.

3.1.2.2 Site 13 - Alternative 2: Institutional Controls and Long-Term Monitoring

Alternative 2 relies on institutional controls to limit exposures to landfill contents and contaminated groundwater. This alternative does not employ engineered treatment or containment to address groundwater contamination.

Institutional controls would be enacted to prohibit use of impacted groundwater. Long-term periodic monitoring would be conducted to assess the alternative's effectiveness and potential threats to human health and the environment. Site conditions and risks would be reviewed every 5 years since contaminants would be left in place. Key components of Alternative 2 are identified on Table 3-1 and described below.

Existing Features - Currently, Site 13 features offer limited protection of human health and the environment. The hard-packed gravel cover over the landfill within the fenced portion of the site (the DPDO area) provides an effective mechanism to limit contact with the landfill contents. The Navy (NWS

Earle personnel) removed the bulk of the protruding waste from the edge of the landfill in the summer of 1997. Groundwater underlying Site 13 is not used as a potable water supply. As a result, there is currently no pathway for human exposure to contaminated groundwater. However, potable water supply wells are situated elsewhere on the base and site groundwater could conceivably be used as a potable water supply in the future, posing a potential human health risk.

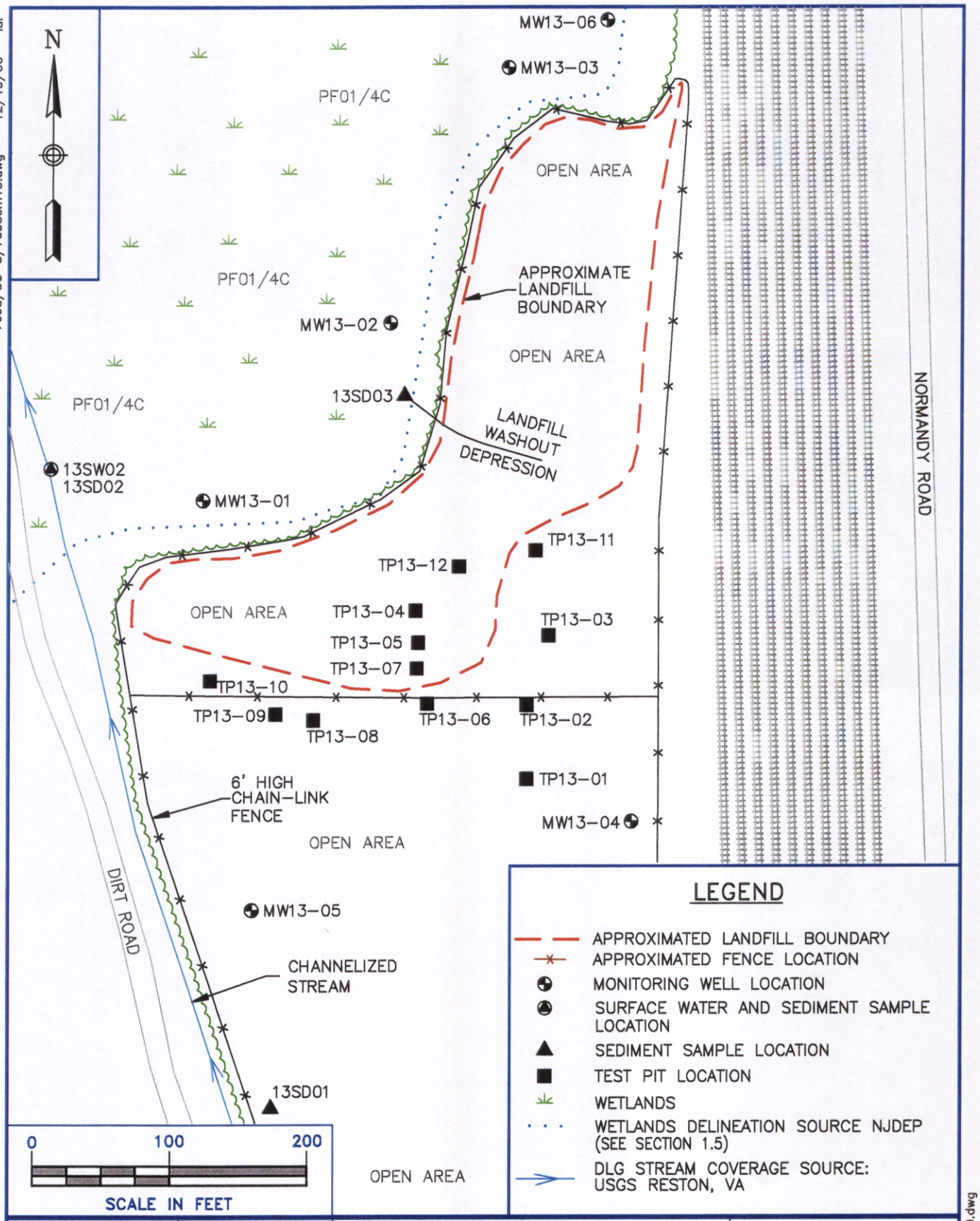
Although active treatment of groundwater would not be conducted, a gradual reduction in concentration of groundwater contaminants by dispersion, dilution, and degradation should occur. This process is estimated to require approximately 45 years to reduce all groundwater concentrations to below the GWQS (see Appendix A for modeling results). Natural attenuation, in the form of breakdown of chlorinated solvents in the shallow formation beneath the Site 13 surface, is evident by the presence of related families of parent-daughter breakdown products. For instance, the presence of vinyl chloride and the dichloroethenes is likely a result of subsurface biologically mediated transformation of tetrachloroethene and other higher-oxidation-state, chlorinated ethane-based compounds to the simpler chlorinated ethane compounds. Long-term monitoring with periodic review will ensure that these compounds do not affect downgradient receptors.

Security Fencing - Security fencing would be installed to deter human and animal entry into the landfill area to protect the integrity of the existing cover. Existing fence (of the DPDO area) over Site 13 landfill areas would be removed and replaced. The fence is expected to be 6-foot-high chain-link fence, with galvanized steel posts installed at 8-foot intervals. A locking gate would be installed to allow controlled access to the site. Figure 3-1 depicts the proposed location of the fencing.

Institutional Controls - Under Alternative 2, land use restrictions would be incorporated into the Base Master Plan to restrict the future use of Site 13 groundwater until natural processes have reduced contaminant concentrations to acceptable levels (GWQC). Use of untreated, contaminated Site 13 groundwater for drinking water would be prohibited.

Because site groundwater does not meet New Jersey groundwater quality standards, a CEA pursuant to N.J.A.C 7:9-6 would be established to provide the state official notice that the constituent standards will not be met for a specified duration and to ensure that use of groundwater in the affected area is suspended until standards are achieved.

Long-Term Monitoring - Under Alternative 2, three new wells would be installed downgradient and groundwater would be sampled periodically to monitor the migration of contaminants from Site 13 and assess the potential impacts to downgradient receptors. The collected data would be evaluated during the 5-year review period.



DRAWN BY LDL DATE 12/20/00	Tetra Tech NUS, Inc.	ALTERNATIVE 2 SITE 13 – DRMO YARD NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY	CONTRACT NO. 7695
CHECKED BY DATE			OWNER NO. 0200
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-1 REV.

7695/OU-5/7695cm10.dwg 12/19/00 ldl

7695/OU-5/7695cm10.dwg

For the purpose of costing, it is assumed that groundwater samples would be collected from the six existing monitoring wells and three new downgradient wells, three surface water locations, and three sediment locations. A total of 12 groundwater, six sediment, and six surface water samples, including QA/QC samples, would be collected annually. All samples would be analyzed for site-specific contaminants (VOCs and metals). The sampling results would be evaluated to assess whether there have been changes in contaminant status and to determine whether additional response actions are warranted.

Five-Year Reviews - Since contaminants would remain in Site 13 groundwater, a review of site conditions and risks would be conducted every 5 years, as required by CERCLA. The reviews would consist of evaluating analytical and hydrogeologic data and assessing whether contaminant migration has increased to determine whether human receptors or natural resources are at risk.

3.1.2.3 Site 13 - Alternative 3: Capping, Institutional Controls, and Long-Term Monitoring

Alternative 3 relies on containment and institutional controls to limit exposures to hazardous substances and minimize migration of contaminants to groundwater and surface water. Active treatment is not employed to address site contamination. Over time, the contaminants in groundwater will likely gradually decrease naturally through physical, biological, and chemical processes. Contaminant concentrations in groundwater will also decrease as a result of reduced infiltration of precipitation through contaminated landfill materials.

Under Alternative 3, a low-permeability cover system that complies with federal and state regulatory requirements would be used to prevent potential human and animal contact with contaminants in landfill materials, limit contaminant leaching to groundwater, and minimize contaminant migration via surface runoff and erosion. The cover system would be installed over all former landfill areas of the site. Access restrictions would be enacted to limit future uses of the site that may result in disturbance of the cover or direct contact with contaminated media.

Long-term, periodic monitoring would be conducted to assess contaminant status and potential threats to human health and the environment. Since wastes would be left in place, site conditions and risks would be reviewed every 5 years. Key components of Alternative 3 are identified on Table 3-1 and described below.

Pre-Design Investigations and Activities - Pre-design investigations would be conducted to collect topographic, chemical, and geologic data needed for the cover system design. A topographic survey of the site would be performed to collect accurate elevation and contour data for use in the cover system

design. Landfill gas sampling may be conducted to confirm that there is no need for a gas vent layer and methane collection system.

A geotechnical evaluation of the landfill may be necessary to evaluate the stability and settling characteristics of the landfill to determine whether actions are required to minimize future differential settling of landfill contents that could damage the cover system.

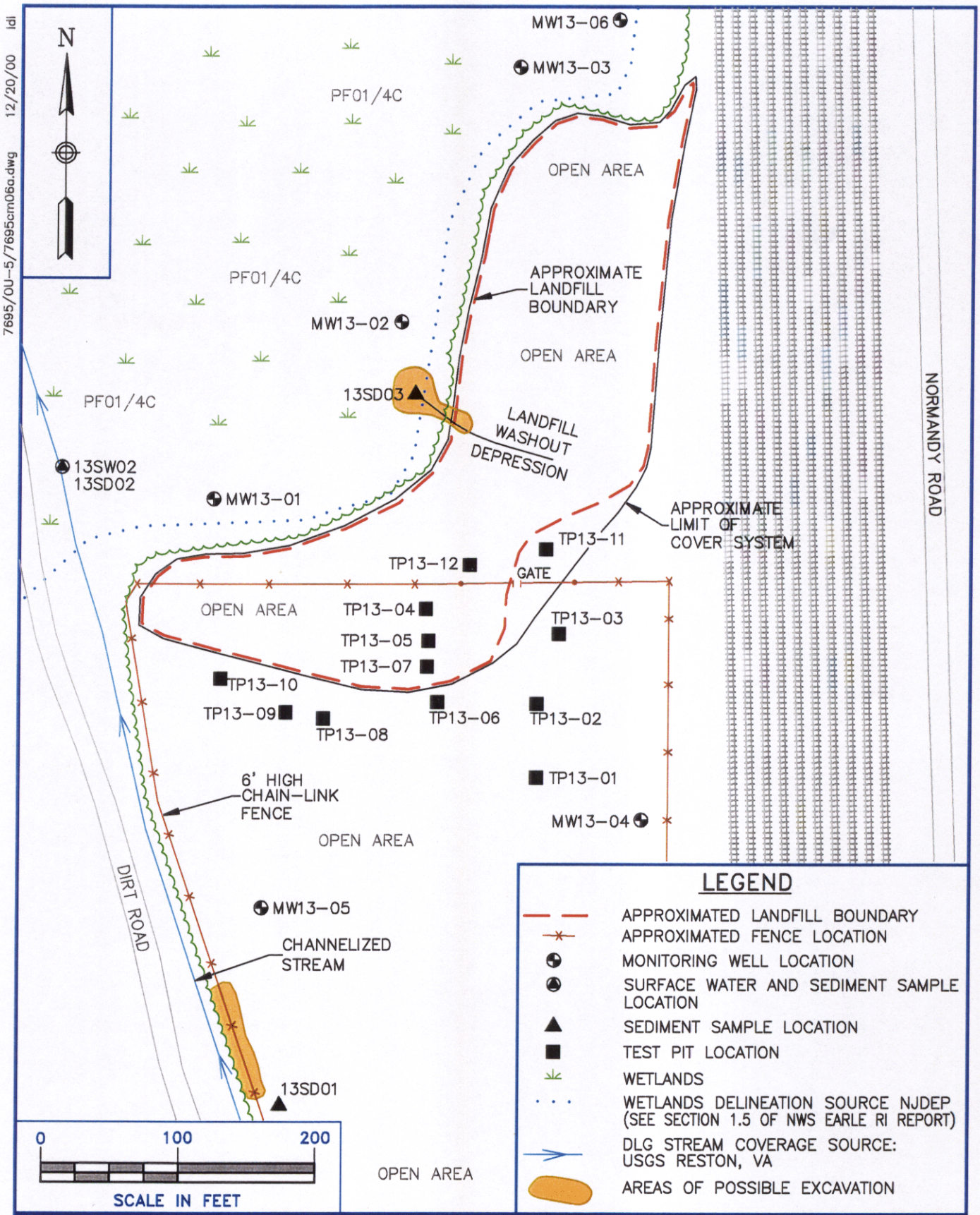
Site Preparation - The site has not been used as a landfill for many years; however, part of the site is currently being used as the DPDO. The balance of the site is slightly vegetated with grasses and a few small pine trees. Clearing and grubbing of the vegetative growth would be necessary to prepare the site for capping. Silt fences or staked hay bales would be required to minimize erosion effects while the trees and vegetation are being removed. Silt barriers would be placed at the perimeter of the level portions of the landfill and at the toe of the landfill area to prevent silt and soil movement to downslope areas and properties. Impacted soils and sediments near current erosion areas would be excavated and placed within the area to be capped. Post excavation sampling would confirm all impacted media has been excavated.

Site Grading - Grading of the landfill area would be required following removal of site vegetation. Compaction of the soils and landfill materials would be performed as needed. The appropriate slopes for the base of the cover (to facilitate drainage) would be determined as part of the cover system design.

Cover System Placement - A low-permeability cover system would be designed and installed to prevent human and animal exposures to landfill material contaminants, to reduce infiltration and resulting metals leaching into groundwater, and to prevent migration of contaminants by wind and surface runoff. The cover design would include an impermeable layer (e.g., membrane or geocomposite clay) and would generally meet RCRA Criteria for Municipal Solid Waste Landfills (40 CFR 258).

For the purpose of this FS, a single-barrier cover system was selected as the representative capping option. Figure 3-2 presents a plan view of conceptual design of the cover. A cross section of a conceptual cover system is presented on Figure 3-3. Descriptions of the individual cover layers are summarized as follows, from bottom to top:

> Subgrade - The base layer of the cover system should be a well-compacted and smooth surface of sufficient thickness to prevent puncture of the barrier layer by landfill materials. The subgrade may be a well-graded sand and gravel. A geotextile material may be used above the subgrade to separate the sand and gravel from the layers above.



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REVISED BY DATE			APPROVED BY DATE
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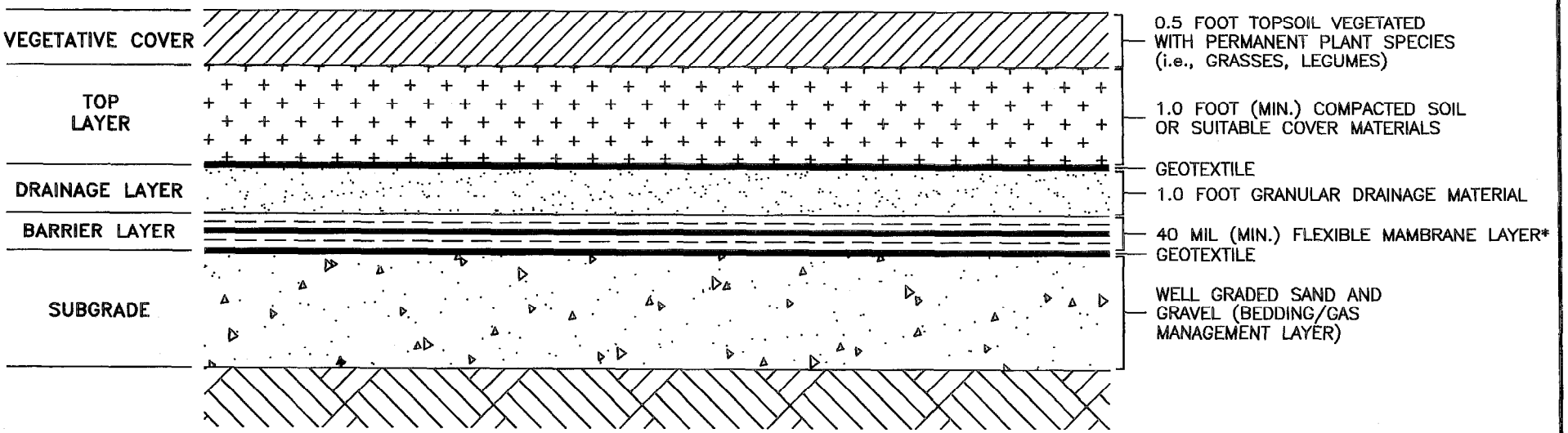

LANDFILL MATERIALS AND SOILS

* MAY SUBSTITUTE ONE FOOT OF CLAY OR EQUAL WITH MAX. PERMEABILITY OF 1.0E-07 CM/SEC

CROSS-SECTIONAL VIEW

NOTE:

NOT FOR DESIGN.

DRAWN BY LDL	DATE 12/20/00	Tetra Tech NUS, Inc.	CONCEPTUAL COVER SYSTEM DESIGN SITE 13 – ALTERNATIVE 3A FEASABILITY STUDY REPORT NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY
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CONTRACT NO. 7695	
OWNER NO. 0200	
APPROVED BY	DATE
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Gas Vent System - A gas vent system would be installed only if a pre-design investigation concludes that one is necessary. Because the landfill has been out of use, covered with permeable cover materials, and received material such as cars, trucks, electronic equipment, sheet metal, furniture, scrap metal, and batteries, the need for a gas venting system is not anticipated.

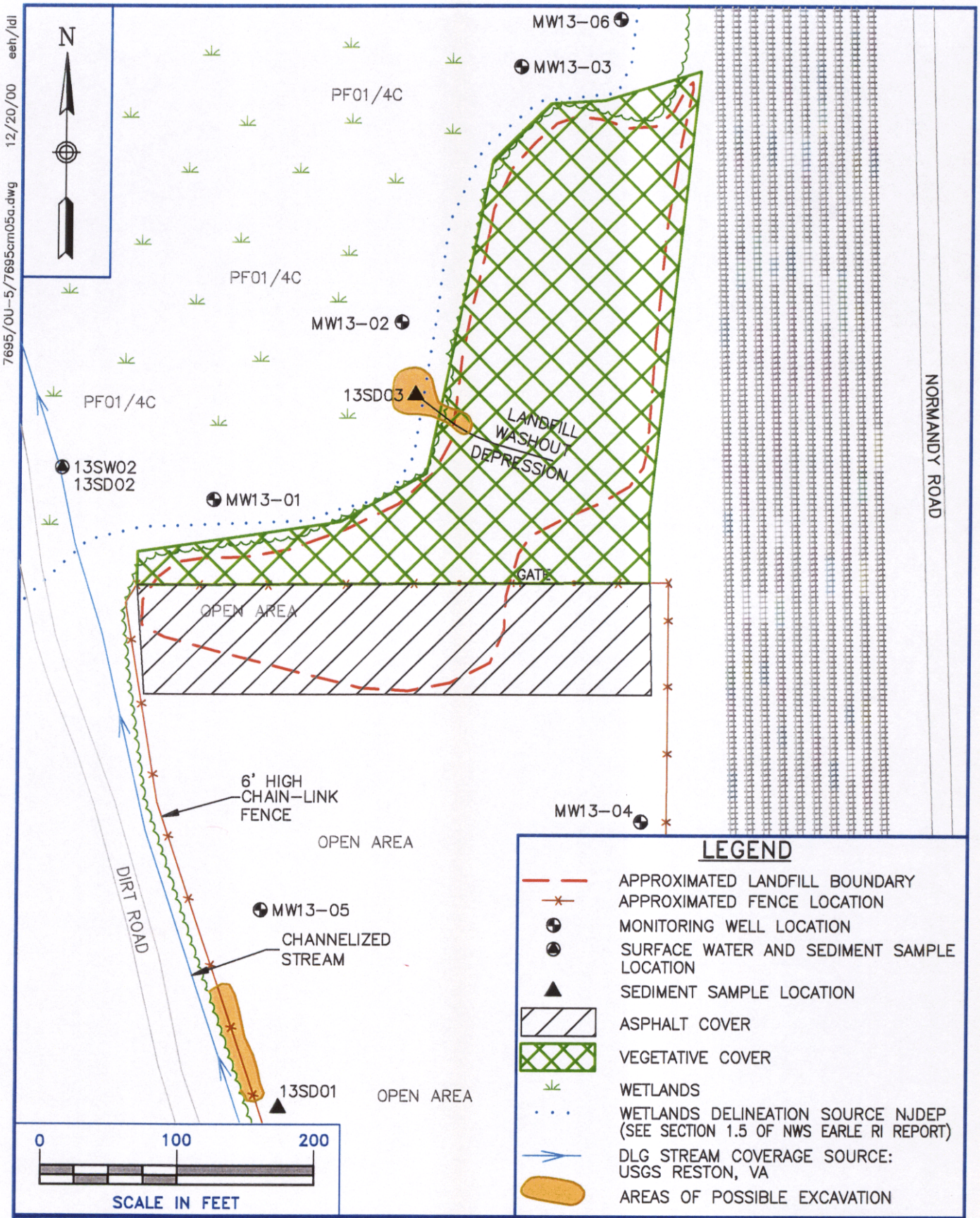
Barrier Layer - This layer would be designed to minimize precipitation infiltration into the landfill materials. In accordance with applicable regulations and guidance, a barrier with a maximum permeability of 1×10^{-7} cm/s, consisting of a minimum of 1 foot of compacted clay or a geomembrane at least 30 mil thick, or the equivalent would be used. For this FS, a geomembrane barrier would be selected as the representative barrier layer. Geomembranes can be installed more efficiently than a compacted clay layer and are less ensitive to extreme weather conditions. The geomembrane may be a flexible membrane liner (FML) composed of low-density synthetics for tolerating subsidence-induced strains.

Drainage Layer - A drainage layer would be installed to prevent the accumulation of water above the infiltration layer that could damage the geomembrane or cause erosion of the top layer. The drainage layer would promote the removal of water to areas outside the cover. For the FS, it was assumed that a geosynthetic drainage layer would be used to channel infiltration to toe drains located at the perimeter of the cover system. Precipitation infiltration that reaches this layer would ultimately be discharged to the wetlands north and west of the site.

Top Layer - The objective of this layer is to protect the cover from erosion by rain or wind and from burrowing animals. The top layer would be either uniform compacted soil (Option A) or pavement (Option B). Covering the cap with pavement would allow continued use of the site as a storage area.

If the soil top layer option is selected, a minimum of 1.5 feet of uniform compacted soil would be placed over the drainage layer. The top layer would be vegetated with permanent plant species such as grasses and legumes to minimize erosion (Figure 3-3). Trees, woody shrubs, and other deep rooted plants that might penetrate the low-permeability layer would be prevented from growing on the cover.

If the pavement top layer option is selected, the area to be paved is depicted on Figure 3-4. The 1.5 feet of compacted soil for the vegetative layer would be replaced with a 6-inch-thick layer of select fill, a layer of roadway stabilization geotextile, a 10-inch-thick layer of aggregate base, and a 2-inch-thick layer of asphalt surface course (Figure 3-5) as required by NAVFAC DM 5.4 (October 1979). Routine inspection and repair would ensure the integrity of the pavement.



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REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-4 / REV.

ALTERNATIVE 3B
SITE 13 – OU-5
NAVAL WEAPONS STATION EARLE
COLTS NECK, NEW JERSEY

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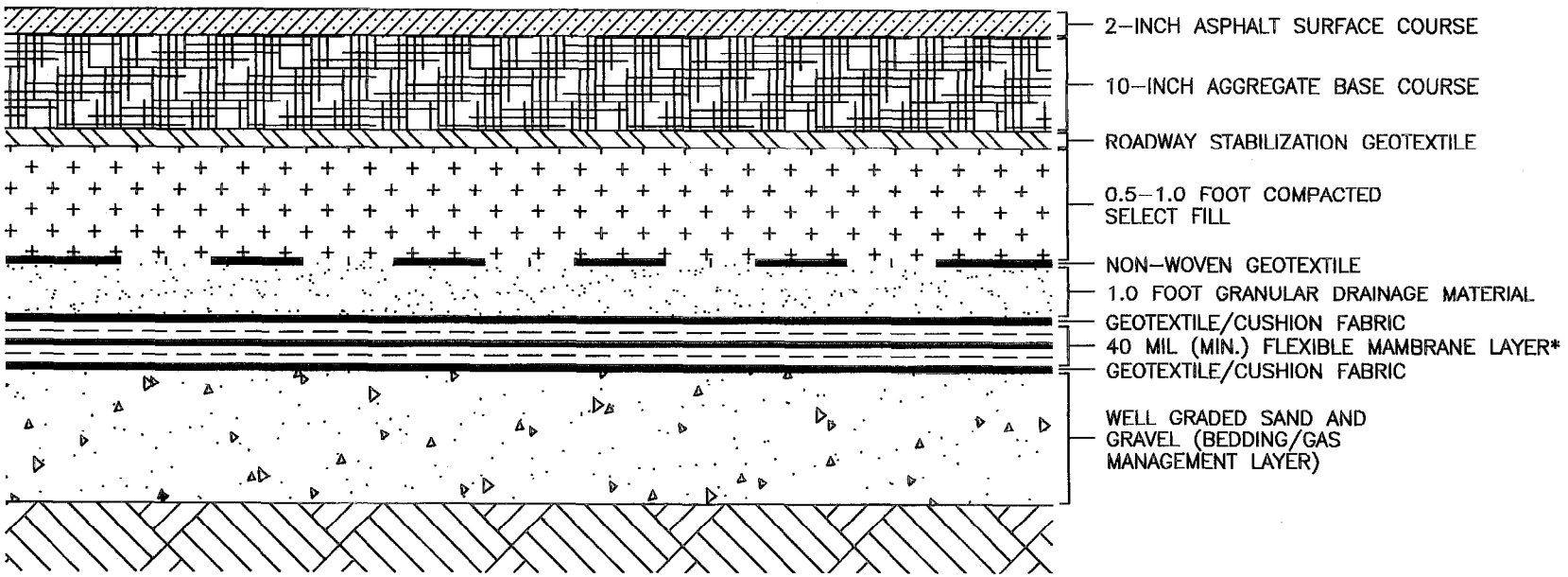

* MAY SUBSTITUTE ONE FOOT OF CLAY OR EQUAL WITH MAX. PERMEABILITY OF 1.0E-07 CM/SEC

CROSS-SECTIONAL VIEW

NOTE:
NOT FOR DESIGN.

DRAWN BY LDL	DATE 12/20/00	Tetra Tech NUS, Inc.	CONCEPTUAL COVER SYSTEM DESIGN SITE 13 – ALTERNATIVE 3B FEASABILITY STUDY REPORT NAVAL WEAPONS STATION EARLE COLTS NECK, NEW JERSEY
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE NOT TO SCALE			

CONTRACT NO. 7695	
OWNER NO. 0200	
APPROVED BY	DATE
DRAWING NO. FIGURE 3-5	REV.

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The final surface slope of cover system would be between three percent (3V:100H) and 5 percent (5V:100H) to ensure slope stability, control erosion, and allow compaction, seeding, and revegetation of the cover materials. The final slope would promote precipitation runoff while inhibiting erosion or infiltration. Surface run-on and runoff controls would be required to channel run-on and runoff, via drainage swales or trenches, to surface drains located on the perimeter of the cover system for ultimate discharge to the adjacent wetlands.

The final slopes and materials to be used in the cover system would be determined during the engineering design. The capped area is expected to be approximately 2 acres.

Security Fencing - Security fencing would be installed to deter human and animal entry into the landfill area to protect the integrity of the cover. The fence is expected to be 6-foot-high chain-link fence, with galvanized steel posts installed at 8-foot intervals. A locking gate would be installed.

Institutional Controls - After the construction of the cover, access restrictions would be used to significantly limit the future activities that could result in intrusion into and possible damage of the cover and accidental exposure to the landfill wastes. Restricted activities would include excavation, excessive vehicular traffic, and use of untreated groundwater for drinking water .

Because site groundwater does not meet New Jersey groundwater quality standards, a CEA pursuant to N.J.A.C 7:9-6 would be established to provide the state official notice that the constituent standards will not be met for a specified duration and to ensure that use of groundwater in the affected area is suspended until standards are achieved.

Operation and Maintenance - To ensure the proper functioning and protectiveness of the cover system, routine mowing (if soil top layer), maintenance of the pavement surface (if pavement top layer), maintenance and repairs of the fencing, runoff and drainage systems, gas vent system (if needed), and the cover system would be required.

Long-Term Monitoring - Under Alternative 3, three new wells would be installed downgradient. Surface water, sediment, and groundwater would be sampled periodically to monitor the migration of contaminants from Site 13 and assess the potential impacts to downgradient receptors. The collected data would be evaluated during the 5-year review period.

For the purpose of costing, it is assumed that groundwater samples would be collected from the six existing monitoring wells and three new downgradient wells, three surface water locations, and three sediment locations. A total of 12 groundwater, six sediment, and six surface water samples, including

QA/QC samples, would be collected annually. All samples would be analyzed for site-specific contaminants (VOCs and metals). The sampling results would be evaluated to assess whether there have been changes in contaminant status and to determine whether additional response actions are warranted.

Five-Year Reviews - Because contaminants remain on the site, a review of site conditions and risks would be conducted every 5 years, as required by CERCLA. The reviews would consist of evaluation of analytical and hydrogeologic data, assessing whether contaminant migration has increased and whether human or biological receptors or groundwater resources are at risk.

3.1.3 Site 13 - Alternatives Screening

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 13. The screening is presented in Table 3-2.

TABLE 3-2
SITE 13 - SCREENING OF REMEDIAL ALTERNATIVES
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
1	No Action: (long-term monitoring, 5 year reviews)	Provides no additional protection of human health or the environment. Does not reduce potential for human exposure to landfill or groundwater contaminants. Does not reduce contaminant migration in the environment. No reduction in toxicity, mobility, or volume of contaminants.	Readily implementable. No technical or administrative difficulties.	Capital: none O&M: low	Retained as baseline alternative in accordance with NCP. Retained.
2	Limited Action (Institutional controls, access restrictions, long-term monitoring, 5-year reviews)	Provides added protection of human health through fencing and institutional controls. Groundwater use would be restricted. Does not reduce contaminant migration to the environment. 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	Capping, Institutional Controls, and Long-Term Monitoring	Protects human health and the environment. Capping landfill materials prevents direct contact exposure and minimizes contaminant migration to the environment. Groundwater use would be restricted. Groundwater contaminants will gradually decrease over time. No reduction of toxicity or volume of contaminants.	Readily implementable. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are widely available.	Capital: moderate O&M: moderate	Retained.

4.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section contains the detailed evaluation of the remedial alternatives that were retained after the screening of alternatives in Section 3.0. In accordance with the EPA RI/FS guidance, each alternative is evaluated with respect to seven criteria: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

4.1 INDIVIDUAL ANALYSIS OF SITE 13 ALTERNATIVES

Detailed evaluations of the remedial alternatives retained for further evaluation in Section 3.1.3, are presented in this section. Detailed cost estimates and assumptions for each alternative are presented in Appendix B.

4.1.1 Site 13 - Alternative 1: No-Action

The no-action alternative was developed as a baseline case, as required by the NCP. The only activities conducted under this alternative are periodic monitoring and evaluation of contaminant migration and a review of site conditions and risks every 5 years.

Overall Protection of Human Health and the Environment

The no-action alternative would not provide protection of human health or the environment. No response actions would be taken to contain or treat contaminated groundwater and no measures would be implemented to prevent future use of site groundwater. Contaminated soils and waste would remain, potentially acting as a continuing source of contaminants to groundwater. Contaminated groundwater would continue to pose a potential health risk and adversely impact the environment until contaminant concentrations reduced to guideline levels.

The potential human health risks from ingestion, inhalation, and contact with contaminated groundwater would not be reduced under Alternative 1. Alternative 1 would involve no active treatment of groundwater, no implementation of institutional controls to restrict use of contaminated groundwater, and no source control measures to reduce contaminant leaching to groundwater. The risks to future residential and industrial receptors of site groundwater would exceed EPA's target levels for carcinogens (residential only) and non-carcinogens. Long-term monitoring of groundwater would make it possible to evaluate site conditions and risks.

Compliance with ARARs

Because groundwater beneath Site 13 exceeds groundwater quality criteria (GWQC) specified in the New Jersey GWQS [N.J.A.C. 7:9-6] and no actions would be taken to reduce contaminant concentrations or establish a CEA, Alternative 1 would not comply with these standards.

Long-Term Effectiveness and Permanence

Since no remedial actions would occur under Alternative 1, the current and future threats to human health and the environment would remain.

The risk assessment concluded that, under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential RME carcinogenic risk of 1.1 E-03 and potential non-carcinogenic risk (HI) greater than 1.0 for three target organs. These calculated risk values all exceed EPA's target risk range. Exposure to contaminated groundwater under a future industrial land use scenario also resulted in exceedence of EPA's target risk range for non-carcinogenic hazards for three target organs. Because Alternative 1 would not include any remedial actions or institutional controls to reduce contaminant concentrations in groundwater or prohibit use of untreated contaminated groundwater, the risk to potential future users of the groundwater would remain unchanged.

The groundwater underlying Site 13 is not currently used as a potable water supply and there are no existing plans for its use; however, public non-community wells and domestic wells are situated elsewhere on or near NWS Earle. If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would not be protected.

Under ambient conditions, a gradual reduction of the contaminants in site groundwater would likely occur through physical, biological, and chemical mechanisms; however, the process is likely to take many years. Five-year reviews would assess whether human health risks are increasing or abating with time in light of future land use or changes in the conditions at the site.

No controls would be used to manage site contaminants under the no-action alternative; therefore, the evaluation of the adequacy and reliability of controls is not applicable.

Reduction of Toxicity, Mobility, or Volume Through Treatment

The no-action alternative would not reduce the toxicity, mobility, or volume of contamination through treatment, since no treatment is used to address the contaminated media.

Short-Term Effectiveness

Since no response actions would occur, implementation of the no-action alternative would not pose additional short-term risks to base personnel or the local community. Short-term risks to workers conducting long-term monitoring would be mitigated by use of appropriate procedures and PPE. Current risks would remain unabated. None of the RAOs would be achieved.

Implementability

Since no response activities would occur, the no-action alternative is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not relevant to this alternative. Monitoring to assess contaminant status would pose no implementability concerns. Additional actions can be easily implemented in the future, if warranted.

Permits would not be required under Alternative 1. Coordination with other agencies may be required as part of the long-term monitoring and 5-year review processes.

Regulatory personnel and environmental specialists are readily available to perform the environmental monitoring and 5-year reviews effectively.

Cost

Capital costs associated with the no-action alternative are $41,400. The average annual operation and maintenance (O&M) cost for long-term monitoring is $23,900 and 5-year reviews are $15,500 per event. Over a 30-year period, the net present-worth cost is $371,000 (at a 7 percent discount rate).

4.1.2 Site 13 - Alternative 2: Institutional Controls and Long-Term Monitoring

Alternative 2 relies on institutional controls to achieve RAOs. The perimeter of the landfill would be fenced to limit access to the landfill area. Access restrictions would be placed to limit future uses of the site that may result in disturbance of the cover or direct contact with contaminated media and to prohibit the use of untreated groundwater as drinking water. Over time, groundwater contamination is expected to gradually decrease by physical, biological, and chemical mechanisms. Long-term, periodic monitoring and 5-year reviews would assess contaminant status and potential threats to human health and the environment. The key components of Alternative 2 are identified on Table 3-1.

Overall Protection of Human Health and the Environment

Alternative 2 would provide protection of human health and the environment by restricting access to contaminated landfill materials and instituting restrictions on use of site groundwater.

Although the potential health risks from direct exposure to landfill contaminants were not quantified in the RI, it is conservatively assumed that direct exposure to landfill contents may pose health risks to humans and animals. These risks would be reduced by installation of a fence around the landfill.

Alternative 2 would also reduce the risks posed by future use of site groundwater. The human health risk assessment concluded that site groundwater poses carcinogenic and non-carcinogenic risks exceeding EPA's target risk range under a future residential exposure scenario. Groundwater contaminant concentrations should eventually decrease to acceptable levels (GWQSs), reducing the long-term risk posed by future use of site groundwater. Implementing access restrictions and establishing the site as a groundwater CEA would provide interim protection by prohibiting use of the aquifer until GWQSs are achieved.

Fencing and access restrictions would provide long-term protection by limiting access to the capped area and restricting activities that could damage or intrude into the existing cover and contaminated media.

The long-term periodic monitoring program would allow the responsible agency to monitor the quality of groundwater leaving the site, assess potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary.

Compliance with ARARs

Implementation of Alternative 2 would comply with some of the ARARs identified in Tables 2-1 through 2-6. Because Alternative 2 does not include active treatment of groundwater, initially, the groundwater beneath Site 13 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, contaminants in the groundwater should gradually reduce and ultimately result in attainment of GWQS. Alternative 2 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQS are achieved. The CEA would be established to provide the state official notice that the constituent standards would not be met for a specified duration and to ensure that consumption of the untreated groundwater is prohibited.

The potential effects of the proposed actions on wetlands, floodplains, water bodies, and other sensitive receptors would be identified and all necessary measures would be taken to comply with the location-specific

federal and state ARARs identified in Tables 2-3 and 2-4. It is expected that Alternative 2 would easily comply with these ARARs.

Brief descriptions of the cited requirements are provided in Section 2.2 of this report.

Long-Term Effectiveness and Permanence

The risk assessment concluded that, under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in a potential carcinogenic risk of 1.1 E-03 and a HI of 8.4 for non-carcinogenic exposures. These risk estimates exceed EPA's target risk range. Implementing institutional controls to prohibit use of untreated contaminated groundwater would reduce these risks and provide long-term protection of human health. A gradual reduction of groundwater contamination should occur that would ultimately result in reduced risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through physical and chemical mechanisms.

The groundwater underlying Site 13 is not currently used as a potable water supply and there are no existing plans for its use; however, public non-community wells and domestic wells are situated elsewhere on or near NWS Earle, indicating that future use of groundwater is conceivable. If site land and groundwater usage changes in the future, potential residential users of groundwater would be protected by institutional controls (access restrictions and CEA) until GWQSs are achieved.

The potential health risks from direct exposure to landfill contaminants were not quantified in the RI; however, it is conservatively assumed that direct exposure to landfill contents may pose health risks to human and ecological receptors. Alternative 2 would reduce the human health risk posed by direct exposure to contaminated landfill materials. Because contaminated soils and landfill materials would remain in place , long-term routine maintenance of the perimeter fencing would be required to ensure the long-term protectiveness.

Periodic monitoring and evaluation of groundwater, surface water, and sediment would allow the responsible agency to monitor the quality of groundwater beneath and leaving the site, assess potential impacts to the adjacent wetlands and downgradient receptors, and determine whether remedial actions are necessary. The monitoring program should be effective in monitoring the risks to downgradient receptors and the environment.

Under ambient conditions, a gradual reduction of the contaminants in site groundwater would likely occur through physical, biological, and chemical mechanisms; however, the process is likely to take many years. Five-year reviews would assess whether human health risks are increasing or abating with time in light of future land use or changes in the conditions at the site. These reviews would be based in large part on

analytical data collected during monitoring events. Review of the effectiveness of access restrictions and the CEA in preventing exposure to site contaminants would also be required.

No difficulties or uncertainties are anticipated in performing the long-term maintenance or monitoring. All materials used in construction of the fencing are readily available. In the event of damage to the fencing, repairs would likely be performed without difficulty. Groundwater monitoring wells may require replacement if sedimentation or vandalism occurs; the wells would be readily replaceable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 would not reduce the toxicity, mobility, or volume of contamination through treatment since no treatment is used to address the contaminated landfill materials or groundwater.

Short-Term Effectiveness

Implementation of Alternative 2 is not expected to pose any significant risks to base personnel or the local community. Minimal increased truck traffic would occur as the result of site preparation and the placement of fencing. Workers who implement Alternative 2 would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated landfill materials, contaminant-laden dusts, and airborne VOCs. Occupational Safety and Health Administration (OSHA) standards would be followed and proper PPE would be used during all remedial activities.

Upon completion of the fencing, Alternative 2 would achieve the RAO for protection of human health by preventing exposure to contaminated soils and the RAO for preventing exposure to contaminants in groundwater. Implementing access restrictions and establishing the groundwater CEA may take a year or longer.

Implementability

Alternative 2 is implementable. No anticipated difficulties or uncertainties exist since common construction techniques are required and are available from several vendors. Long-term monitoring (sampling and analyses) only requires readily available resources. Access restrictions should not be difficult to implement and enforce since the site is part of an active Navy base and coordination with other agencies and property owners is not necessary.

Since long-term monitoring is included under Alternative 2, contaminant presence and migration can be assessed. Monitoring of groundwater, surface water, and sediment would be effective for detecting changes in media quality that may potentially impact downgradient receptors.

Permits would not be required under Alternative 2 since all activities would be conducted on the site; however, the substantive requirements of most ARARs would be met as described previously.

There is ample availability of companies with the trained personnel, equipment, and materials to install fencing and perform maintenance and long-term monitoring. Regulatory personnel and environmental specialists are readily available to perform 5-year reviews.

Cost

Capital costs associated with Alternative 2 $88,900 have been included in the first-year O&M cost. The average annual O&M cost for long-term monitoring is $23,900 and 5-year reviews are $15,500 per event. Over a 30-year period, the net present-worth cost is $419,000 (at a 7 percent discount rate).

4.1.3 Site 13 - Alternative 3: Capping, Institutional Controls, and Long-Term Monitoring

Alternative 3 relies on containment and institutional controls to achieve RAOs. A low-permeability cover system would be used to prevent potential human and animal contact with contaminants in the landfill materials, limit contaminant leaching to groundwater, and minimize contaminant migration via surface runoff and erosion. Impacted soils in deposition areas near current erosion or runoff sites would be excavated and placed under the cap, further limiting the potential for contaminant migration. The perimeter of the landfill would be fenced to limit access to the covered area. Access restrictions would be placed to limit future uses of the site that may result in disturbance of the cover or direct contact with contaminated media and to prohibit the use of untreated groundwater as drinking water. Over time, as a result of reduced leaching of contaminants from the landfill, groundwater contamination is expected to gradually decrease by physical, biological, and chemical mechanisms. Long-term, periodic monitoring and 5-year reviews would assess contaminant status and potential threats to human health and the environment. The key components of Alternative 3 are identified on Table 3-1.

Overall Protection of Human Health and the Environment

Alternative 3 would provide overall protection of human health and the environment by preventing direct exposure to contaminated landfill materials, reducing contaminant migration from the landfill into the environment, and instituting restrictions on use of site groundwater.

Although the potential health risks from direct exposure to landfill contaminants were not quantified in the RI, it is conservatively assumed that direct exposure to landfill contents may pose health risks to humans and animals. These risks would be reduced by installation of an enhanced cover system over the landfill.

Because the enhanced cover would effectively eliminate the direct exposure pathway, the direct contact risks would be eliminated, provided that the cover was properly maintained. The cover system would also prevent contaminant migration to the environment by surface runoff and wind erosion.

Alternative 3 would also reduce the risks posed by future use of site groundwater. The human health risk assessment concluded that site groundwater poses carcinogenic and non-carcinogenic risks exceeding EPA's target risk range under a future residential exposure scenario. Capping the landfill with a low-permeability cover system would significantly reduce infiltration of precipitation into the landfill, thereby reducing contaminant leaching from the landfill materials to the underlying groundwater. Reducing leaching of contaminants from the landfill into the underlying groundwater would eventually result in a decrease of groundwater contaminant concentrations to acceptable levels (GWQSs), reducing the long-term risk posed by future use of site groundwater. Implementing access restrictions and establishing the site as a groundwater CEA would provide interim protection by prohibiting use of the aquifer until GWQSs are achieved.

Fencing and access restrictions would provide additional long-term protection by limiting access to the capped area and restricting activities that could damage or intrude into the cover system and contaminated media.

The long-term periodic monitoring program would allow the responsible agency to monitor the quality of groundwater leaving the site, assess potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary.

Use of engineering controls to minimize generation of fugitive dusts and vapors and proper use of PPE by site workers would effectively minimize short-term risks to the local community and workers posed by implementation of this alternative.

Compliance with ARARs

Implementation of Alternative 3 would comply with all ARARs identified in Tables 2-1 through 2-6. Because Alternative 3 does not include active treatment of groundwater, initially, the groundwater beneath Site 13 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, capping the landfill, as proposed under Alternative 3, would reduce migration of contaminants into groundwater, facilitating a gradual reduction of contaminants and ultimately resulting in attainment of GWQS. Alternative 3 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQS are achieved. The CEA would be established to provide the state official notice that the constituent standards would not be met for a specified duration and to ensure that consumption of the untreated groundwater is prohibited.

The single-barrier cover system and long-term monitoring and maintenance plan proposed under Alternative 3 would comply with federal and state municipal landfill closure and post-closure regulations [40 CFR 258.60 & 258.61and N.J.A.C. 7:26-2A.9].

The potential effects of the proposed remediation on wetlands, floodplains, water bodies, and other sensitive receptors would be identified during the design of Alternative 3 and all necessary measures would be taken to comply with the location-specific federal and state ARARs identified in Tables 2-3 and 2-4. It is expected that Alternative 3 would easily comply with these ARARs.

Brief descriptions of the cited requirements are provided in Section 2.2 of this report.

Long-Term Effectiveness and Permanence

The risk assessment concluded that, under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in a potential carcinogenic risk of 1.1 E-03 and an HI of 8.4 for non-carcinogenic exposures. These risk estimates exceed EPA's target risk range. Capping the landfill, maintaining the cap, and implementing institutional controls to prohibit use of untreated contaminated groundwater would reduce these risks and provide long-term protection of human health.

Capping the landfill with a low-permeability cover system would significantly reduce infiltration of precipitation into the landfill, thereby reducing contaminant leaching from the landfill materials to the underlying groundwater and facilitating gradual reduction of groundwater contamination. Containing the source of groundwater contamination would ultimately result in reduced risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through physical and chemical mechanisms.

The groundwater underlying Site 13 is not currently used as a potable water supply and there are no existing plans for its use; however, public non-community wells and domestic wells are situated elsewhere on or near NWS Earle, indicating that future use of groundwater is conceivable. If site land and groundwater usage changes in the future, potential residential users of groundwater would be protected by institutional controls (access restrictions and CEA) until GWQSs are achieved.

The potential health risks from direct exposure to landfill contaminants were not quantified in the RI; however, it is conservatively assumed that direct exposure to landfill contents may pose health risks to human and ecological receptors. Alternative 3 would reduce the human health risk posed by direct exposure to contaminated landfill materials. Because contaminated soils and landfill materials would remain in place beneath the cover, long-term routine maintenance of the cover system and perimeter fencing would be

required to ensure the long-term protectiveness of the cover. With proper maintenance, the cover system would effectively provide long-term protection.

Periodic monitoring and evaluation of groundwater, surface water, and sediment would allow the responsible agency to monitor the quality of groundwater beneath and leaving the site, assess potential impacts to the adjacent wetlands and downgradient receptors, and determine whether additional remedial actions are necessary. The monitoring program, in combination with the cover system, should be effective in minimizing the risks to downgradient receptors and the environment.

Five-year reviews would be required to assess whether the cover system is effective in preventing direct exposures and reducing contaminant leaching. These reviews would be based in large part on analytical data collected during monitoring events. Review of the effectiveness of access restrictions and the CEA in preventing damage to the cover system and exposure to site contaminants would also be required.

No difficulties or uncertainties are anticipated in performing the long-term maintenance or monitoring. All materials used in construction of the enhanced cover system [either soil cover (Alternative 3A) or asphalt cover (Alternative 3B)] and fencing are readily available and can be replaced. In the event of damage to the cap system, repairs would likely be performed without difficulty. Groundwater monitoring wells may require replacement if sedimentation or vandalism occur; the wells would be readily replaceable.

Because maintenance of the cover system would be continual, catastrophic failure is unlikely. In the event of failure or damage of the cover, existing access restrictions, institutional controls, and monitoring would provide adequate short-term protection of human health until the cover system can be repaired.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 3 would not reduce the toxicity, mobility, or volume of contamination through treatment since no treatment is used to address the contaminated landfill materials or groundwater. However, mobility of contaminants in the landfill materials would be reduced by the cover system.

Short-Term Effectiveness

Implementation of Alternative 3 is not expected to pose any significant risks to base personnel or the local community. Increased truck and heavy equipment traffic would occur as the result of site preparation and the import and placement of capping materials. Coordination and scheduling of truck and heavy equipment traffic on public roads would be required to manage increased vehicular activity.

During site preparation and placement of the cap system, risks posed to base personnel by fugitive dust (bearing adsorbed contaminants) would be minimized by appropriate engineering control measures such as dust suppressants. Workers who implement Alternative 3 would be adequately safeguarded by using appropriate personal protective equipment (PPE) to prevent exposure to contaminated landfill materials, contaminant-laden dusts, and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

No permanent adverse impacts to the environment are anticipated to result from construction of the cap system. Erosion control measures such as hay bales and silt fences would be used to prevent damage to the environment from sediment runoff during cap construction.

The cap system placement would require approximately 18 months to implement, including pre-design and design activities. Upon completion of the cap, Alternative 3 would achieve the RAO for protection of human health by preventing exposure to contaminated soils and the RAO for reducing migration of contaminants to groundwater. Implementing access restrictions and establishing the groundwater CEA may take a year or longer.

Implementability

Alternative 3 is implementable. No anticipated difficulties or uncertainties exist in constructing the enhanced cover system since common construction techniques are required and cover materials are available from several vendors. Long-term monitoring (sampling and analyses) only requires readily available resources. Access restrictions should not be difficult to implement and enforce since the site is part of an active Navy base and coordination with other agencies and property owners is not necessary.

Since long-term monitoring is included under Alternative 3, contaminant presence and migration can be assessed. Monitoring of groundwater, surface water, and sediment would be effective for detecting changes in media quality that may indicate cap failure and for identifying potential impacts to downgradient receptors.

Permits would not be required under Alternative 3 since all activities would be conducted on the site; however, the substantive requirements of all ARARs would be met as described previously.

There is ample availability of companies with the trained personnel, equipment, and materials to perform site preparation, construct the cover system, install fencing, and perform maintenance and long-term monitoring. Regulatory personnel and environmental specialists are readily available to perform 5-year reviews.

Cost

Alternative 3A (Soil Cover)

The capital costs for Alternative 3A total $1,290,100. The average annual O&M costs are $26,800, and 5-year reviews cost $15,500 per event. Over a 30-year period, the net present-worth cost is $1,657,000 (at a 7 percent discount rate).

Alternative 3B (Asphalt Cover)

The capital costs for Alternative 3B total $1,482,600. The average annual O&M costs are $26,800, and 5-year reviews cost $15,500 per event. It was also assumed that the cap would be paved every 10 years at a cost of $50,000. Over a 30-year period, the net present-worth cost is $1,888,000 (at a 7 percent discount rate).

4.1.4 Comparative Analysis of Site 13 Alternatives

As part of the detailed analysis, comparisons of the remedial alternatives are made to identify differences between the alternatives and how site contaminant threats are addressed. The alternatives are compared with respect to each of the evaluation criteria, and differences are identified. Table 4-1 presents summaries of the evaluations for each alternative.

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment. Alternative 2 would be less protective of human health and the environment than Alternative 3 but considerably more protective than Alternative 1. Because no actions are conducted, Alternative 1 would not reduce human health or ecological risk and would not reduce contaminant migration to the environment. Because no actions would be taken under Alternative 1 to contain contaminants or prevent deterioration of the landfill surface, health risks and adverse impacts to the environment are expected to remain the same or increase over time.

Alternative 2 includes access restrictions and establishing a groundwater CEA, which would reduce human health and ecological risks posed by contact with landfill contents. Institutional controls would provide assurance that untreated contaminated groundwater is not used as a potable water source in the future. This would significantly reduce the human health risks by eliminating potential exposure to contaminated groundwater (the driving concern in the human risk assessment).

TABLE 4-1
SITE 13 - COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND LONG-TERM MONITORING	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT			
Prevent Human Exposure to Contaminated Soils and Landfilled Materials	No action taken to prevent human exposure to contaminated soils and landfilled materials. Existing risks would remain. Continued deterioration of the landfill surface would expose more contaminated soils and landfilled materials and result in increased direct exposure risks.	Fencing would reduce the potential for direct contact with contaminated soils and landfilled materials. Current direct contact risks were not quantified, but it is conservatively assumed that landfilled materials may pose excess health risks.	Cover system would prevent direct contact with contaminated soils and landfilled materials. Current direct contact risks were not quantified, but it is conservatively assumed that landfilled materials may pose excess health risks. Any excess risks would be reduced to acceptable levels by installing and maintaining the cap.
Prevent Human Exposure to VOC and Metal Contaminants in Groundwater	No action taken to prevent human exposure to contaminated groundwater. Carcinogenic and non-carcinogenic risks exceeding EPA's target risk range would remain. No actions taken to reduce contaminant leaching to groundwater. No institutional controls implemented to prohibit use of untreated groundwater.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. In time, contaminants would gradually decrease until reaching levels that would not pose excess risk.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. The cover system would reduce leaching of contaminants to groundwater, facilitating gradual reduction of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.
Minimize Contaminant Migration	No actions taken to reduce contaminant leaching to groundwater. Contaminants would continue to leach into groundwater and migrate, potentially affecting downgradient receptors.	No actions taken to reduce contaminant leaching to groundwater. Contaminants would continue to leach into groundwater and migrate, potentially affecting downgradient receptors.	A cover system would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.

TABLE 4-1
SITE 13 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
PAGE 2 OF 5

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND LONG-TERM MONITORING	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
COMPLIANCE WITH ARARs			
Chemical-Specific ARARs	Would not comply with state groundwater quality standards.	Groundwater contaminant concentrations would initially exceed state GWQC; over time GWQC would be achieved. A CEA would be established to provide the state official notification that standards would not be met for a specified duration.	Groundwater contaminant concentrations would initially exceed state GWQC; over time GWQC would be achieved. A CEA would be established to provide the state official notification that standards would not be met for a specified duration.
Location-Specific ARARs	Not Applicable.	Would comply with federal and state ARARs for wetlands, floodplains, and other sensitive receptors.	Would comply with federal and state ARARs for wetlands, floodplains, and other sensitive receptors.
Action-Specific ARARs	Would not comply with federal or state ARARs for post-closure maintenance of municipal landfills.	Would not comply with federal or state ARARs for post-closure maintenance of municipal landfills.	Would comply with federal and state ARARs for closure and post-closure of municipal landfills.
LONG-TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of Residual Risk	Existing risks would remain: approximately 1.1E-03 cancer risk and HI > 1 non-carcinogenic risks from exposure to site groundwater assuming future residential land use and consumption of contaminated groundwater. Increased risk anticipated over time as landfill surface deteriorates.	Existing risks would remain: approximately 1.1E-03 cancer risk and HI > 1 non-carcinogenic risks from exposure to site groundwater. Implementation and enforcement of institutional controls would block exposure to site groundwater. Fencing would reduce potential contact with wastes protruding from the landfill surface.	Existing risks would remain: approximately 1.1E-03 cancer risk and HI > 1 non-carcinogenic risks from exposure to site groundwater. Implementation and enforcement of institutional controls would block exposure to site groundwater. Installation and maintenance of the cap would block direct exposure risks from potential contact with protruding waste.

TABLE 4-1
SITE 13 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND LONG-TERM MONITORING	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Adequacy and Reliability of Controls	No new controls implemented. Existing site features provide limited controls.	If implemented and enforced, institutional controls could prevent damage to the cover, intrusion into contaminated materials, and use of contaminated groundwater.	If properly maintained, the cap system would be reliable for preventing exposure and reducing contaminant migration to the environment. If implemented and enforced, institutional controls could prevent damage to the cap, intrusion into contaminated materials, and use of contaminated groundwater.
Need for 5-Year Review	Review would be required since soil and groundwater contaminants would be left in place.	Same as Alternative 1.	Same as Alternative 1.
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.	No reduction, since no treatment would be employed.
SHORT-TERM EFFECTIVENESS			
Community Protection	No 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.
Worker Protection	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 fence installation and long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during remediation and long-term monitoring.
Environmental Impacts	No adverse impacts to the environment anticipated.	No adverse impacts to the environment anticipated.	No significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.

TABLE 4-1
SITE 13 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Time Until Action is Complete	Not applicable.	Approximately 1 year to institute CEA.	Approximately a year to institute CEA and 1.5 years to design and install cap.
IMPLEMENTABILITY			
Ability to Construct and Operate	No construction or operation involved.	No difficulties anticipated. Fencing is a readily implementable technology.	No difficulties anticipated. Capping is a readily implementable technology.
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	Additional actions would be easily implemented if required.	If additional actions are warranted, the cover system may need to be opened to access contaminated materials.
Ability to Monitor Effectiveness	Monitoring would provide assessment of potential exposures, contaminant presence, migration, or changes in site conditions.	Same as Alternative 1.	Same as Alternative 1.
Ability to Obtain Approvals and Coordinate with Other Agencies	Coordination for 5-year reviews may be required and would be obtainable.	Coordination for 5-year reviews may be required and would be obtainable. Coordination with the state would be required to establish a CEA and would be obtainable.	Coordination for 5-year reviews may be required and would be obtainable. Coordination with the state would be required to establish a CEA and would be obtainable.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	Same as Alternative 1.	Same as Alternative 1.
Availability of Equipment, Specialists, and Materials	Personnel and equipment available for implementation of long-term monitoring and 5-year reviews.	Ample availability of equipment and personnel to install fencing and perform long-term maintenance, monitoring, and 5-year reviews.	Ample availability of equipment and personnel to construct cap and perform long-term maintenance, monitoring, and 5-year reviews.
Availability of Technology	Not required.	Common construction techniques and materials required for construction.	Common construction techniques and materials required for cap construction.

TABLE 4-1
SITE 13 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
OU-5 FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
PAGE 5 OF 5

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND LONG-TERM MONITORING	ALTERNATIVE 3A: CAPPING, INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING	ALTERNATIVE 3B: CAPPING, INSTITUTIONAL CONTROLS, AND LONG-TERM MONITORING
COST				
Capital Cost	$41,400	$88,900	$1,290,100	$1,482,600
First-Year Annual O&M Cost	$23,900	$23,900	$26,800	$26,800
FiveYear Reviews	$15,500	$15,500	$15,500	$15,500
Present Worth Cost*	$371,000	$419,000	$1,657,000	$1,888,000

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

Alternative 3 is most protective of human health and the environment. The enhanced cover system would reduce human health and ecological risks posed by contact with landfill contents and would significantly reduce infiltration through landfill materials and leaching of contaminants to groundwater, thereby reducing contaminant migration into the environment. Routine maintenance of the landfill cover system would ensure its long-term protectiveness. Institutional controls would provide assurance that untreated contaminated groundwater is not used as a potable water source in the future.

Compliance with ARARs

Because Alternatives 1 and 2 do not include any remedial actions, they would not comply with state and federal ARARs pertaining to post-closure of municipal landfills [40 CFR 258.60 & 258.61and N.J.A.C. 7:26-2A.9]. Alternative 3 would comply with these requirements since a cover system would be installed and a long-term maintenance and repair program would be implemented.

All three alternatives would comply with federal and state long-term monitoring requirements through periodic monitoring and evaluation of groundwater, surface water, and sediments.

Alternative 1 would not comply with state ARARs for attainment of groundwater quality standards [N.J.A.C. 7:9-6]. Alternatives 2 and 3 would comply by seeking a temporary exemption (CEA) from these requirements until the GWQS are achieved.

Long-Term Effectiveness and Permanence

Alternative 3 offers substantial long-term protection of human health and the environment. Alternative 2 offers long-term protection of human health and the environment. Under Alternative 1, risks would remain the same or increase over time as the landfill surface erodes because no additional actions would be taken to contain wastes and limit deterioration of the landfill surface. Potential future users of site groundwater may be at risk under Alternative 1 because it lacks institutional controls that would prohibit use of untreated contaminated groundwater.

Alternatives 2 and 3 would mitigate long-term risks due to ingestion of site groundwater by implementing institutional controls to prohibit use of untreated, contaminated groundwater. Alternative 3 would reduce human and ecological risks due to direct exposure to landfill contents by eliminating the potential for exposure and would significantly reduce contaminant leaching into groundwater.

Reduction of Toxicity, Mobility, or Volume through Treatment

Because none of the alternatives includes treatment, they would not reduce the toxicity, mobility, or volume through treatment. Alternative 3 would reduce the mobility of landfill contaminants by significantly reducing precipitation infiltration.

Short-Term Effectiveness

The short-term effectiveness of the alternatives would be similar since the use of appropriate engineering controls and PPE is expected to minimize adverse impacts to base residents and personnel, the local community, and workers during implementation.

Long-term monitoring, which would provide little opportunity for short-term impact, is the only on-site action proposed under Alternative 1. Alternative 2 would present a greater opportunity for short-term impact due to site preparation and installation of the fencing. Alternative 3 would present a greatest opportunity for short-term impact due to site preparation, grading, and either placing additional cover or constructing the enhanced cover system.

Impacts to the environment are not anticipated under Alternatives 1 and 2 since minimal activities would be conducted. Impacts to the environment would be minimized under Alternative 3 by use of erosion and storm water control measures during site work.

Alternative 1 would not achieve any of the RAOs. Alternative 2 would achieve most RAOs within approximately 1 year, which would be the time to implement the CEA. Alternative 3 would achieve all RAOs within approximately 1.5 years, which would be the time to design and install the proposed cover and to implement the CEA.

Implementability

Alternative 1 is easily implemented since the only activities proposed are long-term monitoring and 5-year reviews. Alternative 2 is also easily implemented since the only on-site activities would be installation of the fencing, long-term monitoring, and 5-year reviews. Alternative 3 would be most difficult to implement since it involves the construction of an enhanced cover system over several acres of land; however, no difficulties are anticipated, since common construction techniques are required and cover materials are available from several vendors.

If additional actions are warranted, they could be easily implemented under Alternatives 1 and 2. Additional actions could be implemented under Alternative 3; however, opening the cover system to access contaminated materials may be required.

Cost

The costs associated with each alternative are provided in Table 4-1. Alternative 1, no action, would cost less than Alternative 2, which would cost considerably less to implement than Alternative 3.

To:	**Mike Wierman/ King of Prussia**	**CC:**	**Russell Turner/King of Prussia**
From	**Corey Rich/Pittsburgh**		
Subject:	**ECTran modeling of Contaminants of Concern**		
	NWS Earle Site 13		
	CTO 300, Job No. 7695/0210		
Date:	**November 10, 1997**		

OBJECTIVES

Potential impacts of COCs identified in NWS Earle Site 13 through groundwater pathways need to be further evaluated. Quantitative estimates of the COC-specific maximum groundwater concentrations at the nearest potential groundwater exposure point after installation of a cap over the landfill is required for this evaluation. An ECTran modeling task was conducted to provide the necessary estimates to support the evaluation. This memo summarizes the modeling approach used and the results obtained.

GENERAL APPROACH

Site-specific groundwater flow and contaminant transport models were developed following a general modeling approach. The following steps are included in the general approach:

- Identify the site-specific groundwater COCs - Human health COCs were selected based on the results of the baseline human health risk assessment provided in the RI and RI Addendum Reports.

- Define the existing groundwater plume - Based on the RI information, the size of the groundwater plume, as well as, current representative COC-specific groundwater concentrations in the plume were determined.

- Conceptualized the hydrogeological conditions - Groundwater flow direction, velocity, and impacted saturated zone thickness were defined based on the RI information.

- Identify the nearest potential exposure point - Based on the groundwater flow direction and depth in the source area, the nearest potential downgradient groundwater exposure point was located on the USGS 7.5 minute topographic quadrangles (see Figure 1). The potential groundwater exposure point is an on-property surface water body where contaminated groundwater may discharge into.

- Estimate the maximum groundwater concentration at the exposure point - ECTran model simulations were conducted to determine the COC-specific maximum exposure point concentrations within a 1000 years simulation time frame.

SITE-SPECIFIC ASSUMPTIONS

The site-specific assumptions in the modeling task are summarized below:

• Source Area Plume Size	620 feet (L) x 480 feet (W) (see Figure 2)
• Exposure Point	stream approximately 500 feet downgradient (See Figure 1)
• Hydraulic Conductivity	2.64×10^{-4} cm/s (0.75 feet/day)
• Hydraulic Gradient	0.007 (25'/350') (see Figure 3)
• Effective Porosity	0.25
• Infiltration Rate	0 inches/year (after capping)
• Impacted Saturated Zone Thickness	30 feet (aquifer thickness)

- Initial COC Groundwater Concentrations (ug/L)

Arsenic	39.2
Beryllium	1.6
Cadmium	63.9
Chromium	296
Iron	57900
Lead	18.8
Thallium	23.8
Vinyl chloride	11

SUMMARY OF RESULTS

Table 1 lists the estimated COC-specific maximum groundwater concentrations at the exposure point within 1000 years. As shown in the table, all of the predicted concentrations are much lower than the relevant groundwater criteria. The main reasons for the low groundwater concentrations at the exposure point are the high K_d (and therefore low mobilities) associated with the inorganic constituents evaluated and the low hydraulic conductivity of the aquifer. Because no site-specific K_d value was available, the representative K_d values were selected from two commonly used references. The hydraulic conductivity of the aquifer was based on the results of one slug test.

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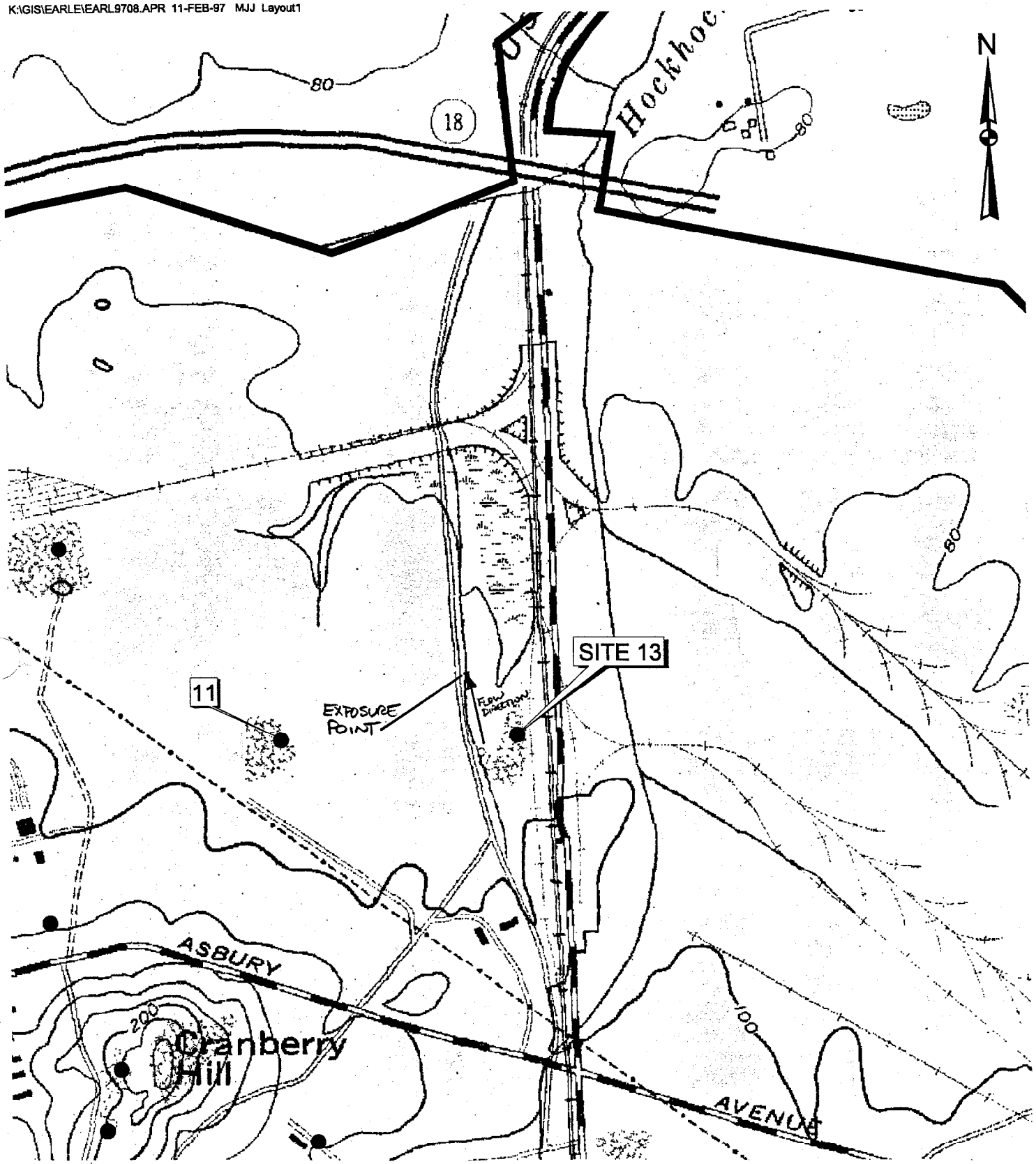

LOCATIONS OF SOURCE AREA AND EXPOSURE ROUTE
NWS EARLE, COLTS NECK, NEW JERSEY

1000 0 1000 2000 Feet

FIGURE 1

Brown & Root Environmental

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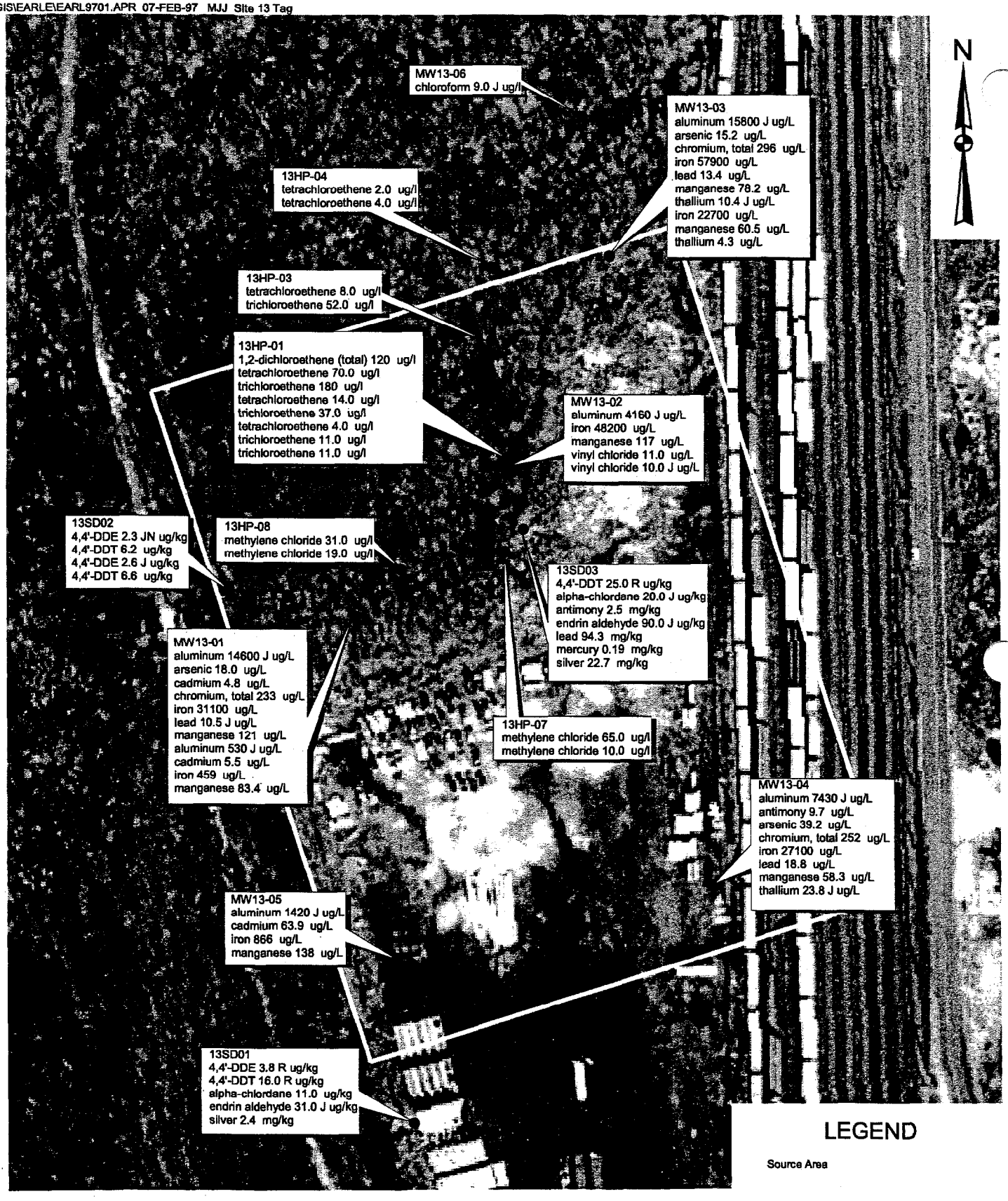
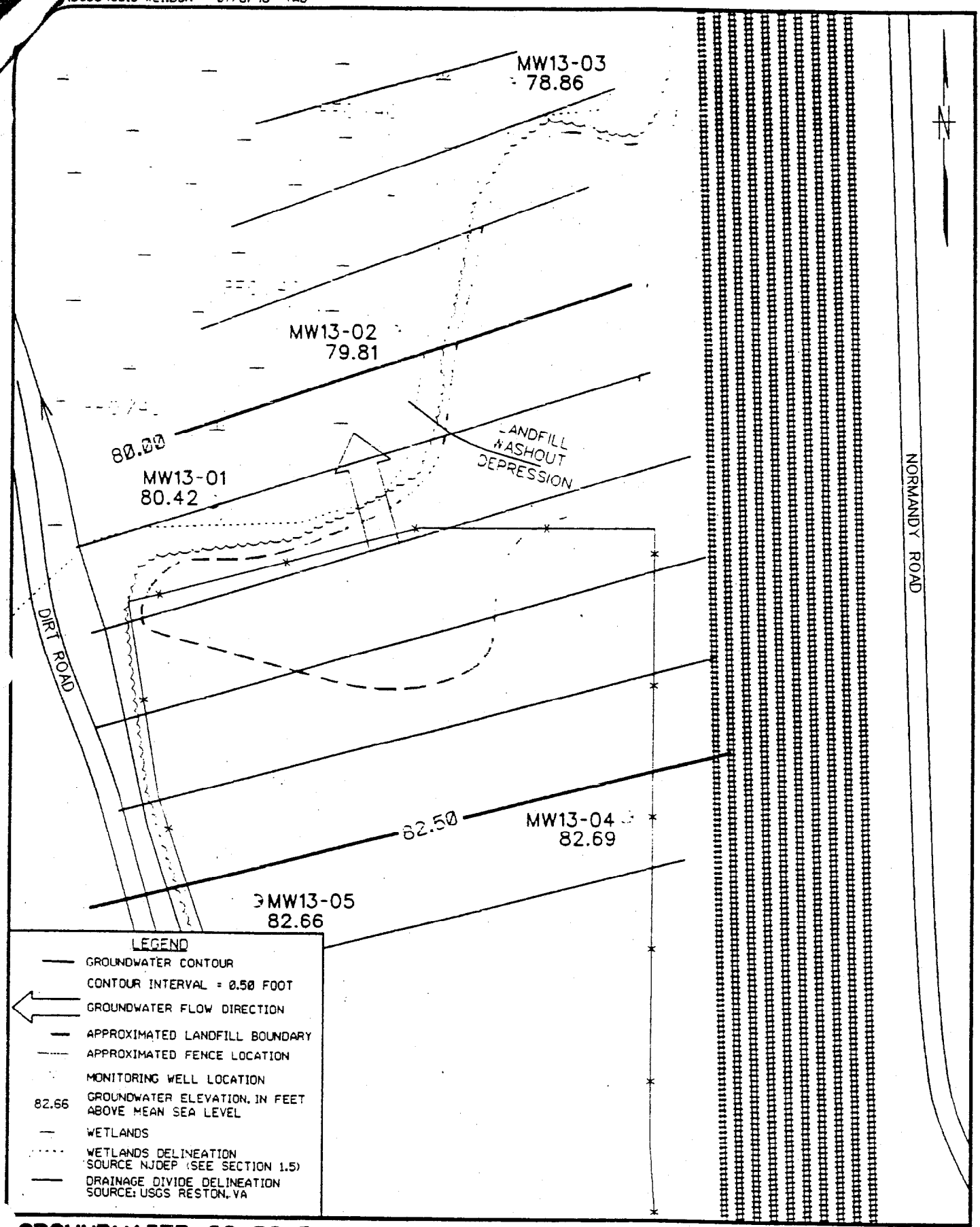


CONCENTRATIONS ABOVE SCREENING LEVELS
SITE 13 - DPDO YARD

120 0 120 240 Feet

FIGURE 2

Brown & Root Environmental



GROUNDWATER CONTOUR MAP AUGUST 7, 1995

SITE 13 - DRMO YARD

0 100 200

SCALE IN FEET

Figure 3

Brown & Root Environmental

Table 1

Maximum Exposure Point Concentration

NWS Earie Site 13

Chemical	KOC (L/kg)	Partitioning Coef. Kd (L/kg)	Ref	Half Life (yr)	Ref	Max. GW Conc. Under Source Area (ug/L)	GW Water Criteria (ug/L)	Ref	Max. GW Conc. At Exp. Point (ug/L)
Arsenic		29	(1)	NA		39.2	8	5	1.03E-10
Beryllium		790	(1)	NA		1.6	4	6	0.00E+00
Cadmium		75	(1)	NA		63.9	4	5	0.00E+00
Chromium		1.80E+06	(1)	NA		296	100	6	0.00E+00
Iron		220	(2)	NA		57900	300	5	0.00E+00
Lead		270	(2)	NA		18.8	10	5	0.00E+00
Thallium		71	(1)	NA		23.8	0.4	7	0.00E+00
Vinyl chloride	18.6	0.0372	(3)	7.92	(4)	11	2	6	2.61E-02

(1) USEPA, Soil Screening Guidance, 1996
(2) Thibault et. al., 1990.
(3) USEPA, Soil Screening Guidance, 1996. Kd=Koc x foc, where foc=0.002 (Default value in Screening Guidance).
(4) Inorganic contaminants do not decay, half-lifes for organic contaminants from Howard et al., 1991.
(5) NJDEP Groundwater Quality Standard.
(6) Maximum Contaminant Level (MCL).
(7) Drinking Water Health Advisory.

ECTran Version 2.0 for Excel 4.0 & 5.0

C ght 1996

BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION,EARLE NJ, S13 INVESTIGATOR: WYU DATE: 11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION MAKING BOX			
CONTAMINANT:	Arsenic	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
		WATER CRITERIA (UG/L):	8.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	0.00E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	2.90E+01	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	0	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3):	1.78
		Kd (L/KG):	1.00E-05

IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
SA TION RATE:	0.95	SATURATION RATE:	0.13
P :	0.25	POROSITY:	0.25
BU NSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	2.90E+01	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	39.2	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	3.92E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	1.03E-10 (UG/L)	1000

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BROWN & ROOT ENVIRONMENTAL
SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE: NAVAL WEAPONS STATION,EARLE NJ, S13

INVESTIGATOR: WYU
DATE: 11/10/97

CONTAMINANT: Arsenic

HALF-LIFE (YRS):
LAYER 2: 0.00E+00
SATURATED LAYER 0.00E+00
DOWNGRADIENT 0.00E+00

INITIAL CONC. (ug/L): 3.92E+01

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480		Kd (L/KG):	2.90E+01	GW V. (FT/YR):	7.67	Kd (L/KG): 29
POROSITY 2:	0.25		SATURATION:	1.00	H (FT):	30.0000	RETARDATION: 175
POROSITY SAT. LAYER:	0.25		THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR): 0
DENSITY 2 (G/CM3):	1.5		DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR): 0.0E+00
DENSITY GMA (G/CM3):	1.50		CBo (PPB):	3.92E+01	Az (FT):	0.09	
			CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS): 0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY):	2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT): 500

TIME INTERVAL (YRS) 20

ELAPSED TIME - YRS	LAYER 2(PPB)	SOURCE AREA CONC.(GMA) (UG/L)	FENCE LINE CONC. (UG/L)
0	0.00E+00	3.92E+01	0.00E+00
20	0.00E+00	3.91E+01	0.00E+00
40	0.00E+00	3.91E+01	0.00E+00
60	0.00E+00	3.90E+01	0.00E+00
80	0.00E+00	3.90E+01	0.00E+00
100	0.00E+00	3.89E+01	0.00E+00
120	0.00E+00	3.89E+01	0.00E+00
140	0.00E+00	3.88E+01	0.00E+00
160	0.00E+00	3.88E+01	0.00E+00
180	0.00E+00	3.87E+01	0.00E+00
200	0.00E+00	3.86E+01	0.00E+00
220	0.00E+00	3.86E+01	0.00E+00
240	0.00E+00	3.85E+01	0.00E+00
260	0.00E+00	3.85E+01	0.00E+00
280	0.00E+00	3.84E+01	0.00E+00
300	0.00E+00	3.84E+01	0.00E+00
320	0.00E+00	3.83E+01	0.00E+00
340	0.00E+00	3.83E+01	0.00E+00
360	0.00E+00	3.82E+01	0.00E+00
380	0.00E+00	3.82E+01	0.00E+00
400	0.00E+00	3.81E+01	0.00E+00
420	0.00E+00	3.81E+01	0.00E+00
440	0.00E+00	3.80E+01	0.00E+00
460	0.00E+00	3.79E+01	0.00E+00
480	0.00E+00	3.79E+01	0.00E+00
500	0.00E+00	3.78E+01	0.00E+00
520	0.00E+00	3.78E+01	0.00E+00
540	0.00E+00	3.77E+01	0.00E+00
560	0.00E+00	3.77E+01	0.00E+00
580	0.00E+00	3.76E+01	0.00E+00
600	0.00E+00	3.76E+01	0.00E+00
620	0.00E+00	3.75E+01	0.00E+00
640	0.00E+00	3.75E+01	0.00E+00
660	0.00E+00	3.74E+01	0.00E+00
680	0.00E+00	3.74E+01	0.00E+00
700	0.00E+00	3.73E+01	0.00E+00
720	0.00E+00	3.73E+01	0.00E+00
740	0.00E+00	3.72E+01	0.00E+00
760	0.00E+00	3.71E+01	0.00E+00
780	0.00E+00	3.71E+01	0.00E+00
800	0.00E+00	3.70E+01	0.00E+00
820	0.00E+00	3.70E+01	0.00E+00
840	0.00E+00	3.69E+01	0.00E+00
860	0.00E+00	3.69E+01	0.00E+00
880	0.00E+00	3.68E+01	0.00E+00
900	0.00E+00	3.68E+01	0.00E+00
920	0.00E+00	3.67E+01	0.00E+00
940	0.00E+00	3.67E+01	0.00E+00
960	0.00E+00	3.66E+01	3.09E-11
980	0.00E+00	3.66E+01	5.70E-11
1000	0.00E+00	3.65E+01	1.03E-10
MAXIMUM:	0.00E+00	3.92E+01	1.03E-10

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BROWN & ROOT ENVIRONMENTAL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S4	INVESTIGATOR:	WYU	DATE:	11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Beryllium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
		WATER CRITERIA (UG/L):	4.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	#DIV/0!
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	7.90E+02	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	0	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3):	1.78
		Kd (L/KG):	1.00E-05

IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
S TION RATE:	0.95	SATURATION RATE:	0.13
P :	0.25	POROSITY:	0.25
BUL ENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER

TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	7.90E+02	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ng/L):	1.6	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:

		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.60E+00 (UG/L)	0
FENCE LINE CONCENTRATION:	0.00E+00 (UG/L)	1000

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BROWN & ROOT ENVIRONMENTAL
SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S4

INVESTIGATOR: WYU
DATE: 11/10/97

CONTAMINANT: Beryllium

HALF-LIFE (YRS):	
LAYER 2:	0.00E+00
SATURATED LAYER	0.00E+00
DOWNGRADIENT	0.00E+00

INITIAL CONC. (ug/L): 1.60E+00

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480	Kd (L/KG):	7.90E+02	GW V. (FT/YR):	7.67	Kd (L/KG):	790
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	4741
POROSITY SAT. LAYER:	0.25	THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.5	DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR):	0.0E+00
DENSITY GMA (G/CM3):	1.50	CBo (PPB):	1.60E+00	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY): 2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT):	500

TIME INTERVAL (YRS) 20

ELAPSED TIME - YRS	LAYER 2(PPB)	SOURCE AREA CONC.(GMA) (UG/L)	FENCE LINE CONC. (UG/L)
0	0.00E+00	1.60E+00	0.00E+00
20	0.00E+00	1.60E+00	0.00E+00
40	0.00E+00	1.60E+00	0.00E+00
60	0.00E+00	1.60E+00	0.00E+00
80	0.00E+00	1.60E+00	0.00E+00
100	0.00E+00	1.60E+00	0.00E+00
120	0.00E+00	1.60E+00	0.00E+00
140	0.00E+00	1.60E+00	0.00E+00
160	0.00E+00	1.60E+00	0.00E+00
180	0.00E+00	1.60E+00	0.00E+00
200	0.00E+00	1.60E+00	0.00E+00
220	0.00E+00	1.60E+00	0.00E+00
240	0.00E+00	1.60E+00	0.00E+00
260	0.00E+00	1.60E+00	0.00E+00
280	0.00E+00	1.60E+00	0.00E+00
300	0.00E+00	1.60E+00	0.00E+00
320	0.00E+00	1.60E+00	0.00E+00
340	0.00E+00	1.60E+00	0.00E+00
360	0.00E+00	1.60E+00	0.00E+00
380	0.00E+00	1.60E+00	0.00E+00
400	0.00E+00	1.60E+00	0.00E+00
420	0.00E+00	1.60E+00	0.00E+00
440	0.00E+00	1.60E+00	0.00E+00
460	0.00E+00	1.60E+00	0.00E+00
480	0.00E+00	1.60E+00	0.00E+00
500	0.00E+00	1.60E+00	0.00E+00
520	0.00E+00	1.60E+00	0.00E+00
540	0.00E+00	1.60E+00	0.00E+00
560	0.00E+00	1.60E+00	0.00E+00
580	0.00E+00	1.60E+00	0.00E+00
600	0.00E+00	1.60E+00	0.00E+00
620	0.00E+00	1.60E+00	0.00E+00
640	0.00E+00	1.60E+00	0.00E+00
660	0.00E+00	1.60E+00	0.00E+00
680	0.00E+00	1.60E+00	0.00E+00
700	0.00E+00	1.60E+00	0.00E+00
720	0.00E+00	1.60E+00	0.00E+00
740	0.00E+00	1.60E+00	0.00E+00
760	0.00E+00	1.60E+00	0.00E+00
780	0.00E+00	1.60E+00	0.00E+00
800	0.00E+00	1.60E+00	0.00E+00
820	0.00E+00	1.60E+00	0.00E+00
840	0.00E+00	1.60E+00	0.00E+00
860	0.00E+00	1.60E+00	0.00E+00
880	0.00E+00	1.60E+00	0.00E+00
900	0.00E+00	1.60E+00	0.00E+00
920	0.00E+00	1.60E+00	0.00E+00
940	0.00E+00	1.60E+00	0.00E+00
960	0.00E+00	1.60E+00	0.00E+00
980	0.00E+00	1.60E+00	0.00E+00
1000	0.00E+00	1.60E+00	0.00E+00
MAXIMUM:	0.00E+00	1.60E+00	0.00E+00

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BROWN & ROOT ENVIRONMENTAL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S4	**INVESTIGATOR:**	WYU	**DATE:**	11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Cadmium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
		WATER CRITERIA (UG/L):	4.00E+00	CONSTANT CONCENTRATION (YES.NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	#DIV/0!
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	7.50E+01	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	0	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3):	1.78
		Kd (L/KG):	1.00E-05
IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
S[illegible]TION RATE:	0.95	SATURATION RATE:	0.13
P[illegible]:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER

TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	7.50E+01	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	63.9	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	6.39E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	0.00E+00 (UG/L)	1000

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BROWN & ROOT ENVIRONMENTAL
SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S4

INVESTIGATOR: WYU
DATE: 11/10/97

CONTAMINANT: Cadmium

HALF-LIFE (YRS):
LAYER 2: 0.00E+00
SATURATED LAYER 0.00E+00
DOWNGRADIENT 0.00E+00

INITIAL CONC. (ug/L): 6.39E+01

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480	Kd (L/KG):	7.50E+01	GW V. (FT/YR):	7.67	Kd (L/KG):	75
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	451
POROSITY SAT. LAYER:	0.25	THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.5	DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR):	0.0E+00
DENSITY GMA (G/CM3):	1.50	CBo (PPB):	6.39E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY): 2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT):	500

TIME INTERVAL (YRS)	20	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	0.00E+00	6.39E+01	0.00E+00
20	0.00E+00	6.39E+01	0.00E+00
40	0.00E+00	6.38E+01	0.00E+00
60	0.00E+00	6.38E+01	0.00E+00
80	0.00E+00	6.38E+01	0.00E+00
100	0.00E+00	6.37E+01	0.00E+00
120	0.00E+00	6.37E+01	0.00E+00
140	0.00E+00	6.37E+01	0.00E+00
160	0.00E+00	6.36E+01	0.00E+00
180	0.00E+00	6.36E+01	0.00E+00
200	0.00E+00	6.36E+01	0.00E+00
220	0.00E+00	6.35E+01	0.00E+00
240	0.00E+00	6.35E+01	0.00E+00
260	0.00E+00	6.34E+01	0.00E+00
280	0.00E+00	6.34E+01	0.00E+00
300	0.00E+00	6.34E+01	0.00E+00
320	0.00E+00	6.33E+01	0.00E+00
340	0.00E+00	6.33E+01	0.00E+00
360	0.00E+00	6.33E+01	0.00E+00
380	0.00E+00	6.32E+01	0.00E+00
400	0.00E+00	6.32E+01	0.00E+00
420	0.00E+00	6.32E+01	0.00E+00
440	0.00E+00	6.31E+01	0.00E+00
460	0.00E+00	6.31E+01	0.00E+00
480	0.00E+00	6.31E+01	0.00E+00
500	0.00E+00	6.30E+01	0.00E+00
520	0.00E+00	6.30E+01	0.00E+00
540	0.00E+00	6.30E+01	0.00E+00
560	0.00E+00	6.29E+01	0.00E+00
580	0.00E+00	6.29E+01	0.00E+00
600	0.00E+00	6.29E+01	0.00E+00
620	0.00E+00	6.28E+01	0.00E+00
640	0.00E+00	6.28E+01	0.00E+00
660	0.00E+00	6.28E+01	0.00E+00
680	0.00E+00	6.27E+01	0.00E+00
700	0.00E+00	6.27E+01	0.00E+00
720	0.00E+00	6.26E+01	0.00E+00
740	0.00E+00	6.26E+01	0.00E+00
760	0.00E+00	6.26E+01	0.00E+00
780	0.00E+00	6.25E+01	0.00E+00
800	0.00E+00	6.25E+01	0.00E+00
820	0.00E+00	6.25E+01	0.00E+00
840	0.00E+00	6.24E+01	0.00E+00
860	0.00E+00	6.24E+01	0.00E+00
880	0.00E+00	6.24E+01	0.00E+00
900	0.00E+00	6.23E+01	0.00E+00
920	0.00E+00	6.23E+01	0.00E+00
940	0.00E+00	6.23E+01	0.00E+00
960	0.00E+00	6.22E+01	0.00E+00
980	0.00E+00	6.22E+01	0.00E+00
1000	0.00E+00	6.22E+01	0.00E+00
MAXIMUM:	0.00E+00	6.39E+01	0.00E+00

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Chromium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+02	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	#DIV/0!
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	1.80E+06	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	0	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3):	1.78
		Kd (L/KG):	1.00E-05

IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
S[illegible]TION RATE:	0.95	SATURATION RATE:	0.13
P[illegible]Y:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER

TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	1.80E+06	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	296	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.96E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	0.00E+00 (UG/L)	1000

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SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	CONTAMINANT:	Chromium
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	11/10/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	2.96E+02

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480	Kd (L/KG):	1.80E+06	GW V. (FT/YR):	7.67	Kd (L/KG):	1800000
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	10800001
POROSITY SAT. LAYER:	0.25	THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.5	DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR):	0.0E+00
DENSITY GMA (G/CM3):	1.50	CBo (PPB):	2.96E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY): 2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT):	500

TIME INTERVAL (YRS)	20	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	0.00E+00	2.96E+02	0.00E+00
20	0.00E+00	2.96E+02	0.00E+00
40	0.00E+00	2.96E+02	0.00E+00
60	0.00E+00	2.96E+02	0.00E+00
80	0.00E+00	2.96E+02	0.00E+00
100	0.00E+00	2.96E+02	0.00E+00
120	0.00E+00	2.96E+02	0.00E+00
140	0.00E+00	2.96E+02	0.00E+00
160	0.00E+00	2.96E+02	0.00E+00
180	0.00E+00	2.96E+02	0.00E+00
200	0.00E+00	2.96E+02	0.00E+00
220	0.00E+00	2.96E+02	0.00E+00
240	0.00E+00	2.96E+02	0.00E+00
260	0.00E+00	2.96E+02	0.00E+00
280	0.00E+00	2.96E+02	0.00E+00
300	0.00E+00	2.96E+02	0.00E+00
320	0.00E+00	2.96E+02	0.00E+00
340	0.00E+00	2.96E+02	0.00E+00
360	0.00E+00	2.96E+02	0.00E+00
380	0.00E+00	2.96E+02	0.00E+00
400	0.00E+00	2.96E+02	0.00E+00
420	0.00E+00	2.96E+02	0.00E+00
440	0.00E+00	2.96E+02	0.00E+00
460	0.00E+00	2.96E+02	0.00E+00
480	0.00E+00	2.96E+02	0.00E+00
500	0.00E+00	2.96E+02	0.00E+00
520	0.00E+00	2.96E+02	0.00E+00
540	0.00E+00	2.96E+02	0.00E+00
560	0.00E+00	2.96E+02	0.00E+00
580	0.00E+00	2.96E+02	0.00E+00
600	0.00E+00	2.96E+02	0.00E+00
620	0.00E+00	2.96E+02	0.00E+00
640	0.00E+00	2.96E+02	0.00E+00
660	0.00E+00	2.96E+02	0.00E+00
680	0.00E+00	2.96E+02	0.00E+00
700	0.00E+00	2.96E+02	0.00E+00
720	0.00E+00	2.96E+02	0.00E+00
740	0.00E+00	2.96E+02	0.00E+00
760	0.00E+00	2.96E+02	0.00E+00
780	0.00E+00	2.96E+02	0.00E+00
800	0.00E+00	2.96E+02	0.00E+00
820	0.00E+00	2.96E+02	0.00E+00
840	0.00E+00	2.96E+02	0.00E+00
860	0.00E+00	2.96E+02	0.00E+00
880	0.00E+00	2.96E+02	0.00E+00
900	0.00E+00	2.96E+02	0.00E+00
920	0.00E+00	2.96E+02	0.00E+00
940	0.00E+00	2.96E+02	0.00E+00
960	0.00E+00	2.96E+02	0.00E+00
980	0.00E+00	2.96E+02	0.00E+00
1000	0.00E+00	2.96E+02	0.00E+00
MAXIMUM:	0.00E+00	2.96E+02	0.00E+00

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	INVESTIGATOR:	WYU	DATE:	11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Iron	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
HALF-LIFE (YRS):	0.00E+00	WATER CRITERIA (UG/L):	3.00E+02	CONSTANT CONCENTRATION (YES,NO)?	NO
				TRY NEW GOAL:	#DIV/0!
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	2.20E+02	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	0	SATURATION RATE:	0.95
SATURATION RATE:	0.6	POROSITY:	0.25
POROSITY:	0.25	BULK DENSITY (G/CM^3):	1.78
BULK DENSITY (G/CM^3)	1.5	Kd (L/KG):	1.00E-05

IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
S... TION RATE:	0.95	SATURATION RATE:	0.13
P... T:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	2.20E+02	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ng/L):	57900	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	5.79E+04 (UG/L)	0
FENCE LINE CONCENTRATION:	0.00E+00 (UG/L)	1000

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SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	CONTAMINANT:	Iron
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	11/10/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	5.79E+04

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480	Kd (L/KG):	2.20E+02	GW V. (FT/YR):	7.67	Kd (L/KG):	220
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	1321
POROSITY SAT. LAYER:	0.25	THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.5	DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR):	0.0E+00
DENSITY GMA (G/CM3):	1.50	CBo (PPB):	5.79E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY): 2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT):	500

TIME INTERVAL (YRS)	20	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	0.00E+00	5.79E+04	0.00E+00
20	0.00E+00	5.79E+04	0.00E+00
40	0.00E+00	5.79E+04	0.00E+00
60	0.00E+00	5.79E+04	0.00E+00
80	0.00E+00	5.79E+04	0.00E+00
100	0.00E+00	5.78E+04	0.00E+00
120	0.00E+00	5.78E+04	0.00E+00
140	0.00E+00	5.78E+04	0.00E+00
160	0.00E+00	5.78E+04	0.00E+00
180	0.00E+00	5.78E+04	0.00E+00
200	0.00E+00	5.78E+04	0.00E+00
220	0.00E+00	5.78E+04	0.00E+00
240	0.00E+00	5.78E+04	0.00E+00
260	0.00E+00	5.78E+04	0.00E+00
280	0.00E+00	5.77E+04	0.00E+00
300	0.00E+00	5.77E+04	0.00E+00
320	0.00E+00	5.77E+04	0.00E+00
340	0.00E+00	5.77E+04	0.00E+00
360	0.00E+00	5.77E+04	0.00E+00
380	0.00E+00	5.77E+04	0.00E+00
400	0.00E+00	5.77E+04	0.00E+00
420	0.00E+00	5.77E+04	0.00E+00
440	0.00E+00	5.77E+04	0.00E+00
460	0.00E+00	5.77E+04	0.00E+00
480	0.00E+00	5.76E+04	0.00E+00
500	0.00E+00	5.76E+04	0.00E+00
520	0.00E+00	5.76E+04	0.00E+00
540	0.00E+00	5.76E+04	0.00E+00
560	0.00E+00	5.76E+04	0.00E+00
580	0.00E+00	5.76E+04	0.00E+00
600	0.00E+00	5.76E+04	0.00E+00
620	0.00E+00	5.76E+04	0.00E+00
640	0.00E+00	5.76E+04	0.00E+00
660	0.00E+00	5.75E+04	0.00E+00
680	0.00E+00	5.75E+04	0.00E+00
700	0.00E+00	5.75E+04	0.00E+00
720	0.00E+00	5.75E+04	0.00E+00
740	0.00E+00	5.75E+04	0.00E+00
760	0.00E+00	5.75E+04	0.00E+00
780	0.00E+00	5.75E+04	0.00E+00
800	0.00E+00	5.75E+04	0.00E+00
820	0.00E+00	5.75E+04	0.00E+00
840	0.00E+00	5.74E+04	0.00E+00
860	0.00E+00	5.74E+04	0.00E+00
880	0.00E+00	5.74E+04	0.00E+00
900	0.00E+00	5.74E+04	0.00E+00
920	0.00E+00	5.74E+04	0.00E+00
940	0.00E+00	5.74E+04	0.00E+00
960	0.00E+00	5.74E+04	0.00E+00
980	0.00E+00	5.74E+04	0.00E+00
1000	0.00E+00	5.74E+04	0.00E+00
MAXIMUM:	0.00E+00	5.79E+04	0.00E+00

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	INVESTIGATOR:	WYU	DATE:	11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Lead	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+01	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	#DIV/0!
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	2.70E+02	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	0	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3):	1.78
		Kd (L/KG):	1.00E-05
IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
SATURATION RATE:	0.95	SATURATION RATE:	0.13
POROSITY:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	2.70E+02	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	18.8	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.88E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	0.00E+00 (UG/L)	1000

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BROWN & ROOT ENVIRONMENTAL

SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, 85	CONTAMINANT:	Lead
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	11/10/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.88E+01

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480	Kd (L/KG):	2.70E+02	GW V. (FT/YR):	7.67	Kd (L/KG):	270
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	1621
POROSITY SAT. LAYER:	0.25	THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.5	DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR):	0.0E+00
DENSITY GMA (G/CM3):	1.50	CBo (PPB):	1.88E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY): 2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT):	500

TIME INTERVAL (YRS) 20		SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	0.00E+00	1.88E+01	0.00E+00
20	0.00E+00	1.88E+01	0.00E+00
40	0.00E+00	1.88E+01	0.00E+00
60	0.00E+00	1.88E+01	0.00E+00
80	0.00E+00	1.88E+01	0.00E+00
100	0.00E+00	1.88E+01	0.00E+00
120	0.00E+00	1.88E+01	0.00E+00
140	0.00E+00	1.88E+01	0.00E+00
160	0.00E+00	1.88E+01	0.00E+00
180	0.00E+00	1.88E+01	0.00E+00
200	0.00E+00	1.88E+01	0.00E+00
220	0.00E+00	1.88E+01	0.00E+00
240	0.00E+00	1.88E+01	0.00E+00
260	0.00E+00	1.88E+01	0.00E+00
280	0.00E+00	1.88E+01	0.00E+00
300	0.00E+00	1.88E+01	0.00E+00
320	0.00E+00	1.88E+01	0.00E+00
340	0.00E+00	1.88E+01	0.00E+00
360	0.00E+00	1.87E+01	0.00E+00
380	0.00E+00	1.87E+01	0.00E+00
400	0.00E+00	1.87E+01	0.00E+00
420	0.00E+00	1.87E+01	0.00E+00
440	0.00E+00	1.87E+01	0.00E+00
460	0.00E+00	1.87E+01	0.00E+00
480	0.00E+00	1.87E+01	0.00E+00
500	0.00E+00	1.87E+01	0.00E+00
520	0.00E+00	1.87E+01	0.00E+00
540	0.00E+00	1.87E+01	0.00E+00
560	0.00E+00	1.87E+01	0.00E+00
580	0.00E+00	1.87E+01	0.00E+00
600	0.00E+00	1.87E+01	0.00E+00
620	0.00E+00	1.87E+01	0.00E+00
640	0.00E+00	1.87E+01	0.00E+00
660	0.00E+00	1.87E+01	0.00E+00
680	0.00E+00	1.87E+01	0.00E+00
700	0.00E+00	1.87E+01	0.00E+00
720	0.00E+00	1.87E+01	0.00E+00
740	0.00E+00	1.87E+01	0.00E+00
760	0.00E+00	1.87E+01	0.00E+00
780	0.00E+00	1.87E+01	0.00E+00
800	0.00E+00	1.87E+01	0.00E+00
820	0.00E+00	1.87E+01	0.00E+00
840	0.00E+00	1.87E+01	0.00E+00
860	0.00E+00	1.87E+01	0.00E+00
880	0.00E+00	1.87E+01	0.00E+00
900	0.00E+00	1.87E+01	0.00E+00
920	0.00E+00	1.87E+01	0.00E+00
940	0.00E+00	1.87E+01	0.00E+00
960	0.00E+00	1.87E+01	0.00E+00
980	0.00E+00	1.87E+01	0.00E+00
1000	0.00E+00	1.87E+01	0.00E+00
MAXIMUM:	0.00E+00	1.88E+01	0.00E+00

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BROWN & ROOT ENVIRONMENTAL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	INVESTIGATOR:	WYU	DATE:	11/10/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Thallium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	0.000E+00
		WATER CRITERIA (UG/L):	4.00E-01	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	#DIV/0!
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	INCREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E-16
Kl (L/KG):	7.10E+01	LENGTH (FT):	620
		WIDTH (FT):	480
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	0.00E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	0	SATURATION RATE:	0.95
SATURATION RATE:	0.6	POROSITY:	0.25
POROSITY:	0.25	BULK DENSITY (G/CM^3):	1.78
BULK DENSITY (G/CM^3)	1.5	Kd (L/KG):	1.00E-05

IS THERE A TYPE 1 LAYER (YES,NO)?	NO	IS THERE A TYPE 2 LAYER (YES,NO)?	NO
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
HOW MANY SUBLAYERS (1 - 10)?	1	HOW MANY SUBLAYERS (1 - 10)?	1
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	20
S[illegible]TION RATE:	0.95	SATURATION RATE:	0.13
P[illegible]Y:	0.25	POROSITY:	0.25
BULK DENSITY (G/CM^3)	1.5	BULK DENSITY (G/CM^3)	1.5
Kd (L/KG):	1.00E-05	Kd (L/KG):	1.00E-05
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0

SATURATED LAYER

TOTAL SATURATED ZONE THICKNESS, B (FT):	30	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	0.343
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	7.67	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	7.10E+01	SPECIFY MIXING DAETH (Computed from formula if input NO)	30
POROSITY:	0.25	MIXING DEPTH, H (FT):	30.0
VERTICAL DISPERSIVITY, Az (FT):	0.0883	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	50.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	16.7	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	23.8	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.38E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	0.00E+00 (UG/L)	1000

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BROWN & ROOT ENVIRONMENTAL
SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S5

INVESTIGATOR: WYU
DATE: 11/10/97

CONTAMINANT: Thallium

HALF-LIFE (YRS):	
LAYER 2:	0.00E+00
SATURATED LAYER	0.00E+00
DOWNGRADIENT	0.00E+00

INITIAL CONC. (ug/L): 2.38E+01

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480		Kd (L/KG):	7.10E+01	GW V. (FT/YR):	7.67	Kd (L/KG): 71
POROSITY 2:	0.25		SATURATION:	1.00	H (FT):	30.0000	RETARDATION: 427
POROSITY SAT. LAYER:	0.25		THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR): 0
DENSITY 2 (G/CM3):	1.5		DECAY (1/DAY):	0.00E+00	DISPERSIVITY:		DECAY (1/YR): 0.0E+00
DENSITY GMA (G/CM3):	1.50		CBo (PPB):	2.38E+01	Az (FT):	0.09	
			CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS): 0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY):	2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT): 500

TIME INTERVAL (YRS)	20		SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)		(UG/L)	(UG/L)
0	0.00E+00		2.38E+01	0.00E+00
20	0.00E+00		2.38E+01	0.00E+00
40	0.00E+00		2.38E+01	0.00E+00
60	0.00E+00		2.38E+01	0.00E+00
80	0.00E+00		2.37E+01	0.00E+00
100	0.00E+00		2.37E+01	0.00E+00
120	0.00E+00		2.37E+01	0.00E+00
140	0.00E+00		2.37E+01	0.00E+00
160	0.00E+00		2.37E+01	0.00E+00
180	0.00E+00		2.37E+01	0.00E+00
200	0.00E+00		2.37E+01	0.00E+00
220	0.00E+00		2.36E+01	0.00E+00
240	0.00E+00		2.36E+01	0.00E+00
260	0.00E+00		2.36E+01	0.00E+00
280	0.00E+00		2.36E+01	0.00E+00
300	0.00E+00		2.36E+01	0.00E+00
320	0.00E+00		2.36E+01	0.00E+00
340	0.00E+00		2.36E+01	0.00E+00
360	0.00E+00		2.36E+01	0.00E+00
380	0.00E+00		2.35E+01	0.00E+00
400	0.00E+00		2.35E+01	0.00E+00
420	0.00E+00		2.35E+01	0.00E+00
440	0.00E+00		2.35E+01	0.00E+00
460	0.00E+00		2.35E+01	0.00E+00
480	0.00E+00		2.35E+01	0.00E+00
500	0.00E+00		2.35E+01	0.00E+00
520	0.00E+00		2.34E+01	0.00E+00
540	0.00E+00		2.34E+01	0.00E+00
560	0.00E+00		2.34E+01	0.00E+00
580	0.00E+00		2.34E+01	0.00E+00
600	0.00E+00		2.34E+01	0.00E+00
620	0.00E+00		2.34E+01	0.00E+00
640	0.00E+00		2.34E+01	0.00E+00
660	0.00E+00		2.33E+01	0.00E+00
680	0.00E+00		2.33E+01	0.00E+00
700	0.00E+00		2.33E+01	0.00E+00
720	0.00E+00		2.33E+01	0.00E+00
740	0.00E+00		2.33E+01	0.00E+00
760	0.00E+00		2.33E+01	0.00E+00
780	0.00E+00		2.33E+01	0.00E+00
800	0.00E+00		2.33E+01	0.00E+00
820	0.00E+00		2.32E+01	0.00E+00
840	0.00E+00		2.32E+01	0.00E+00
860	0.00E+00		2.32E+01	0.00E+00
880	0.00E+00		2.32E+01	0.00E+00
900	0.00E+00		2.32E+01	0.00E+00
920	0.00E+00		2.32E+01	0.00E+00
940	0.00E+00		2.32E+01	0.00E+00
960	0.00E+00		2.31E+01	0.00E+00
980	0.00E+00		2.31E+01	0.00E+00
1000	0.00E+00		2.31E+01	0.00E+00
MAXIMUM:	0.00E+00		2.38E+01	0.00E+00

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BROWN & ROOT ENVIRONMENTAL
SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S5

CONTAMINANT: Vinyl chloride

HALF-LIFE (YRS):
LAYER 2: 7.92E+00
SATURATED LAYER 7.92E+00
DOWNGRADIENT 7.92E+00

INITIAL CONC. (ug/L): 1.10E+01

_STIGATOR: WYU
DATE: 11/10/97

SATURATED LAYER

INFILT (FT/YR):	1E-16			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	620			GW Q3 (L/DAY):	2.14E+03		
WIDTH (FT):	480	Kd (L/KG):	3.72E-02	GW V. (FT/YR):	7.67	Kd (L/KG):	0.0372
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	1.2232
POROSITY SAT. LAYER:	0.25	THICKNESS (FT):	30.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.5	DECAY (1/DAY):	2.40E-04	DISPERSIVITY:		DECAY (1/YR):	8.8E-02
DENSITY GMA (G/CM3):	1.50	CBo (PPB):	1.10E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.31E-12	Q2 (L/DAY):	2.14E+03	Ay (FT):	16.67	DISTANCE TO F.L. (FT): 500

TIME INTERVAL (YRS)	2	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	0.00E+00	1.10E+01	0.00E+00
2	0.00E+00	9.05E+00	0.00E+00
4	0.00E+00	7.44E+00	0.00E+00
6	0.00E+00	6.12E+00	1.58E-13
8	0.00E+00	5.04E+00	6.09E-10
10	0.00E+00	4.14E+00	8.23E-08
12	0.00E+00	3.41E+00	2.07E-06
14	0.00E+00	2.80E+00	1.97E-05
16	0.00E+00	2.31E+00	1.03E-04
18	0.00E+00	1.90E+00	3.55E-04
20	0.00E+00	1.56E+00	9.26E-04
22	0.00E+00	1.28E+00	1.96E-03
24	0.00E+00	1.06E+00	3.54E-03
26	0.00E+00	8.69E-01	5.68E-03
28	0.00E+00	7.15E-01	8.29E-03
30	0.00E+00	5.88E-01	1.12E-02
32	0.00E+00	4.84E-01	1.42E-02
34	0.00E+00	3.98E-01	1.72E-02
36	0.00E+00	3.27E-01	1.98E-02
38	0.00E+00	2.69E-01	2.21E-02
40	0.00E+00	2.21E-01	2.39E-02
42	0.00E+00	1.82E-01	2.51E-02
44	0.00E+00	1.50E-01	2.58E-02
46	0.00E+00	1.23E-01	2.61E-02
48	0.00E+00	1.01E-01	2.58E-02
50	0.00E+00	8.34E-02	2.52E-02
52	0.00E+00	6.86E-02	2.42E-02
54	0.00E+00	5.65E-02	2.30E-02
56	0.00E+00	4.64E-02	2.16E-02
58	0.00E+00	3.82E-02	2.01E-02
60	0.00E+00	3.14E-02	1.86E-02
62	0.00E+00	2.59E-02	1.70E-02
64	0.00E+00	2.13E-02	1.55E-02
66	0.00E+00	1.75E-02	1.39E-02
68	0.00E+00	1.44E-02	1.25E-02
70	0.00E+00	1.18E-02	1.12E-02
72	0.00E+00	9.74E-03	9.91E-03
74	0.00E+00	8.01E-03	8.76E-03
76	0.00E+00	6.59E-03	7.71E-03
78	0.00E+00	5.42E-03	6.75E-03
80	0.00E+00	4.46E-03	5.90E-03
82	0.00E+00	3.67E-03	5.13E-03
84	0.00E+00	3.02E-03	4.45E-03
86	0.00E+00	2.48E-03	3.85E-03
88	0.00E+00	2.04E-03	3.32E-03
90	0.00E+00	1.68E-03	2.85E-03
92	0.00E+00	1.38E-03	2.45E-03
94	0.00E+00	1.14E-03	2.10E-03
96	0.00E+00	9.35E-04	1.79E-03
98	0.00E+00	7.69E-04	1.53E-03
100	0.00E+00	6.33E-04	1.30E-03
MAXIMUM:	0.00E+00	1.10E+01	2.61E-02

ASSUMPTIONS
ESTIMATED COSTS FOR REMEDIAL ALTERNATIVES
OU-5 (SITE 13)

The following major assumptions were made in estimating the cost of the alternatives for Site 13.

- Installation of the monitoring wells will be difficult due to the presence of wetlands, which are located immediately adjacent to the site. The cost of well installation was adjusted accordingly.

- The area of the landfill cap is well defined by test pits along the southern boundary of the landfill , however, the other boundaries are not as well defined and could vary. The other boundaries are defined by surface features (railroad tracks and wetland area). Since the wetland boundary has not been field delineated and detailed topography of the site is not available, the landfill boundaries should be viewed as uncertain and will be confirmed in the field during the design phase.

- No detailed topography exists for this site. In order to estimate the amount of regrading required to achieve minimum grades for cost estimation purposes, relative topography was assumed based on field observations. The regrading volumes based on the assumed topography are very uncertain and can have a significant effect the cost estimate. The existing grades would be confirmed in the design phase as part of the topographic survey.

- It is assumed that the landfill cap can be designed and installed without significant effect to the adjacent wetlands areas. Therefore, it is assumed that construction of a replacement wetland will not required.

- A sediment basin may not be required for temporary surface water controls. Because the site is relatively small, the surface water runoff may be handled with silt fence. Construction of the sediment basins would most likely require disturbance in the wetland area. It is felt that building a sediment basin in the wetland area would be more detrimental to the environment than would be the advantages of a sediment basin over the use of silt fence alone. If room does exist for a sediment basin between the landfill and the wetlands it should be included. To be conservative the cost of construction of the sediment basin is included in the cost estimate, assuming that there would be no affect on the adjacent wetlands.

- For Option B of Alternative 3 in which the cap is paved, the paved area is assumed to be larger than the landfill boundary to provide a more regular paved configuration to accommodate future use of the site. The low permeability layer in the cap would only extend over the landfill materials.

- For Option B, it was assumed that a permanent detention basin may not be required although it is likely that the post-construction discharge will be greater than the pre-construction (existing) discharge due to the paved area. Construction of a detention basin would likely require permanent disruption of the wetland. Since the wetland is already acting as a large detention basin, it is felt that constructing a detention basin would not provide sufficient benefit to offset the potential affects to the adjacent wetlands. If during design it is found that sufficient space is available outside the wetland area for a permanent detention structure, it should be included. To be conservative, the cost of the detention structure is included in the cost estimate (the sediment basin would be converted to a detention basin).

- Time to construct either option A or B is assumed to be 3 months.

ASSUMPTIONS
ESTIMATED COSTS FOR REMEDIAL ALTERNATIVES
OU-5 (SITE 13)
(CONTINUED)

- All construction cost at normal safety levels (PPE Level D). No additional cost included for safety upgrade.
- Access to site not heavily restricted due to station security.

CALCULATION WORKSHEET Order No. 19116 (01-91)

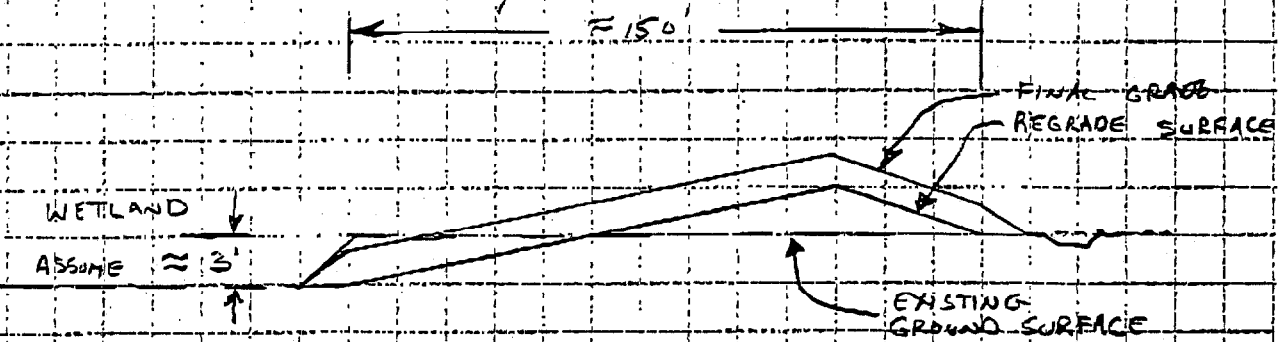
CLIENT NWS EARLE	JOB NUMBER 7695
SUBJECT SITE 13 FS COST ESTIMATE	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
DCW 11/20/97	MJW 12/3/97		

PURPOSE: ESTIMATE QUANTITIES FOR COST ESTIMATE ALTERNATIVE 3 CAPPING, OPTIONS A AND B

1. AREA OF LANDFILL CAP — USE A PLANIMETER TO ESTIMATE THE AREA OF THE LANDFILL CAP BASED ON FIG 15-1 IN THE RI. THE AREA IS APPROXIMATELY 1.7 ACRES.

2. VOLUME OF WASTE REGRADING CONTOURS AND ELEVATIONS ARE NOT AVAILABLE FOR THIS SITE. ASSUME THE LANDFILL IS FLAT AND THEN DROPS STEEPLY INTO INTO THE WETLAND AREA, BASED ON DESCRIPTION IN THE RI



ASSUME THAT WASTE CUT/FILL CAN BE BALANCED
ASSUME 1/2 THE LANDFILL WILL BE CUT AN AVERAGE OF 1/2 THE ASSUMED THICKNESS (3')

THE VOLUME OF CUT IS THEN

$$1.7/2 \text{ ACRES} \cdot 43560 \text{ FT/AC} \cdot 3/2 \text{ FT} \cdot \frac{1 \text{ CY}}{27 \text{ FT}} = 2057 \text{ CY.}$$

VOLUME OF WASTE CUT = 2100 C.Y.
VOLUME OF WASTE FILL = 2100 C.Y.

CLIENT		JOB NUMBER	
SUBJECT			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY MJW 12/3/97	APPROVED BY	DATE

3. CLEAR & GRUBB

ASSUME THE CLEAR & GRUBBED AREA APPROXIMATELY 25% LARGER THAN THE SIZE OF THE LANDFILL

1.25 x 1.7 = 2.1 AC

4. STORM DRAINAGE SYSTEM

ASSUME A PERIMETER DITCH WILL BE EXCAVATED UPGRADIENT OF THE CAP TO CONTROL RUNON. ASSUME RUNOFF FROM THE CAP WILL DRAIN DIRECTLY INTO THE WETLANDS.

LENGTH OF DITCH 900 LF, 2' DEEP WITH A CROSS SECTION 16 ft²

EXCAVATION FOR DITCHES = (900 x 16 / 27) + 200 c.y. = 733 c.y.

ASSUME CHANNELS ARE LINED WITH 6" TOPSOIL

12' WIDE x 900' LONG x 6" · 1FT/12IN · 1CY/27FT³ = 200 c.y.

5. CAP COMPONENTS OPTION A

- 12" GAS MANAGEMENT LAYER
  1' x 1.7 x 43560 / 27 = 2743 S.Y.
- 40 MIL VEPE (SMOOTH
  1.7 x 43560 = 74052 S.F.
- CUSHION FABRIC (12 OZ)
  1.7 x 43560 / 9 = 8228 S.Y.
- 12" DRAINAGE LAYER
  1 x 1.7 x 43560 / 27 = 2743 C.Y.
- NONWOVEN GEOTEXTILE
  = 8228 S.Y.
- 12" SELECT FILL
  = 2743 C.Y.

6" TOP SOIL
0.5 x 1.7 x 43560 / 27 = 1371 C.Y.

- GAS VENTS ASSUME 4 — 4 EA

PASSIVE GAS VENTS ARE REQUIRED

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
SUBJECT: SITE 13	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
DCW	MJW 12/3/97		

6. CAP COMPONENTS OPTION B OTHER COMPONENTS BELOW THE NON-WOVEN GEOTEXTILE ARE THE SAME AS OPTION A. THE VEGETATIVE LAYER IS THEN REPLACED BY

6"	SELECT FILL	1371 C.Y.
	ROADWAY STABILIZATION FABRIC	8228 S.Y.
10"	AGGREGATE BASE COURSE	
	10/12 x 1.7 x 43560/27	2285 C.Y.
2"	ASPHALT SURFACE	8228 S.Y.

7. FENCE

ASSUME 6' HIGH CHAIN LINK FENCE 1200 LF

8. REMOVE OLD FENCE 500 LF

9. SEDIMENT CONTROL MEASURES

SILT FENCE AND STRAW BALES WILL BE USED TO CONTROL THE SILT ACCUMULATION. BECAUSE OF THE PROXIMITY OF THE WETLANDS, A SEDIMENT BASIN WOULD HAVE TO BE EITHER CONSTRUCTED IN THE WETLAND OR ON THE LANDFILL. THE MAXIMUM ALLOWABLE AREA TO THE SILT FENCE IS 1 ACRE. BREAK SILT FENCE INTO TWO SECTIONS TO COVER THE LANDFILL. USE A DOUBLE ROW OF SILT FENCE DUE TO THE SENSITIVE NATURE OF THE WETLANDS.

1300 LF

BECAUSE THE EXACT LOCATION OF THE WETLANDS ARE UNKNOWN, AND A SEDIMENT BASIN MAY BE NEEDED, INCLUDE IT IN THE COST ESTIMATE.

CLIENT	JOB NUMBER
SUBJECT: SITE 13	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
DCW 12/1/97	MJW 12/3/97		

10) SEDIMENT / DETENTION BASIN

IN THE EVENT THAT ROOM BETWEEN THE EXISTING LANDFILL AND THE WETLAND IS AVAILABLE A SEDIMENT BASIN (AND A DETENTION BASIN FOR OPTION B) SHOULD BE INCLUDED IN THE DESIGN.

- SIZE THE SEDIMENT BASIN ON THE VOLUME OF THE 2-YR, 24-HR STORM, PLUS THE SEDIMENT STORAGE CAPACITY (NJ STANDARDS FOR EROSION AND SEDIMENT CONTROL, 1987)

- THE VOLUME OF THE 2-YEAR STORM IS GIVEN BY THE FOLLOWING:
  - CURVE NUMBER FOR BARE "TYPE B" SOIL IS 86 (TR-55 MANUAL)
  - THE RAINFALL DEPTH IS 3.4" (TR-55 MANUAL)
  - FROM FIGURE 2-1 (TR-55 MANUAL) THE RUNOFF DEPTH IS 2.0 INCHES
  - THE RUNOFF VOLUME IS THEN

    $1.7\ AC \times 2''/12 \cdot 43560 = 12342\ C.F.$

- SEDIMENT STORAGE VOLUME IS GIVEN BY 0.07 AC-FT PER ACRE PER YEAR OF CONSTRUCTION (ASSUME 1 YEAR CONST LENGTH) (BASED ON NJ STANDARDS FOR EROSION AND SEDIMENT CONTROL, 1987)
  - $1.7 \times 0.07 = 0.119$ AC-FT OR 5184 C.F.

- TOTAL VOLUME = 12342 + 5184 = 17526 CF OR 650 C.Y.

- ASSUME 650 C.Y. ARE EXCAVATED WITH THE EXCAVATED MATERIAL USED TO CONSTRUCT BERMS TO GIVE THE REQUIRED FREEBOARD

THEREFORE EXCAVATE 650 C.Y.,
PLACE/COMPACT 650 C.Y.

ADD $5000 FOR OUTLET STRUCTURES / MISC ITEMS

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
SUBJECT SITE 13	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
	MJW 12/3/97		

III) PRE-DESIGN STUDIES

a) TOPOGRAPHIC SURVEY
ASSUME 6 ACRES, GROUND SURVEY, FAIRLY OPEN SAY
$7,500

b) GEOTECHNICAL INVESTIGATION
BECAUSE SITE IS RINGED WITH MONITORING WELLS(?)
ASSUME TWO BORINGS ARE REQUIRED 20' DEEP

DRILLING
MOB/DEMOB $1000
2 BORINGS @ 20' DEEP $20/FT $800
CONTINUOUS SPLIT SPOON SAMPLING
$10 PER 2' SPOON
(2 X 20 FT/2) X $10 $200
$2000

GEOTECHNICAL ANALYSIS

MOISTURE CONTENT (D2216)	4	$10 EA	$40
SOIL CLASSIFICATION (D2487)	4	$130 EA	$520
TRIAXIAL COMPRESSION (D4767)	2	$600 EA	$1200
			$1760

ENGINEER, FIELD PEOPLE $2000 SAY $6000

c) WETLAND DELINEATION $5000

d) TEST PIT INVESTIGATION $10,000
ASSUME 20 TEST PITS REQUIRED
ASSUME WASTE LIMIT NEXT TO WETLANDS CAN BE IDENTIFIED BASED ON TOPOGRAPHY

CALCULATION WORKSHEET

Order No. 19116 (01-91)

CLIENT	JOB NUMBER
NWS Earle	7695
SUBJECT: Monitoring Well Installation Cost	
BASED ON	DRAWING NUMBER
BY: JJR 11/22/97	CHECKED BY: MJW 12/3/97
APPROVED BY	DATE

Install 3 monitoring wells at 25' deep using 4" PVC

Mob/Demob drillers	$1000
75' of 4" PVC installed	$3000
Split spoons	$468
Develop wells say $300/each	$900
Drum waste (No disposal) say 6 drums	$450
Drum Disposal $930 plus $1275 for sampling	2205
Well Guards + Pad	$1200
	9253 say $9300

all subcontractor cost

Well Installation Oversight

say at $400/day	for 5 days	$2000
Travel & Livin	Travel	$1000
	Livin 3 x $115	575
Misc	say	100
		$3675 say $3700

CALCULATION WORKSHEET Order No. 19116 (01-91) PAGE 1 OF 1

CLIENT	JOB NUMBER
NWS EARLE	7695

SUBJECT: Field Sampling Sites 3 & 13

BASED ON: | DRAWING NUMBER:

BY	CHECKED BY	APPROVED BY	DATE
TJR 11/20/97	MJW 12/3/97		

Field Sampling for Site 13

9 wells, 3 surface waters, & 3 sediment samples

Use a Crew of 2 (one P_3 & one D_3)

assume 4 days to perform task (2 days on site & 2 days to Mob, Demob & Travel)

P_3 at 21.27/hr		D_1 at 13.85/hr
26.59	DLB at 125%	17.31
47.86		31.16
5.00	Procurement Labor say $5	5.00
52.86/hr		36.16/hr
x10	10hr work day	x10
$529/day		362/day
x4	4 days	x4
$2116/Trip		1,448/Trip
1000	Travel	$1,000 say $1000/RT including on site car
230	Living	250 say $115/day on site
$3,346		$2,678
334	G&A at 10%	267
$3,680		$2946
368	Award at 10%	294
$4,049		$3240
3,240		
7,289		
1,000	add for Field Equipment (PPE, Monitoring, Sampling shipping)	
$8,298 or		
$8,300		

Also Use for Site 3 for sampling

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 1 - No Action
Capital Cost Summary

Prepared by TJR
Checked by DW

	ITEM	SUBCONTRACTED	MATERIAL	LABOR	EQUIPMENT	TOTAL
1	MONITORING WELL INSTALLATION	$16,000	$0	$0	$0	$16,000
2	OVERSIGHT	$0	$0	$3,700	$0	$3,700
		$16,000	$0	$3,700	$0	$19,700
	Overhead on Labor Cost @ 30%			$1,110		$1,110
	G & A on Labor @ 10%			$370		$370
	G & A on Material Cost @ 10%		$0			$0
	G & A on Subcontract Cost @ 10%	$1,600				$1,600
	Total Direct Cost	$17,600	$0	$5,180	$0	$22,780
	Indirects on Total Direct Labor Cost @ 75%			$3,885		$3,885
	Profit on Total Direct Cost @ 10%					$2,278
						$28,943
	Health and Safety Monitoring @ 10%					$2,894
	Total Field Cost					$31,837
	Contingency on Total Field Cost @ 20%					$6,367
	Engineering on Total Field Cost @ 10%					$3,184
	TOTAL COST					$41,388

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 1 - No Action
Capital Cost

Prepared by TJK
Checked by DW

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MONITORING WELL INSTALLATION												
1.1 Well Installation	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	3 wells/25' deep
1.2 Well Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000	
							$16,000	$0	$0	$0	$16,000	
2 OVERSIGHT												
2.1 Engineering Oversight	1	ls			$3,700.00		$0	$0	$3,700	$0	$3,700	for one week
							$0	$0	$3,700	$0	$3,700	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 1 - No Action
Annual Cost

Prepared by TJK

Checked by DJJ

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$9,300		Collect three surface water samples, three sediment samples and nine groundwater samples, per sampling period, plus travel, living and shipping cost
Analysis/Water	$8,100		Eighteen water samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Analysis/Sediment	$2,500		Six sediment samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Annual Report	$4,000		Ten hours per sampling report plus other direct cost
Site Review		$15,500	Review of Site Conditions by 3 Engineers for Years 5, 10, 15, 20, 25, 30
TOTALS	$23,900	$15,500	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 1 - No Action
Present Worth Analysis

Prepared by TSR

Checked by DW

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$41,388		$41,388	1.000	$41,388
1		$23,900	$23,900	0.935	$22,347
2		$23,900	$23,900	0.873	$20,865
3		$23,900	$23,900	0.816	$19,502
4		$23,900	$23,900	0.763	$18,236
5		$39,400	$39,400	0.713	$28,092
6		$23,900	$23,900	0.666	$15,917
7		$23,900	$23,900	0.623	$14,890
8		$23,900	$23,900	0.582	$13,910
9		$23,900	$23,900	0.544	$13,002
10		$39,400	$39,400	0.508	$20,015
11		$23,900	$23,900	0.475	$11,353
12		$23,900	$23,900	0.444	$10,612
13		$23,900	$23,900	0.415	$9,919
14		$23,900	$23,900	0.388	$9,273
15		$39,400	$39,400	0.362	$14,263
16		$23,900	$23,900	0.339	$8,102
17		$23,900	$23,900	0.317	$7,576
18		$23,900	$23,900	0.296	$7,074
19		$23,900	$23,900	0.277	$6,620
20		$39,400	$39,400	0.258	$10,165
21		$23,900	$23,900	0.242	$5,784
22		$23,900	$23,900	0.226	$5,401
23		$23,900	$23,900	0.211	$5,043
24		$23,900	$23,900	0.197	$4,708
25		$39,400	$39,400	0.184	$7,250
26		$23,900	$23,900	0.172	$4,111
27		$23,900	$23,900	0.161	$3,848
28		$23,900	$23,900	0.150	$3,585
29		$23,900	$23,900	0.141	$3,370
30		$39,400	$39,400	0.131	$5,161
				TOTAL PRESENT WORTH	**$371,382**

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 2 - Limited Action
Capital Cost Summary

Prepared by TJR

Checked by DLW

	ITEM	SUBCONTRACTED	MATERIAL	LABOR	EQUIPMENT	TOTAL
1	MONITORING WELL INSTALLATION	$16,000	$0	$0	$0	$16,000
2	OVERSIGHT	$0	$0	$3,700	$0	$3,700
3	SITE SECURITY	$12,505	$0	$0	$0	$12,505
4	INSTITUTIONAL CONTROLS	$15,000	$0	$0	$0	$15,000
		$43,505	$0	$3,700	$0	$47,205
	Overhead on Labor Cost @ 30%			$1,110		$1,110
	G & A on Labor @ 10%			$370		$370
	G & A on Material Cost @ 10%		$0			$0
	G & A on Subcontract Cost @ 10%	$4,351				$4,351
	Total Direct Cost	$47,856	$0	$5,180	$0	$53,036
	Indirects on Total Direct Labor Cost @ 75%			$3,885		$3,885
	Profit on Total Direct Cost @ 10%					$5,304
						$62,224
	Health and Safety Monitoring @ 10%					$6,222
	Total Field Cost					$68,446
	Contingency on Total Field Cost @ 20%					$13,689
	Engineering on Total Field Cost @ 10%					$6,845
	TOTAL COST					$88,980

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 2 - Limited Action
Capital Cost

Prepared by TJR
Checked by DW

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MONITORING WELL INSTALLATION												
1.1 Well Installation	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	3 wells/25' deep
1.2 Well Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000	
							$16,000	$0	$0	$0	$16,000	
2 OVERSIGHT												
2.1 Engineering Oversight	1	ls			$3,700.00		$0	$0	$3,700	$0	$3,700	for one week
							$0	$0	$3,700	$0	$3,700	
3 SITE SECURITY												
3.1 Fence Removal and Replacement	500	lf	$2.05				$1,025	$0	$0	$0	$1,025	
3.2 Install New 6' High Chain Link Fence	700	lf	$16.40				$11,480	$0	$0	$0	$11,480	
							$12,505	$0	$0	$0	$12,505	
4 INSTITUTIONAL CONTROLS												
4.1 CEA & Modify Base Master Plan	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	
							$15,000	$0	$0	$0	$15,000	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 2 - Limited Action
Annual Cost

Prepared by TJR

Checked by DW

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$9,300		Collect three surface water samples, three sediment samples and nine groundwater samples, per sampling period, plus travel, living and shipping cost
Analysis/Water	$8,100		Eighteen water samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Analysis/Sediment	$2,500		Six sediment samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Annual Report	$4,000		Ten hours per sampling report plus other direct cost
Site Review		$15,500	Review of Site Conditions by 3 Engineers for Years 5, 10, 15, 20, 25, 30
TOTALS	$23,900	$15,500	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 2 - Limited Action
Present Worth Analysis

Prepared by KJ
Checked by DW

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$88,980		$88,980	1.000	$88,980
1		$23,900	$23,900	0.935	$22,347
2		$23,900	$23,900	0.873	$20,865
3		$23,900	$23,900	0.816	$19,502
4		$23,900	$23,900	0.763	$18,236
5		$39,400	$39,400	0.713	$28,092
6		$23,900	$23,900	0.666	$15,917
7		$23,900	$23,900	0.623	$14,890
8		$23,900	$23,900	0.582	$13,910
9		$23,900	$23,900	0.544	$13,002
10		$39,400	$39,400	0.508	$20,015
11		$23,900	$23,900	0.475	$11,353
12		$23,900	$23,900	0.444	$10,612
13		$23,900	$23,900	0.415	$9,919
14		$23,900	$23,900	0.388	$9,273
15		$39,400	$39,400	0.362	$14,263
16		$23,900	$23,900	0.339	$8,102
17		$23,900	$23,900	0.317	$7,576
18		$23,900	$23,900	0.296	$7,074
19		$23,900	$23,900	0.277	$6,620
20		$39,400	$39,400	0.258	$10,165
21		$23,900	$23,900	0.242	$5,784
22		$23,900	$23,900	0.226	$5,401
23		$23,900	$23,900	0.211	$5,043
24		$23,900	$23,900	0.197	$4,708
25		$39,400	$39,400	0.184	$7,250
26		$23,900	$23,900	0.172	$4,111
27		$23,900	$23,900	0.161	$3,848
28		$23,900	$23,900	0.150	$3,585
29		$23,900	$23,900	0.141	$3,370
30		$39,400	$39,400	0.131	$5,161
				TOTAL PRESENT WORTH	**$418,973**

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option A)
Capital Cost Summary

Prepared by TJR

Checked by DW

	ITEM	SUBCONTRACTED	MATERIAL	LABOR	EQUIPMENT	TOTAL
1	PRE-DESIGN INVESTIGATION	$38,500	$0	$0	$0	$38,500
2	MOBILIZATION/SITE SUPPORT/DEMOBILIZATION	$20,868	$20,208	$16,708	$24,443	$82,226
3	DECONTAMINATION FACILITIES & SERVICES	$8,600	$10,361	$1,086	$90	$20,138
4	SITE MANAGEMENT STAFFING	$0	$0	$51,770	$0	$51,770
5	LANDFILL CAP	$1,850	$260,383	$56,763	$76,908	$395,904
6	SITE RESTORATION	$27,505	$2,450	$690	$659	$31,304
7	POST CONSTRUCTION SUBMITTALS	$15,000	$0	$5,000	$0	$20,000
		$112,323	$293,402	$132,017	$102,100	$639,842
	Overhead on Labor Cost @ 30%			$39,605		$39,605
	G & A on Labor @ 10%			$13,202		$13,202
	G & A on Material Cost @ 10%		$29,340			$29,340
	G & A on Subcontract Cost @ 10%	$11,232				$11,232
	Total Direct Cost	$123,555	$322,742	$184,823	$102,100	$733,221
	Indirects on Total Direct Labor Cost @ 75%			$138,618		$138,618
	Profit on Total Direct Cost @ 10%					$73,322
						$945,160
	Health and Safety Monitoring @ 5%					$47,258
	Total Field Cost					$992,418
	Contingency on Total Field Cost @ 20%					$198,484
	Engineering on Total Field Cost @ 10%					$99,242
	TOTAL COST					$1,290,144

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option A)
Capital Cost

Prepared by TJK
Checked by D-J

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 PRE-DESIGN INVESTIGATION												
1.1 Topographic Survey (includes new well locations)	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500	
1.2 Geotechnical Investigation	1	ls	$6,000.00				$6,000	$0	$0	$0	$6,000	
1.3 Wetland Delineation	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Test Pit Investigation	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000	
1.5 Soil/Gas Survey	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000	
							$38,500	$0	$0	$0	$38,500	
2 MOBILIZATION/SITE SUPPORT/DEMOBILIZATION												
2.1 Office Trailer	3	mo	$181.00				$543	$0	$0	$0	$543	
2.2 Storage Trailer	3	mo	$95.00				$285	$0	$0	$0	$285	
2.3 Portable Communication Equipment	2	sets	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.4 Equipment Mob/Demob	5	ea			$54.00	$250.00	$0	$0	$270	$1,250	$1,520	
2.5 Site Utilities Hook-up	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000	
2.6 Site Utilities	3	mo	$4,000.00				$12,000	$0	$0	$0	$12,000	
2.7 Portable Toilet (2)	6	mo	$90.00				$540	$0	$0	$0	$540	
2.8 Pick-up Truck	3	mo	$500.00	$100.00			$1,500	$300	$0	$0	$1,800	
2.9 Access Road	1	ls		$3,000.00	$1,000.00	$1,000.00	$0	$3,000	$1,000	$1,000	$5,000	
2.10 Silt Fence	1300	lf		$0.45	$0.22		$0	$585	$286	$0	$871	
2.11 Sediment/Detention Basin												
a) Excavate/Grade	650	cy			$0.20	$0.67	$0	$0	$130	$436	$566	
b) Compaction	650	cy			$0.11	$0.12	$0	$0	$72	$78	$150	12" lifts/4 passes
c) Outlet Structures & Misc. Items	1	ls		$2,500.00	$2,000.00	$500.00	$0	$2,500	$2,000	$500	$5,000	
d) Runoff Ditch	900	lf		$11.73	$6.81	$10.45	$0	$10,557	$6,129	$9,405	$26,091	
e) Topsoil for Ditch	200	cy		$16.33	$6.04	$13.72	$0	$3,266	$1,208	$2,744	$7,218	
2.12 Clear and Grub Site	2.1	ac			$2,673.00	$4,300.00	$0	$0	$5,613	$9,030	$14,643	brush, stumps, trees
							$20,868	$20,208	$16,708	$24,443	$82,226	
3 DECONTAMINATION FACILITIES & SERVICES												
3.1 Decon Pad												
a) 4" sand	12.4	cy		$25.00			$0	$310	$0	$0	$310	10 mile haul
b) 6' stone	18.5	cy		$15.00			$0	$278	$0	$0	$278	
c) Railroad Ties (6'*8'*8')	20	ea		$27.83	$12.60	$2.40	$0	$557	$252	$48	$857	pressure treated
d) Geotextile 170 mil nonwoven	123	sy		$2.77	$0.46	$0.03	$0	$341	$57	$4	$401	
3.2 Laundry Service	12	wk	$250.00				$3,000	$0	$0	$0	$3,000	
3.3 Decontamination Service	3	mo	$1,200.00				$3,600	$0	$0	$0	$3,600	
3.4 Purchase Decon Water	10000	gal	$0.20				$2,000	$0	$0	$0	$2,000	
3.5 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	
3.6 Spent Water Storage	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	
3.7 Rock Construction Entrance												
a) Grade (dozer)	19	cy			$0.20	$0.67	$0	$0	$4	$13	$17	
b) Stone (import) 3/4" to 1 1/2"	19	cy		$23.05			$0	$438	$0	$0	$438	10 mile haul
c) Install Stone 8" thick	19	cy			$1.85	$0.35	$0	$0	$35	$7	$42	
d) Maintain Entrance	1	ls		$437.90	$38.87	$19.38	$0	$438	$39	$19	$496	100% of installation cost
							$8,600	$10,361	$1,086	$90	$20,138	
4 SITE MANAGEMENT STAFFING												
4.1 Site Manager	12	wk			$1,506.53		$0	$0	$18,078	$0	$18,078	
4.2 Site Supervisor/Foreman	12	wk			$1,438.05		$0	$0	$17,257	$0	$17,257	
4.3 Site Engineer	12	wk			$1,369.58		$0	$0	$16,435	$0	$16,435	
							$0	$0	$51,770	$0	$51,770	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option A)
Capital Cost

Prepared by TJK
Checked by DLW

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
5 LANDFILL CAP												
5.1 Grade Landfill Materials	2100	cy			$0.37	$1.39	$0	$0	$777	$2,919	$3,696	300 hp dozer
5.2 Compact Landfill Materials	2100	cy			$0.11	$0.12	$0	$0	$231	$252	$483	12" lifts/4 passes
5.3 Import Sand for Gas Mgmt Layer	2743	cy		$25.20			$0	$69,124	$0	$0	$69,124	10 mile haul
5.4 Install Gas Mgmt Layer	2743	cy			$0.58	$1.11	$0	$0	$1,591	$3,045	$4,636	
5.5 Install 40 mil VFPE or GCL	74052	sf		$0.31	$0.09	$0.10	$0	$22,956	$6,665	$7,405	$37,026	
5.6 Third Party Testing of VFPE/GCL	1	ls	$1,850.00				$1,850	$0	$0	$0	$1,850	assume 5% of liner cost
5.7 Install Cushion Fabric	8228	sy		$2.77	$0.48	$0.03	$0	$22,792	$3,949	$247	$26,988	12 oz. = 170 mil
5.8 Import Drainage Layer Stone	2743	cy		$37.28			$0	$102,259	$0	$0	$102,259	AASHTO #57
5.9 Install Drainage Layer	2743	cy			$5.16	$0.65	$0	$0	$14,154	$1,783	$15,937	
5.10 Install Non-woven Geotextile	8228	sy		$1.08	$0.28	$0.02	$0	$8,886	$2,304	$165	$11,355	60 mil
5.11 Import Select Fill	2743	cy		$4.25	$6.04	$13.72	$0	$11,658	$16,568	$37,634	$65,859	10 mile haul
5.12 Place/Grade/ Compact Select Fill	2743	cy			$0.58	$1.27	$0	$0	$1,591	$3,484	$5,075	
5.13 Import Topsoil	1371	cy		$16.33	$6.04	$13.72	$0	$22,388	$8,281	$18,810	$49,479	
5.14 Place & Grade Topsoil	1371	cy			$0.33	$0.85	$0	$0	$452	$1,165	$1,618	
5.15 Install 4" PVC Gas Vents	4	ea		$80.00	$50.00		$0	$320	$200	$0	$520	
							$1,850	$260,383	$56,763	$76,908	$395,904	
6 SITE RESTORATION												
6.1 Hydroseed w/ mulch & fertilizer	91.5	msf		$26.78	$7.54	$7.20	$0	$2,450	$690	$659	$3,799	#7 utility mix
6.2 Well Installation	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	3 wells/25' deep
6.3 Fence Removal and Replacement	500	lf	$2.05				$1,025	$0	$0	$0	$1,025	
6.4 Install New 6' High Chain Link Fence	700	lf	$16.40				$11,480	$0	$0	$0	$11,480	
							$27,505	$2,450	$690	$659	$31,304	
7 POST CONSTRUCTION SUBMITTALS												
7.1 Construction As-Builts	1	ls			$5,000.00		$0	$0	$5,000	$0	$5,000	
7.2 CEA & Modify Base Master Plan	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	
							$15,000	$0	$5,000	$0	$20,000	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option A)
Annual Cost

Prepared by TSK

Checked by RW

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Site Maintenance	$1,428		1 Laborer / 1 Day per Month for 12 Months
	$720		Mobilization & Demobilization (pickup truck)
	$500		Misc. Materials (seed, rock, soil)
	$300		Misc. Equipment (mowers, hand tools)
Sampling	$9,300		Collect three surface water samples, three sediment samples and nine groundwater samples, per sampling period, plus travel, living and shipping cost
Analysis/Water	$8,100		Eighteen water samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Analysis/Sediment	$2,500		Six sediment samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Annual Report	$4,000		Ten hours per sampling report plus other direct cost
Site Review		$15,500	Review of Site Conditions by 3 Engineers for Years 5, 10, 15, 20, 25, 30
TOTALS	$26,848	$15,500	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option A)
Present Worth Analysis

Prepared by [illegible]
Checked by DW

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,290,144		$1,290,144	1.000	$1,290,144
1		$26,848	$26,848	0.935	$25,103
2		$26,848	$26,848	0.873	$23,438
3		$26,848	$26,848	0.816	$21,908
4		$26,848	$26,848	0.763	$20,485
5		$42,348	$42,348	0.713	$30,194
6		$26,848	$26,848	0.666	$17,881
7		$26,848	$26,848	0.623	$16,726
8		$26,848	$26,848	0.582	$15,626
9		$26,848	$26,848	0.544	$14,605
10		$42,348	$42,348	0.508	$21,513
11		$26,848	$26,848	0.475	$12,753
12		$26,848	$26,848	0.444	$11,921
13		$26,848	$26,848	0.415	$11,142
14		$26,848	$26,848	0.388	$10,417
15		$42,348	$42,348	0.362	$15,330
16		$26,848	$26,848	0.339	$9,101
17		$26,848	$26,848	0.317	$8,511
18		$26,848	$26,848	0.296	$7,947
19		$26,848	$26,848	0.277	$7,437
20		$42,348	$42,348	0.258	$10,926
21		$26,848	$26,848	0.242	$6,497
22		$26,848	$26,848	0.226	$6,068
23		$26,848	$26,848	0.211	$5,665
24		$26,848	$26,848	0.197	$5,289
25		$42,348	$42,348	0.184	$7,792
26		$26,848	$26,848	0.172	$4,618
27		$26,848	$26,848	0.161	$4,323
28		$26,848	$26,848	0.150	$4,027
29		$26,848	$26,848	0.141	$3,786
30		$42,348	$42,348	0.131	$5,548
				TOTAL PRESENT WORTH	**$1,656,719**

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option B)
Capital Cost Summary

Prepared by TJR

Checked by DW

	ITEM	SUBCONTRACTED	MATERIAL	LABOR	EQUIPMENT	TOTAL
1	PRE-DESIGN INVESTIGATION	$38,500	$0	$0	$0	$38,500
2	MOBILIZATION/SITE SUPPORT/DEMOBILIZATION	$20,868	$20,208	$19,114	$28,313	$88,502
3	DECONTAMINATION FACILITIES & SERVICES	$8,600	$10,361	$1,086	$90	$20,138
4	SITE MANAGEMENT STAFFING	$0	$0	$51,770	$0	$51,770
5	LANDFILL CAP	$1,850	$392,567	$51,522	$53,297	$499,236
6	SITE RESTORATION	$27,505	$6,990	$1,968	$1,879	$38,342
7	POST CONSTRUCTION SUBMITTALS	$15,000	$0	$5,000	$0	$20,000
		$112,323	$430,125	$130,460	$83,579	$756,487
	Overhead on Labor Cost @ 30%			$39,138		$39,138
	G & A on Labor @ 10%			$13,046		$13,046
	G & A on Material Cost @ 10%		$43,013			$43,013
	G & A on Subcontract Cost @ 10%	$11,232				$11,232
	Total Direct Cost	$123,555	$473,138	$182,644	$83,579	$862,916
	Indirects on Total Direct Labor Cost @ 75%			$136,983		$136,983
	Profit on Total Direct Cost @ 10%					$86,292
						$1,086,190
	Health and Safety Monitoring @ 5%					$54,310
	Total Field Cost					$1,140,500
	Contingency on Total Field Cost @ 20%					$228,100
	Engineering on Total Field Cost @ 10%					$114,050
	TOTAL COST					$1,482,649

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option B)
Capital Cost

Prepared by TJR
Checked by DW

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 PRE-DESIGN INVESTIGATION												
1.1 Topographic Survey (includes new well locations)	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500	
1.2 Geotechnical Investigation	1	ls	$6,000.00				$6,000	$0	$0	$0	$6,000	
1.3 Wetland Delineation	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Test Pit Investigation	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000	
1.5 Soil/Gas Survey	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000	
							$38,500	$0	$0	$0	$38,500	
2 MOBILIZATION/SITE SUPPORT/DEMOBILIZATION												
2.1 Office Trailer	3	mo	$181.00				$543	$0	$0	$0	$543	
2.2 Storage Trailer	3	mo	$95.00				$285	$0	$0	$0	$285	
2.3 Portable Communication Equipment	2	sets	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.4 Equipment Mob/Demob	5	ea			$54.00	$250.00	$0	$0	$270	$1,250	$1,520	
2.5 Site Utilities Hook-up	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000	
2.6 Site Utilities	3	mo	$4,000.00				$12,000	$0	$0	$0	$12,000	
2.7 Portable Toilet (2)	6	mo	$90.00				$540	$0	$0	$0	$540	
2.8 Pick-up Truck	3	mo	$500.00	$100.00			$1,500	$300	$0	$0	$1,800	
2.9 Access Road	1	ls		$3,000.00	$1,000.00	$1,000.00	$0	$3,000	$1,000	$1,000	$5,000	
2.10 Silt Fence	1300	lf		$0.45	$0.22		$0	$585	$286	$0	$871	
2.11 Sediment/Detention Basin												
a) Excavate/Grade	650	cy			$0.20	$0.67	$0	$0	$130	$436	$566	
b) Compaction	650	cy			$0.11	$0.12	$0	$0	$72	$78	$150	12" lifts/4 passes
c) Outlet Structures & Misc. Items	1	ls		$2,500.00	$2,000.00	$500.00	$0	$2,500	$2,000	$500	$5,000	
d) Runoff Ditch	900	lf		$11.73	$6.81	$10.45	$0	$10,557	$6,129	$9,405	$26,091	
e) Topsoil for Ditch	200	cy		$16.33	$6.04	$13.72	$0	$3,266	$1,208	$2,744	$7,218	
2.12 Clear and Grub Site	3	ac			$2,673.00	$4,300.00	$0	$0	$8,019	$12,900	$20,919	brush, stumps, trees
							$20,868	$20,208	$19,114	$28,313	$88,502	
3 DECONTAMINATION FACILITIES & SERVICES												
3.1 Decon Pad												
a) 4" sand	12.4	cy		$25.00			$0	$310	$0	$0	$310	10 mile haul
b) 6' stone	18.5	cy		$15.00			$0	$278	$0	$0	$278	
c) Railroad Ties (6'*8'*8')	20	ea		$27.83	$12.60	$2.40	$0	$557	$252	$48	$857	pressure treated
d) Geotextile 170 mil nonwoven	123	sy		$2.77	$0.46	$0.03	$0	$341	$57	$4	$401	
3.2 Laundry Service	12	wk	$250.00				$3,000	$0	$0	$0	$3,000	
3.3 Decontamination Service	3	mo	$1,200.00				$3,600	$0	$0	$0	$3,600	
3.4 Purchase Decon Water	10000	gal	$0.20				$2,000	$0	$0	$0	$2,000	
3.5 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	
3.6 Spent Water Storage	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	
3.7 Rock Construction Entrance												
a) Grade (dozer)	19	cy			$0.20	$0.67	$0	$0	$4	$13	$17	
b) Stone (import) 3/4" to 1 1/2"	19	cy		$23.05			$0	$438	$0	$0	$438	10 mile haul
c) Install Stone 8" thick	19	cy			$1.85	$0.35	$0	$0	$35	$7	$42	
d) Maintain Entrance	1	ls		$437.90	$38.87	$19.38	$0	$438	$39	$19	$496	100% of installation cost
							$8,600	$10,361	$1,086	$90	$20,138	
4 SITE MANAGEMENT STAFFING												
4.1 Site Manager	12	wk			$1,506.53		$0	$0	$18,078	$0	$18,078	
4.2 Site Supervisor/Foreman	12	wk			$1,438.05		$0	$0	$17,257	$0	$17,257	
4.3 Site Engineer	12	wk			$1,369.58		$0	$0	$16,435	$0	$16,435	
							$0	$0	$51,770	$0	$51,770	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option B)
Capital Cost

Prepared by TJR
Checked by DW

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
5 LANDFILL CAP												
5.1 Grade Landfill Materials	2100	cy			$0.37	$1.39	$0	$0	$777	$2,919	$3,696	300 hp dozer
5.2 Compact Landfill Materials	2100	cy			$0.11	$0.12	$0	$0	$231	$252	$483	12" lifts/4 passes
5.3 Import Sand for Gas Mgmt Layer	2743	cy		$25.20			$0	$69,124	$0	$0	$69,124	10 mile haul
5.4 Install Gas Mgmt Layer	2743	cy			$0.58	$1.11	$0	$0	$1,591	$3,045	$4,636	
5.5 Install 40 mil VFPE or GCL	74052	sf		$0.31	$0.09	$0.10	$0	$22,956	$6,665	$7,405	$37,026	
5.6 Third Party Testing of VFPE/GCL	1	ls	$1,850.00				$1,850	$0	$0	$0	$1,850	assume 5% of liner cost
5.7 Install Cushion Fabric	8228	sy		$2.77	$0.48	$0.03	$0	$22,792	$3,949	$247	$26,988	12 oz. = 170 mil
5.8 Import Drainage Layer Stone	2743	cy		$37.28			$0	$102,259	$0	$0	$102,259	AASHTO #57
5.9 Install Drainage Layer	2743	cy			$5.16	$0.65	$0	$0	$14,154	$1,783	$15,937	
5.10 Install Non-woven Geotextile	8228	sy		$1.08	$0.28	$0.02	$0	$8,886	$2,304	$165	$11,355	60 mil
5.11 Import Select Fill	1936	cy		$4.25	$6.04	$13.72	$0	$8,228	$11,693	$26,562	$46,483	10 mile haul
5.12 Place/Grade/ Compact Select Fill	1936	cy			$0.58	$1.27	$0	$0	$1,123	$2,459	$3,582	
5.13 Install Roadway Geotextile	11616	sy		$0.45	$0.06	$0.02	$0	$5,227	$697	$232	$6,156	
5.14 Install Aggregate Base Course	3227	cy		$35.50	$1.19	$1.47	$0	$114,559	$3,840	$4,744	$123,142	
5.15 Install Asphalt Wear Course - 2"	11616	sy		$3.29	$0.37	$0.30	$0	$38,217	$4,298	$3,485	$45,999	
5.16 Install 4" PVC Gas Vents	4	ea		$80.00	$50.00		$0	$320	$200	$0	$520	
							$1,850	$392,567	$51,522	$53,297	$499,236	
6 SITE RESTORATION												
6.1 Hydroseed w/ mulch & fertilizer	261	msf		$26.78	$7.54	$7.20	$0	$6,990	$1,968	$1,879	$10,837	#7 utility mix
6.2 Well Installation	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	3 wells/25' deep
6.3 Fence Removal and Replacement	500	lf	$2.05				$1,025	$0	$0	$0	$1,025	
6.4 Install New 6' High Chain Link Fence	700	lf	$16.40				$11,480	$0	$0	$0	$11,480	
							$27,505	$6,990	$1,968	$1,879	$38,342	
7 POST CONSTRUCTION SUBMITTALS												
7.1 Construction As-Builts	1	ls			$5,000.00		$0	$0	$5,000	$0	$5,000	
7.2 CEA & Modify Base Master Plan	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000	
							$15,000	$0	$5,000	$0	$20,000	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option B)
Annual Cost

Prepared by [illegible]

Checked by [illegible]

Item	Item Cost Annually	Item Cost per 5 Years	Item Cost Years 10 & 20	Notes
Site Maintenance	$1,428			1 Laborer / 1 Day per Month for 12 Months
	$720			Mobilization & Demobilization (pickup truck)
	$500			Misc. Materials (seed, rock, soil)
	$300			Misc. Equipment (mowers, hand tools)
Cap Repaving			$50,000	Repave cap in years 10 & 20 with 2" wear course
Sampling	$9,300			Collect three surface water samples, three sediment samples and nine groundwater samples, per sampling period, plus travel, living and shipping cost
Analysis/Water	$8,100			Eighteen water samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Analysis/Sediment	$2,500			Six sediment samples, per sampling period, (including blanks & duplicates for each medium) VOCs and metals
Annual Report	$4,000			Ten hours per sampling report plus other direct cost
Site Review		$15,500		Review of Site Conditions by 3 Engineers for Years 5, 10, 15, 20, 25, 30
TOTALS	$26,848	$15,500	$50,000	

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey
Operable Unit 5 (Site 13)
Alternative 3 - Capping (Option B)
Present Worth Analysis

Prepared by [illegible]

Checked by DCW

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,482,649		$1,482,649	1.000	$1,482,649
1		$26,848	$26,848	0.935	$25,103
2		$26,848	$26,848	0.873	$23,438
3		$26,848	$26,848	0.816	$21,908
4		$26,848	$26,848	0.763	$20,485
5		$42,348	$42,348	0.713	$30,194
6		$26,848	$26,848	0.666	$17,881
7		$26,848	$26,848	0.623	$16,726
8		$26,848	$26,848	0.582	$15,626
9		$26,848	$26,848	0.544	$14,605
10		$92,348	$92,348	0.508	$46,913
11		$26,848	$26,848	0.475	$12,753
12		$26,848	$26,848	0.444	$11,921
13		$26,848	$26,848	0.415	$11,142
14		$26,848	$26,848	0.388	$10,417
15		$42,348	$42,348	0.362	$15,330
16		$26,848	$26,848	0.339	$9,101
17		$26,848	$26,848	0.317	$8,511
18		$26,848	$26,848	0.296	$7,947
19		$26,848	$26,848	0.277	$7,437
20		$92,348	$92,348	0.258	$23,826
21		$26,848	$26,848	0.242	$6,497
22		$26,848	$26,848	0.226	$6,068
23		$26,848	$26,848	0.211	$5,665
24		$26,848	$26,848	0.197	$5,289
25		$42,348	$42,348	0.184	$7,792
26		$26,848	$26,848	0.172	$4,618
27		$26,848	$26,848	0.161	$4,323
28		$26,848	$26,848	0.150	$4,027
29		$26,848	$26,848	0.141	$3,786
30		$42,348	$42,348	0.131	$5,548
				TOTAL PRESENT WORTH	**$1,887,524**