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FEASIBILITY STUDY
for
SITES 4, 5, 19 and 26

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey

Northern Division
Naval Facilities Engineering Command
Contract No. N62472-90-D-1298
Contract Task Order 0279

July 1997

BROWN & ROOT ENVIRONMENTAL

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July 31, 1997

Mr. J. Kolicius, Code 1821
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10 Industrial Highway, Mail Stop No. 82
Lester, Pennsylvania 19113-2090

Reference: Contract No. N62472-90-D-1298 (CLEAN)
Contract Task Order (CTO) No 279

Subject: Submission of Final Feasibility Study for Sites 4, 5, 19, and 26 (Changed Pages)
NWS Earle - Colts Neck, New Jersey

Dear Mr. Kolicius:

Brown and Root (B&R) Environmental is pleased to provide 14 copies of the subject changed pages. At your request, we are providing Jeff Gratz, of the United States Environmental Protection Agency (EPA), Region II, with three copies, Bob Marcolina, of New Jersey Department of Environmental Protection, with three copies, Greg Goepfert of NWS Earle with three copies, and you with five copies.

These changed pages address EPA comments on the draft final FS and reflect Navy preference for proposed remediation of Site 26. A reply document to EPA Region II comments is attached.

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

Sincerely,

Russ Turner

Russell E. Turner
Project Manager

RET/ejc

c: Greg Goepfert (NWS Earle)
Jeffrey Gratz (EPA Region II)
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File

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R-51-1-7-11

FEASIBILITY STUDY
for
SITES 4, 5, 19, and 26

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 14
Naval Facilities Engineering Command
10 Industrial Highway, Mall Stop #82
Lester, Pennsylvania 19113-2090

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July 1997

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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 Site was completed in December 1996. Upon review of the data presented in the RI, the Navy and EPA agreed to group Sites 4 and 5 into Operable Unit-1 (OU-1), Site 19 into Operable Unit-2 (OU-2), and Site 26 into Operable Unit-3 (OU-3) based on the volumes of waste materials present, the types of contaminants detected, and the potential for contaminant migration to human and environmental receptors.

This report presents the feasibility study (FS) performed for the OU-1, OU-2 and OU-3 Sites. 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 remedial alternatives developed for Sites 4, 5, 19, and 26.

The remedial options developed in this document will be used by the Navy to select a preferred remedy for each site. A Proposed Remedial Action 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 would 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. 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 4 - Landfill West of "D" Group

Site 4 consists of a 5-acre landfill that received approximately 10,200 tons of mixed domestic and industrial wastes between 1943 and 1960. The bulk of the materials disposed at Site 4 included metal

scrap (steel banding, pipes, and empty trash barrels) and construction debris (lumber, concrete, brick, etc.). Pesticide and herbicide containers, paint residues, and rinsewaters were also disposed in this landfill. Industrial wastes apparently only comprise a small portion of the disposed materials. Reports prepared by previous contractors indicate the potential presence of other wastes in the landfill including containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics, and asbestos. The landfill materials are currently covered by a thin layer of sandy soil. This landfill was never formally closed.

Site 5 - Landfill West of Army Barricades

Site 5 consists of a landfill situated west of the Army Barricades that received approximately 6,600 tons of mixed domestic and industrial wastes between 1968 and 1978. The materials disposed at Site 5 included domestic wastes consisting of paper, glass, and plastics; construction debris (consisting of lumber, concrete, bricks, metal scrap, etc.); and industrial wastes consisting of wood, pesticide and herbicide containers, containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics, and small amounts of asbestos.

The landfill materials are currently covered by a vegetated layer of soil that appears to vary in thickness from 1 to 3 feet throughout most of the site. Approximately 1 acre of the landfill is currently occupied by the skeet and shooting range, which is used recreationally by the public. Apparently this landfill was never formally closed.

Site 19 - Paint Chip and Sludge Disposal Area

Site 19 consists of an ordnance maintenance area where paint chips and sludges were discharged into a topographic depression near Building S-34 from the early 1940s until the early 1960s. Paint slurries and solvent residues were discharged into a open drainage swale. The site occupies an approximately 300-foot circular area, half of which is paved with asphalt; the remainder has a gravel surface. The topographic depression measures approximately 50 feet in diameter and varies in depth between 5 to 10 feet. A small drainage ditch runs from the depression to a small stream in the wetlands adjacent to Site 19. The paved portion of this site is currently used for training Navy fork lift operators.

Site 26 - Explosive "D" Washout Area

The explosive "D" washout area located behind Building BG-1 was used for a 1-year period during the 1960s to remove and recover ammonium picrate (explosive "D") from artillery shells. The shells were

washed with hot water, and the ammonium picrate solution was discharged into a settling tank. The ammonium picrate precipitated as the solution cooled and was then recovered for reuse or disposal. Overflow from the settling tank was discharged into an unlined percolation pit. It is estimated that approximately 20,000 pounds of ammonium picrate may have been lost from the percolation pit as the result of heavy rainfall and flooding. A tile-lined open pipe connects Building BG-1 and the percolation pit. A process leaching system, consisting of a grease pit and a cesspool-type leach tank, is also located adjacent to the building.

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, 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 of 17 sites be performed. 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)

Objective of the FS

The overall objective of this FS is to develop and evaluate alternatives that address source control and groundwater remediation actions for the four sites. The general FS process is described below:

- Develop Remedial Action Objectives that incorporate clean-up goals protective of human health and the environment. The Remedial Action Objectives 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 Remedial Action Objectives.

- 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. The alternatives consist of a range of remedial technologies for source control or groundwater remediation.

- 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 the NWS Earle OU-1, OU-2, and OU-3 Sites.

Site 4 RAOs

To address the potential threats posed by contaminated soil and landfilled materials at Site 4, the RAO to protect human health is to prevent human exposure to contaminated soils and landfilled materials.

Because continued leaching of soil contaminants would degrade groundwater underlying Site 4, the RAO for protection of the environment is to minimize contaminant migration into adjacent wetlands (surface water and sediments) and groundwater. The groundwater RAOs for protection of human health are to prevent human exposure to VOC and metal contaminants in groundwater and to restore the aquifer to the applicable standard.

Site 5 RAOs

To address the potential threats posed by contaminated soil and landfilled materials at Site 5, the RAO to protect human health is to prevent human exposure to contaminated soils and landfilled materials.

Because continued leaching of soil contaminants would degrade groundwater underlying Site 5, the RAO for protection of the environment is to minimize contaminant migration into groundwater. The groundwater RAOs for protection of human health are to prevent human exposure to VOC and metal contaminants in groundwater and to restore the aquifer to the applicable standard.

Site 19 RAOs

To address the potential threats posed by contaminated soils/sediments at Site 19, the RAO to protect human health is to prevent human exposure to contaminated soils/sediments.

The RAO for protection of the environment is to minimize contaminant migration into groundwater and adjacent wetlands.

The groundwater RAOs for protection of human health are to prevent human exposure to contaminated groundwater and to restore the aquifer to the applicable standard.

SITE 26 RAOs

For the protection of human health, the RAO is to prevent potential human exposures to contaminated groundwater.

For the protection of the environment, the RAO is to mitigate VOC contaminants in groundwater.

Groundwater Fate and Transport Modeling

As part of the FS, computer modeling of the fate and transport of contaminant plumes associated with each NWS Earle site was prepared to help assess the duration until the plume concentrations diminish to background or state groundwater quality criteria and 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.

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 compliance with ARARs. Remedial alternatives included source control actions such as no action; consolidation and capping; excavation, on-site solidification, and on-base disposal; and off-base disposal. The groundwater response actions considered for these remedial alternatives included in-situ groundwater treatment, ex-situ groundwater treatment, and institutional controls. With the implementation of source control actions, reduced leaching of soil contaminants to groundwater would result and groundwater would not be degraded further.

Summaries of remedial alternatives that passed the screening step for each site are presented in the following section.

Site 4 Remedial Alternatives

Site 4 - 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.

Site 4 - Alternative 3: Capping, Institutional Controls, and Long-Term Monitoring

This alternative is a containment option that utilizes capping and institutional controls to prevent potential human exposure to contaminated soils and landfilled materials and to minimize further contaminant leaching into groundwater. Over time, the contaminants in groundwater will likely attenuate naturally through chemical and biological degradation (VOCs only) and physical and chemical processes (metals and VOCs). Contaminant concentrations in groundwater will 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 will 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. Following capping, the cap would be maintained as needed. Institutional controls would be enacted to limit future uses of the site that may result in disturbance of the soil cover or direct contact with contaminated media and to prohibit use of untreated contaminated groundwater.

Long-term, periodic (beginning as semi-annual) monitoring would be conducted to assess contaminant status and potential threats to human health and the environment. Site conditions and risks would be reviewed every five years since wastes are left in place.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (CEA) pursuant to New Jersey Administrative Code (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. The CEA would be lifted once RAOs are met.

Site 5 Remedial Alternatives

Site 5 - 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 would be the only activities conducted under this alternative.

Site 5 - Alternative 3: Capping, and Institutional Controls, and Long-Term Monitoring

This alternative is a containment option that utilizes capping and institutional controls to prevent potential human exposure to contaminated soils and landfilled materials, and to minimize further contaminant leaching into groundwater. Areas of previous active landfill operations (to be determined during pre-design studies) will be capped while the remaining area would be left in its current condition if adequate soil cover is present and erosion is not evident. Over time, the contaminants in groundwater will likely attenuate naturally through chemical and biological degradation (VOCs only) and physical and chemical

processes (metals and VOCs). Contaminant concentrations in groundwater will also decrease as a result of reduced infiltration of precipitation through landfilled materials.

For the new cap, a low-permeability cover system that complies with federal and state regulatory requirements will 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. Both the new and existing cap, where it remains, would be periodically maintained. Institutional controls would be enacted to limit future uses of the site that may result in disturbance of the new and existing cap or direct contact with contaminated media and to prohibit use of untreated contaminated groundwater.

Long-term, periodic (beginning as semi-annual) monitoring would be conducted to assess contaminant status and potential threats to human health and the environment. Site conditions and risks would be reviewed every 5 years since wastes are left in place.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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. The CEA would be lifted once RAOs are met.

Site 19 Remedial Alternatives

Site 19 - 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.

Site 19 - Alternative 4: Excavation, On-Site Solidification, On-Site Disposal, and Long-Term Monitoring

Alternative 4 employs soil treatment to limit exposure to hazardous substances and minimize migration of contaminants to groundwater and the adjacent wetlands. Contaminants in site groundwater would naturally attenuate over time through precipitation, adsorption, dilution, and dispersion after leaching of contaminants from site soils and sediments is abated.

Under this alternative, the contaminated sediments and soils from the drainage ditch and the topographic depression would be excavated and treated by solidification to immobilize metals in a stable matrix. Treated soils would be placed in the topographic depression. The depression would be backfilled with clean fill; graded level with the surrounding paved surface; and closed with an asphalt cover to form a treated-soil containment cell. Access restrictions would be enacted to limit future uses of the site that may result in intrusion into the treated-soil cell. Access restrictions would also prohibit the use of untreated groundwater for drinking water.

Long-term, periodic (beginning as semi-annual) monitoring of groundwater, surface water, and sediments would be conducted to assess contaminant status and potential threats to human health and the environment. Site conditions and risks would be reviewed every 5 years since wastes are left in place.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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. The CEA would be lifted once RAOs are met.

Site 19 - Alternative 5: Excavation and Disposal

Under Alternative 5, all contaminated soils and sediments in excess of selected clean-up goals would be excavated and sent off site for disposal or consolidated into Site 4 prior to capping. Site 19 soils would no longer pose threats to groundwater or the adjacent wetlands. Once the source of contamination is removed, contaminants in site groundwater would naturally attenuate over time through precipitation, adsorption, dilution, and dispersion. Institutional controls would be enacted to prohibit the use of untreated contaminated groundwater for drinking water.

Long-term, periodic (beginning as semi-annual) monitoring of groundwater, surface water, and sediments would be conducted to assess contaminant status and potential threats to human health and the

environment. Site conditions and risks would be reviewed every 5 years as long as groundwater contamination remains.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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. The CEA would be lifted once RAOs are met.

Site 26 Remedial Alternatives

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 this alternative is to evaluate the overall human health and environmental protection provided by the site in its present state. No measures would be implemented to remove or contain the suspected contaminant source (the process leach tank and associated soils), to prevent potential human exposure to site groundwater, or to mitigate contaminant migration in the environment. Periodic reviews of site conditions, typically every 5 years, and long-term monitoring of groundwater, surface water, and sediments would be conducted under this alternative.

Alternative 2: Source Removal, Institutional Controls, and Long-Term Monitoring

Alternative 2 relies on source removal and institutional controls to limit exposures to hazardous substances. No engineered treatment or containment would be employed to address contaminated groundwater; however, the suspected contaminant source (the process leach tank and associated soils) would be removed to abet natural attenuation of groundwater contamination. Institutional controls would be used to preclude use of untreated groundwater. Long-term monitoring would be conducted to monitor natural attenuation effectiveness and potential threats to human health and the environment. Site conditions and risks would be reviewed every 5 years.

Alternative 2 would provide protection of human health through suspected source removal and use of institutional controls to restrict consumption of treated contaminated groundwater until groundwater criteria are met. Groundwater contaminants would be expected to decrease through natural attenuation over time.

Periodic (beginning as semi-annual) long-term monitoring would be conducted to assess contaminant status and potential threats to human health and the environment and to gauge the progress of anticipated natural attenuation. Site conditions and risks would be formally reviewed every 5 years to evaluate remedy progress.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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. The CEA would be lifted once RAOs are met.

If the excavated process leach tank and/or soils were determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 2A, if it is determined that soils are subject to RCRA Land Disposal Restrictions (LDRs) [40 CFR 268], the source materials would be treated off site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed off site at a RCRA Subtitle C facility.

Under Alternative 2B, only soils that pass the Toxicity Characteristic Leaching Procedure (TCLP) test and are determined to not be hazardous would be disposed at the existing on-base landfill.

Alternative 3: Reactive Wall Treatment (Source Removal, In-Situ Permeable Reactive Wall, Groundwater Treatment, Institutional Controls, and Long-Term Monitoring)

Alternative 3 employs suspected source removal, in-situ groundwater treatment, and institutional controls to protect human health and the environment. The suspected contaminant source (the process leach tank and associated VOC contaminated soils) would be removed and the groundwater would be treated in-situ using permeable reactive wall technology. Because of the relatively slow groundwater velocity, it is anticipated that a significant portion of the groundwater contaminants will naturally attenuate before they reach the reactive wall. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQS are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every 5 years until the groundwater remediation is complete.

A principal component of Alternative 3 is in-situ permeable reactive wall groundwater treatment. This technology is innovative and does not yet have a track record of demonstrated success. Nevertheless, it is believed to be suitable for Site 26 contaminants, and the FS concluded its application will prove successful. The permeable treatment wall will act as a passive treatment barrier, which will effectively prevent off-site migration of contaminated groundwater; therefore, upon completion of the treatment wall, downgradient receptors would be protected. The treatment wall would not immediately protect potential receptors of contaminated groundwater beneath Site 26; long-term, permanent protection would be achieved after a treatment duration of approximately 45 years. In the interim, contaminants would be removed both by the treatment wall and natural attenuation.

In the interim period, until remediation goals for site groundwater have been achieved, human health would be protected through use of institutional controls that would restrict use of untreated contaminated groundwater as drinking water.

If the excavated process leach tank and/or soils were determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 3A, if it is determined that soils are subject to RCRA Land Disposal Restrictions [40 CFR 268], soils would be treated off site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed off site at a RCRA Subtitle C facility.

Under Alternative 3B, only soils that pass the TCLP test and are determined to not be hazardous would be disposed at the existing on-base landfill.

Alternative 4: Pump-And-Treat (Source Removal, Groundwater Extraction, Groundwater Treatment by Air Stripping, Institutional Controls, and Long-Term Monitoring)

Alternative 4 employs suspected source removal, groundwater pumping and treatment, and institutional controls to protect human health and the environment. The suspected contaminant source (the process leach tank and associated VOC contaminated soils) would be removed. A groundwater containment system consisting of groundwater extraction wells would be placed near the downgradient edge of the plume, and the groundwater would be extracted and treated above ground by air stripping. Additional groundwater extraction wells would be placed in the vicinity of the high- concentration plume area, also for groundwater pumping and above-ground treatment. It is anticipated that a significant portion of the groundwater contaminants would naturally attenuate before they are captured by the groundwater

extraction system. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQS are achieved. Periodic long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be formally reviewed every 5 years until the groundwater remediation is complete.

Alternative 4 would employ suspected source removal, groundwater extraction and treatment, and natural attenuation to provide long-term protection of human health and the environment. The groundwater extraction system would be designed to prevent off-site migration of contaminated groundwater; therefore, upon completion of the extraction system, downgradient receptors of contaminated groundwater would be protected. Potential users of contaminated groundwater beneath Site 26 would not be protected by Alternative 4 until groundwater remediation goals were achieved throughout the plume. It is anticipated that long-term, permanent protection would be achieved after a treatment duration of less than 45 years. During this period, groundwater contaminants would be removed both by the extraction system and through natural attenuation.

In the interim period, until remediation goals for site groundwater have been achieved, human health would be protected through use of institutional controls that would restrict use of untreated contaminated groundwater as drinking water.

If the excavated process leach tank and/or soils were determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 4A, if it is determined that the source materials are subject to RCRA Land Disposal Restrictions [40 CFR 268], the source materials would be treated off site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed off site at a RCRA Subtitle C facility.

Under Alternative 4B, only soils that pass the TCLP test and are determined to not be hazardous would be disposed at the existing on-base landfill.

Alternative 5: Air Sparging with Soil Vapor Extraction (Source Removal, Institutional Controls, and Long-Term Monitoring)

Under Alternative 5, the suspected source of groundwater contaminants (the process leach tank and associated VOC-contaminated soils) would be removed, and the VOCs present in groundwater and saturated soils would be removed from the aquifer through a combination of air sparging and soil vapor extraction (AS/SVE), which comprises an active in-situ remediation process. The VOCs would be collected above ground and sent off site for reuse, recycling, or destruction. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQC are achieved. Periodic long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be formally reviewed every 5 years until the groundwater remediation is complete.

Alternative 5 would employ suspected source removal and in-situ groundwater treatment to provide long-term protection of human health and the environment. The groundwater treatment system would be designed to reduce volume and concentration of contaminated groundwater; therefore, upon successful start-up of the treatment system (the plume area could actually widen during initial operations), downgradient receptors of contaminated groundwater would begin to be protected. However, potential users of contaminated groundwater beneath Site 26 would not be protected by Alternative 5 until groundwater remediation goals were achieved throughout the plume. It is anticipated that long-term, permanent protection would be achieved after a treatment duration of approximately 5 years. During this period, groundwater contaminants would be removed both by the AS/SVE, which comprises an active in-situ remediation process and by natural attenuation.

In the interim period, until remediation goals for site groundwater have been achieved, human health would be protected through use of institutional controls that would restrict use of untreated contaminated groundwater as drinking water.

If the excavated process leach tank and/or soils were determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 5A, if it is determined that the source materials are subject to RCRA Land Disposal Restrictions [40 CFR 268], the source materials would be treated off site prior to disposal, in accordance with

these regulations. Any wastes determined to be subject to LDRs would be disposed off site at a RCRA Subtitle C facility.

Under Alternative 5B, only source materials that pass the TCLP test and are determined to not be hazardous would be disposed at the existing on-base landfill.

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. Summaries and comparative evaluation of alternatives for Sites 4, 5, 19, and 26 are presented in Tables ES-1 through ES-4, respectively.

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

Two other evaluation criteria, state and community acceptance, will be addressed in the Record of Decision following the receipt of comments during public comment period, after the Proposed Remedial Action Plan has been presented to the public.

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

CRITERION:	ALTERNATIVE 1: NO ACTION	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.	Enhanced 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 for drinking water.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. The cover system would reduce leaching of contaminants to groundwater, facilitating natural attenuation 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 downgradient, potentially affecting downgradient receptors.	The cover system would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.
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 by natural attenuation. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Location-Specific ARARs	Not Applicable.	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 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 1.4×10^{-4} excess cancer risk (ECR) and HI = 3.3 non-carcinogenic risks from exposure to site groundwater. Increased risk anticipated over time as landfill surface deteriorates.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} ECR and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Installation and maintenance of the cap would reduce direct exposure risks to less than 1×10^{-6} ECR and HI less than 1.0.
Adequacy and Reliability of Controls	No new controls implemented. Existing site features provide limited controls.	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.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT		
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	Groundwater contamination eventually eliminated by natural attenuation.

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

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
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.
Worker Protection	No risk to workers anticipated if proper PPE is used during 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 significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.
Time Until Action is Complete	Not applicable.	1.5 years enhanced cap is in place. Natural attenuation will likely take longer.
IMPLEMENTABILITY		
Ability to Construct and Operate	No construction or operation involved.	No difficulties anticipated. Capping is a readily implementable technology.
Ease of Doing More Action if Needed	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 within.
Ability to Monitor Effectiveness	Monitoring would provide assessment of potential exposures, contaminant presence, migration, or changes in site conditions.	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.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	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 construct cap and perform long-term maintenance, monitoring, and 5-year reviews.
Availability of Technology	Not required.	Common construction techniques and materials required for cap construction.

TABLE ES-1
SITE 4 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
COST		
Capital Cost	$0	$1,983,000
First-Year Annual O&M Cost	$21,600	$29,600
Present Worth Cost*	$302,000	$2,400,000

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

TABLE ES-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT		
Prevent Human Exposure to Contaminated Landfill Soils and Materials	No action taken to prevent human exposure to landfilled materials. Existing risks would remain. Continued deterioration of the landfill surface, particularly the eastern portion, would expose more landfilled materials and result in increased direct exposure risks.	New cover system over eastern 1 acre of landfill and would prevent direct contact with contaminated materials. Existing soil/vegetative cover over western portion of landfill would limit direct contact with contaminated materials. Current direct contact risks were not quantified, but it is conservatively assumed that landfilled materials may pose excess health risk. Excess risks would be reduced by installing the new cap and maintaining the new and existing caps.
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 for drinking water.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. The enhanced cover system would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.
Minimize Contaminant Migration to Groundwater	No actions taken to reduce contaminant leaching to groundwater. Contaminants would continue to leach into groundwater and migrate downgradient, potentially affecting downgradient receptors.	The enhanced 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 ES-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	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 by natural attenuation. A classification exception area (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.
Action-Specific ARARs	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 1.3×10^{-4} ECR and HI = 5.2 non-carcinogenic risks from exposure to site groundwater. Increased risk anticipated over time as landfill surface deteriorates, especially on eastern portion of landfill.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Installation of the new cap, maintenance of the new and existing caps, and implementation of access restrictions to prevent intrusion into contaminated materials would reduce direct exposure risks.
Adequacy and Reliability of Controls	No new controls implemented. Existing site features provide limited controls.	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.

TABLE ES-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Need for 5-Year Review	Review would be required since soil and groundwater contaminants would be left in place.	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.	Groundwater contamination eventually eliminated by natural attenuation.
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.
Worker Protection	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during cap construction and long-term monitoring.
Environmental Impacts	No adverse impacts to the environment anticipated.	No significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.
Time Until Action is Complete	Not applicable.	14 months until enhanced cap is in place. Natural attenuation will likely take longer.
IMPLEMENTABILITY		
Ability to Construct and Operate	No construction or operation involved.	No difficulties anticipated. Capping is a readily implementable technology.
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	If additional actions are warranted in the eastern portion of the landfill, the single barrier cover system may need to be opened to access contaminated materials within. Additional actions would be easily implemented in the western portion of the landfill.
Ability to Monitor Effectiveness	Monitoring would provide assessment of potential exposures, contaminant presence, migration, or changes in site conditions.	Same as Alternative 1.

TABLE ES-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
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.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	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 construct cap and perform long-term maintenance, monitoring, and 5-year reviews.
Availability of Technology	Not required.	Common construction techniques and materials required for cap construction.
COST		
Capital Cost	$0	$588,000
First-Year Annual O&M Cost	$15,800	$18,600
Present Worth Cost*	$230,000	$852,000

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

TABLE ES-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT			
Prevent Human Exposure to Contaminated Soils.	No action taken to prevent human exposure to contaminated soils and sediments.	Excavation, treatment, and on-site disposal would prevent direct contact with contaminated materials.	Excavation and off-site disposal would prevent direct contact with contaminated materials.
Prevent Human Exposure to Contaminated 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 for drinking water.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. Excavation and solidification of soils would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. Excavation and off-site disposal of soils would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.
Minimize Contaminant Migration to Groundwater and Adjacent Wetlands	No actions taken to reduce contaminant migration to groundwater or wetlands. Contaminants would continue to leach into groundwater and migrate into wetlands via surface runoff.	Excavation and solidification of contaminated soils would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.	Excavation and removal of contaminated soils would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, 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 by natural attenuation. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration. Alternative 4 would be implemented in compliance with RCRA Land Disposal Restrictions.	Same as Alternative 4.
Location-Specific ARARs	Not Applicable.	Would comply with federal and state ARARs for wetlands, floodplains, and other sensitive receptors.	Same as Alternative 4.
Action-Specific ARARs	Not Applicable.	If soils and sediments are determined to be hazardous, Alternative 4 would comply with federal and state ARARs for siting and operation of hazardous waste treatment facilities.	If soils and sediments are determined to be hazardous, Alternative 5 would comply with federal and state ARARs for transport/disposal of hazardous waste.

TABLE ES-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
LONG-TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of Residual Risk	Existing risks would remain: Approximately 3.3 x 10^{-4} ECR and HI = 3.0 non-carcinogenic risks from exposure to site groundwater; Risks exceeding EPA's protective guideline for exposure to lead in soil, dust, and groundwater (estimated 15.5 percent children exposed may have blood lead levels >10μg/l vs guideline of maximum 5 percent).	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1 x 10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Excavation, treatment, and on-site containment of contaminated soils and sediments would reduce direct exposure risks to acceptable levels for lead exposure.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1 x 10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Excavation and off-site disposal of contaminated soils and sediments would reduce direct exposure risks to acceptable levels for lead exposure.
Adequacy and Reliability of Controls	No new controls implemented.	Solidification is a widely demonstrated, reliable technology for immobilization of metals in soils and sediments. Combined with on-site containment, solidification is expected to provide permanent protection from direct contact exposures and long-term reduction in contaminant leaching to groundwater.	Because contaminated soils and sediments would be removed, no controls would be necessary for preventing exposure and reducing contaminant migration to the environment. If implemented and enforced, institutional controls could prevent 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.	Review would be required since groundwater contaminants would remain, in excess of GWQC.

TABLE ES-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT			
Treatment Process Used	None.	Solidification/Natural Attenuation	Natural Attenuation
Amount Treated or Destroyed	None.	260 cubic yards of soil/sediment. All of contaminated groundwater.	All of contaminated groundwater.
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	Mobility of metals in soils and sediments reduced through treatment by solidification. Contaminated groundwater treated through natural attenuation.	Contaminated groundwater treated through natural attenuation.
Irreversible Treatment	Not Applicable	Solidification treatment is expected to provide effective long-term immobilization of contaminants. Since contaminants are immobilized, rather than destroyed, treatment may not be irreversible. Contaminatd groundwater irreversibly addressed by natural attenuation.	Contaminatd groundwater irreversibly addressed by natural attenuation.
Statutory Preference for Treatment	No	Yes	Yes
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.	Same as Alternative 4.
Worker Protection	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during remediation and long-term monitoring.	Same as Alternative 4.

TABLE ES-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Environmental Impacts	No adverse impacts to the environment anticipated.	No significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.	Same as Alternative 4.
Time Until Action is Complete	Not applicable.	8 months until RAOs for exposure to contaminated soils and sediments achieved. 1 year until RAOs for exposure to site groundwater are achieved.	Alternative 5A: 2.5 months until RAOs for exposure to contaminated soils and sediments achieved. Alternative 5A: 11 months until RAOs for exposure to contaminated soils and sediments achieved (including time to prepare Site 4 landfill for acceptance of excavated soils). Both 5A and 5B: 1 year until RAOs for exposure to site groundwater are achieved.
IMPLEMENTABILITY			
Ability to Construct and Operate	No construction or operation involved.	No construction or operational difficulties anticipated. Common construction techniques used for excavation and on-site disposal. Precautions would be taken to minimize damage to wetlands during excavation. Solidification is a well demonstrated technology employing common equipment and materials.	No construction or operational difficulties anticipated. Common construction techniques and equipment used for excavation and off-site disposal. Precautions would be taken to minimize damage to wetlands during excavation.

TABLE ES-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	If additional actions are warranted, the solidified materials could be excavated and removed.	Same as Alternative 1.
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. Alt. 5A: manifests would be required for off-site transportation and disposal of contaminated materials.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	No off-site TSD capacity or services required. Ample availability of companies to provide equipment and services for solidification treatment.	Alt. 5A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 5B: Sufficient area available for disposal of materials at the Site 4 landfill.
Availability of Equipment, Specialists, and Materials	Personnel and equipment available for implementation of long-term monitoring and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform excavation, treatment, disposal, long-term monitoring, and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform excavation, off-site disposal, long-term monitoring, and 5-year reviews.

TABLE ES-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Availability of Technology	Not required.	Solidification is a well demonstraded technology employing relative common and available equipment and materials. Several vendors are available that could provide the necessary equipment and materials.	Common construction techniques and materials required for excavation and off-site disposal
COST			
Capital Cost	$0	$491,000	Alt. 5A: $375,000 Alt. 5B: $153,000
First-Year Annual O&M Cost	$21,600	$21,600	Alt. 5A: $21,600 Alt. 5B: $21,600
Present Worth Cost**	$302,000	$793,000	Alt. 5A: $677,000 Alt. 5B: $455,000

Notes:
* Evaluation presented pertains to Alternative 5A (off-base disposal) and Alternative 5B (on-base disposal) unless otherwise noted.
** Present worth cost is based on discount rate of 7%

TABLE ES-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT				
Prevent Human Exposure to Contaminated Groundwater	Provides no additional protection against human exposure to contaminated groundwater. Carcinogenic and non-carcinogenic risks exceeding EPA's target risk range would remain. No institutional controls implemented to restrict use of untreated contaminated groundwater for drinking water. No actions taken to reduce contaminant leaching to groundwater from process leach tank and associated contaminated soils. Time required for natural attenuation to reduce contaminants to levels that would not pose risk may be longer than in Alternative 2.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.	The proposed in-situ system would immediately prevent exposure to downgradient receptors by treating the advancing plume while natural attenuation would ultimately reduce groundwater contaminant concentrations at the site to levels that would not pose excess risk. Institutional controls would minimize potential exposure to site groundwater during the treatment period by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating groundwater remediation.	Provides collection and ex-situ treatment of the advancing contaminant plume which would immediately prevent exposure to downgradient receptors while natural attenuation ultimately reduces groundwater contaminant concentrations to levels that would not pose excess risk. Institutional controls would minimize potential exposure to site groundwater during the treatment period by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating groundwater remediation.
Mitigate Migration of VOC Contaminated Groundwater	No actions taken to reduce migration of contaminated groundwater. Relies on natural attenuation.	Same as Alternative 1.	The permeable reactive wall treatment system, installed immediately downgradient of the contaminant plume, would prevent further migration of contaminated groundwater by degrading dissolved contaminants as they migrate through the wall.	The groundwater extraction and treatment system would contain and treat the contaminant plume, preventing further migration of contaminated groundwater.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
COMPLIANCE WITH ARARS				
Chemical-Specific ARARs	Would not comply with state groundwater quality standards or statutory requirements.	Groundwater contaminant concentrations would initially exceed state GWQC; over time GWQC would be achieved by natural attenuation. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration. Alternative 2 would be implemented in compliance with RCRA Land Disposal Restrictions.	Groundwater contaminant concentrations would initially exceed GWQC: over time treatment and natural attenuation would reduce contaminant levels below GWQC. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration. Alternative 3 would be implemented in compliance with RCRA Land Disposal Restrictions	Same as Alternative 3
Location-Specific ARARs	Not Applicable.	Not Applicable.	Not Applicable.	Not Applicable.
Action-Specific ARARs	Not Applicable.	If soils and sediments are determined to be hazardous, Alternative 2 would comply with federal and state ARARs for generation, transport, and disposal of hazardous wastes.	Same as Alternative 2.	If soils and sediments are determined to be hazardous, Alternative 4 would comply with federal and state ARARs for transport of hazardous waste. The on-site treatment facility would be constructed and operated in accordance with federal and state hazardous waste facility regulations.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
LONG-TERM EFFECTIVENESS AND PERMANENCE				
Magnitude of Residual Risk	Existing risks would remain. Future residential receptor of site groundwater: 1.7×10^{-4} carcinogenic and HI > 1 non-carcinogenic risks for three target organs. Future industrial receptor of site groundwater: HI > 1 non-carcinogenic risks for three target organs.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks.	Groundwater treatment would result in permanent reduction of risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0. In the interim, until groundwater remediation goals are achieved, implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0.	Same as Alternative 3.
Adequacy and Reliability of Controls	No new controls implemented.	Long-term enforcement of institutional controls would be required to ensure their effectiveness for preventing use of contaminated groundwater.	Permeable reactive wall treatment is a new and innovative process that has been demonstrated primarily in bench- and pilot-scale projects over the past 5 years. Although the technology shows promise, its long-term effectiveness is uncertain. Potential limitations include biofouling, coating of the reactive materials, or reduced permeability due to buildup of precipitated inorganics. The likelihood of these problems occurring and the reparability of the wall in the event that problems occur are not known. The technology vendor recommends agitation of the reactive wall materials every 5 to	Groundwater extraction and air stripping are widely used, effective technologies for the remediation of VOC contaminated groundwater. There is little uncertainty associated with long-term operation or maintenance of the system. The process would be easily monitored and maintained. Routine maintenance and replacement of system components could be accomplished with little interruption of system operation. Long-term enforcement of installation controls would be required to ensure their effectiveness for preventing use of

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
			10 years to liberate deposited inorganic precipitates. If the wall became ineffective and could not be repaired, the reactive metal materials or the entire wall would have to be replaced. Regular process monitoring would effectively identify any changes in the effectiveness of the process. Long-term enforcement of institutional controls would be required to ensure their effectiveness for preventing use of contaminated groundwater.	contaminanted groundwater.
Need for 5-Year Review	Review would be required since groundwater contaminants would be left in place.	Review would be required since groundwater contaminants would be left in place and institutional controls would be implemented.	Review would be required for the duration of the groundwater remediation period since groundwater contaminants would remain above remediation goals and institutional controls would be implemented.	Same as Alternative 3.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT				
Treatment Process Used	None.	None.	In-situ permeable reactive wall.	Air stripping with activated carbon polishing.
Amount Treated or Destroyed	None.	None.	1 million gallons contaminated groundwater, containing 2800 grams TCE plus other VOCs, remediated per year.	Same as Alternative 3.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	Same as Alternative 1.	The In-situ treatment system would contain the contaminant plume and degrade the chlorinated VOCs to reduce the toxicity, mobility, and volume of contaminated groundwater. Over a period of approximately 45 years, the contaminants of concern in site groundwater would be reduced to acceptable levels.	The groundwater extraction and treatment system would contain the contaminant plume and remove the VOCs to reduce the toxicity, mobility, and volume of contaminated groundwater. Over a period of approximately 45 years, the contaminants of concern in site groundwater would be reduced to acceptable levels.
Irreversible Treatment	Not Applicable	Not Applicable	Yes, contaminants are degraded to form non-toxic compounds.	Yes, contaminants are removed from groundwater.
Statutory Preference for Treatment	No	No	Yes	Yes
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.	Same as Alternative 2.	Same as Alternative 2.
Worker Protection	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, and long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, installation of the permeable reaction wall, and long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, installation and operation of the groundwater extraction and treatment systems, and long-term monitoring.
Environmental Impacts	No adverse impacts to the environment anticipated.	No adverse impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.	Same as Alternative 2.	Same as Alternative 2.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
Time Until Action is Complete	Not applicable.	1 year until RAO for preventing exposure to site groundwater is achieved. Would not meet RAO for mitigating migration of VOC contaminated groundwater. 50 years until contaminants are reduced to acceptable concentrations by natural attenuation.	1 year until RAO for preventing exposure to site groundwater is achieved. 10 months until RAO for mitigating migration of VOC contaminated groundwater is achieved. 45 years until contaminants are reduced to acceptable concentrations by in-situ groundwater treatment.	1 year until RAO for preventing exposure to site groundwater is achieved. 7 months until RAO for mitigating migration of VOC contaminated groundwater is achieved. 45 years until contaminants are reduced to acceptable concentrations by extraction and treatment of groundwater.
IMPLEMENTABILITY				
Ability to Construct and Operate	No construction or operation involved.	No construction or operational difficulties anticipated. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.	No significant construction or operational difficulties anticipated. Common construction equipment and somewhat specialized construction techniques used for installation of treatment wall. With vendor training and oversight, wall could be installed by non-specialized construction crews. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.	No construction or operational difficulties anticipated. Common well installation and construction techniques and equipment used to installation of extraction system. Modular treatment system would be easily constructed. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
Ability to Monitor Effectiveness	Groundwater monitoring would provide assessment of contaminant presence, migration, and changes in site conditions.	Same as Alternative 1.	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. Permits would be required and obtainable for off-base transportation and disposal of contaminated source area soils. Permits would not be required for on-base disposal.	Same as Alternative 2.	Same as Alternative 2.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	Alt. 2A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 2B: Sufficient area available for disposal of materials at both on-base landfills.	Alt. 3A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 3B: Sufficient area available for disposal of materials at both on-base landfills.	Alt. 4A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 4B: Sufficient area available for disposal of materials at both on-base landfills.
Availability of Equipment, Specialists, and Materials	Personnel and equipment available for implementation of long-term monitoring and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform source removal, long-term monitoring, and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform source removal, treatment system installation and operation, long-term monitoring, and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform source removal, extraction and treatment system installation and operation, long-term monitoring, and 5-year reviews.

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: SOURCE REMOVAL		ALTERNATIVE 3: REACTIVE WALL		ALTERNATIVE 4: PUMP-AND-TREAT	
Availability of Technology	Not required.	Not required.		Reactive wall technology only available from one vendor, but the equipment, materials, and personnel required to construct treatment system are available from several vendors/companies.		Groundwater extraction and air stripping are widely used, conventional technologies available from a variety of companies.	
COST							
		2A	2B	3A	3B	4A	4B
Capital Cost	$14,100	$157,000	$140,000	$1,637,000	$1,620,000	$712,000	$695,000
First-Year Annual O&M Cost	$12,700	$12,700		$60,100		$215,700	$214,900
Five-Year Reviews	$ 15,500	$15,500		$28,500		$15,500	
Present Worth Cost*	$204,000	$348,000	$331,000	$2,386,000	$2,369,000	$3,100,000	$3,073,000

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

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Prevent Human Exposure to Contaminated Groundwater	Air sparging and soil vapor extraction treatment processes, combined with enhanced biodegradation and natural attenuation would initially result in a wider plume volume/area, but would actively reduce the concentration of contaminants in the entire plume. This treatment alternative would be expected to reduce overall contaminant concentration of the entire plume more quickly than other Alternatives Institutional controls would minimize potential exposure to site groundwater during the treatment period by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating groundwater remediation.
Mitigate Migration of VOC Contaminated Groundwater	The groundwater plume would initially widen, but the overall treatment period would be shorter than other alternatives.
COMPLIANCE WITH ARARS	
Chemical-Specific ARARs	Same as Alternative 3.
Location-Specific ARARs	Not Applicable

TABLE ES-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
Action-Specific ARARs	Same as Alternative 4.
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	Same as Alternative 3
Adequacy and Reliability of Controls	Air sparging and soil vapor extraction are widely used, effective technologies for the remediation of VOC contaminated groundwater. There is little uncertainty associated with long-term operation or maintenance of the system. The process would be easily monitored and maintained. Routine maintenance and replacement of system components could be accomplished with little interruption of system operation. Regular process monitoring would effectively identify any changes in the effectiveness of the process. Long-term enforcement of institutional controls would be required to ensure their effectiveness for preventing use of contaminated groundwater.
Need for 5-Year Review	Same as Alternative 3
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT	
Treatment Process Used	Air Sparging/soil vapor extraction with air emissions control
Amount Treated or Destroyed	Entire plume

TABLE ES-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
Reduction of Toxicity, Mobility, or Volume Through Treatment	Toxicity is reduced by actively stripping VOCs from the plume volume. Mobility is not affected, although as remediation progresses, the plume edge is expected to retreat. The volume of the plume (contaminated with VOC above GWQC) is expected to grow during initial treatment, but to diminish with time
Irreversible Treatment	Yes, contaminants are removed and/or treated to form non-toxic compounds
Statutory Preference for Treatment	Yes
SHORT-TERM EFFECTIVENESS	
Community Protection	Same as Alternative 2
Worker Protection	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, installation and operation of the groundwater air sparging and soil vapor extraction systems, and long-term monitoring.
Environmental Impacts	Same as Alternative 2
Time Until Action is Complete	1 year until RAO for preventing exposure to site groundwater is achieved through implementation of Institutional Controls. Approximately 5 years until RAO for mitigating migration of VOC contaminated groundwater is achieved. Approximately 5 (or more) years until contaminants are reduced to acceptable concentrations by air sparging/soil vapor extraction and biodegration in groundwater.

TABLE ES-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
IMPLEMENTABILITY	
Ability to Construct and Operate	No construction or operational difficulties anticipated. Common well installation and construction techniques and equipment used for installation of treatment system. Modular treatment system would be easily constructed. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.
Ease of Doing More Action if Needed	Same as Alternative 1.
Ability to Monitor Effectiveness	Same as Alternative 1.
Ability to Obtain Approvals and Coordinate with Other Agencies	Same as Alternative 2
Availability of Treatment, Storage Capacities, and Disposal Services	Alt. 5A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 5B: Sufficient area available for disposal of materials at both on-base landfills.

TABLE ES-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
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FINAL

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction	
Availability of Equipment, Specialists, and Materials	Ample availability of companies with trained personnel, equipment, and materials to perform source removal, AS/SVE treatment system installation and operation, long-term monitoring, and 5-year reviews.	
Availability of Technology	AS/SVE is a widely used readily available combination of equipment/techniques provided by a variety of companies.	
COST	5A	5B
Capital Cost	$1,698,000	$1,680,000
First Year O&M Cost	$499,000 (average year)	
Five-Year Reviews	$15,500	
Present Worth Cost*	$3,755,000	$3,738,000

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

1.0 INTRODUCTION AND BACKGROUND INFORMATION

This FS report presents an executive summary (preceding this section), a summary of previous investigations for the four sites addressed in this FS (Section 1.0), identification and screening of remedial technologies for the four sites (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 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 four sites have also been presented. For a full understanding of site conditions, the Final Remedial Investigation (RI) Report, July 1996, must be reviewed. The RI report is the essential companion document to this FS, both having been 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 ARARs and 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 individual sites 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 feasibility study (FS) report includes a discussion of remedial alternatives for the Operable Unit 1 (OU-1) sites, which include Sites 4 (Landfill West of "D" Group), and 5 (Landfill West of Army Barricades); Operable Unit 2 (OU-2), Site 19 (Paint Chip and Sludge Disposal Area); and Operable Unit 3 (OU-3), Site 26 (Explosive "D" Washout Area). The OU-1, OU-2 and OU-3 sites are all located within the Mainside area of Naval Weapons Station (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 and OU-1, OU-2 and OU-3 sites.

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 all the sites included in OU-1, OU-2 and OU-3, 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 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 for each site 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

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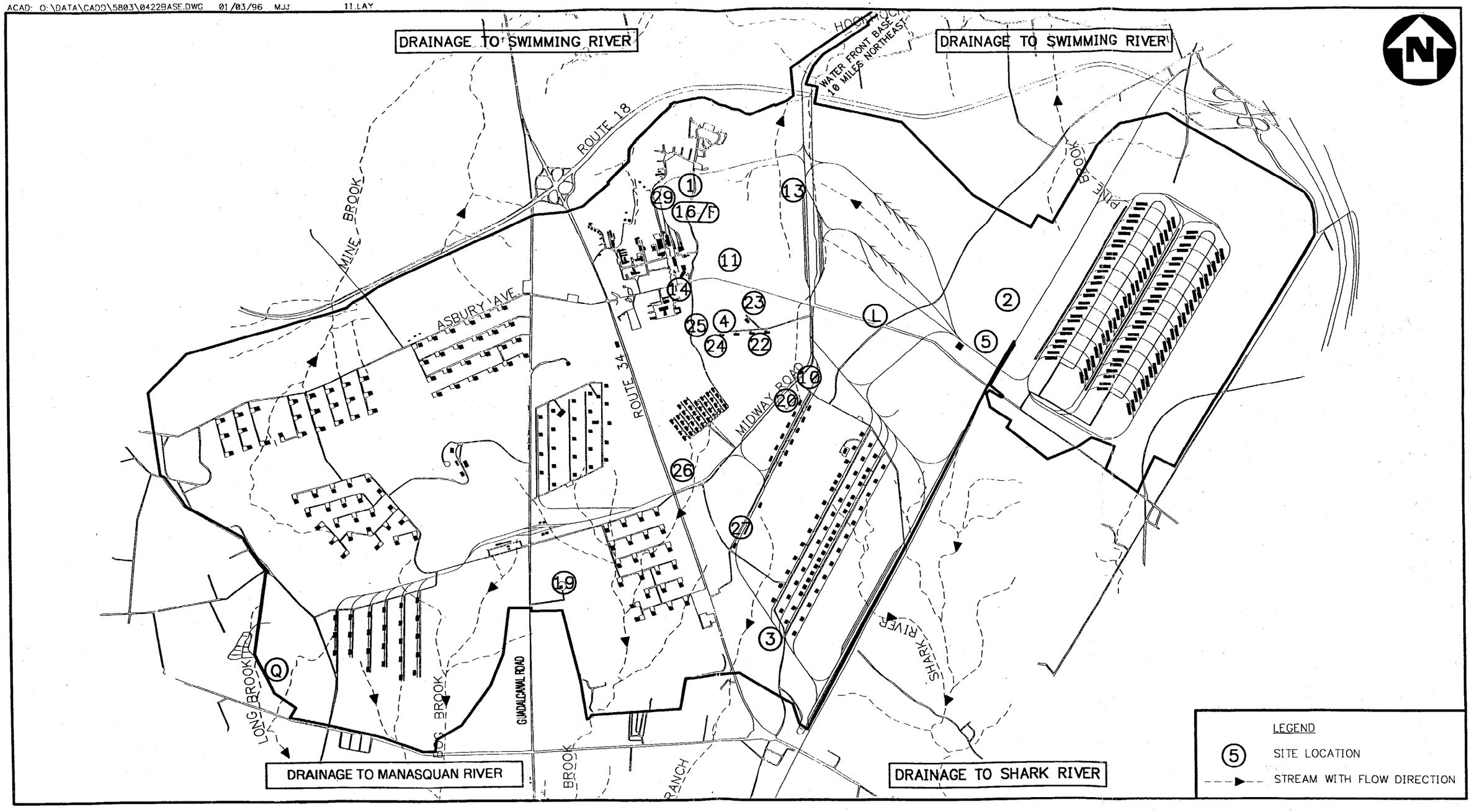

FIGURE 1-1

SITE LOCATIONS AND SURFACE DRAINAGE MAP
NWS EARLE, COLTS NECK, NEW JERSEY

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Brown & Root Environmental

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primarily composed of clay, silt, sand, and gravel and were deposited in continental, coastal, and marine 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 for each site are discussed in the site summary sections (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-1, OU-2 and OU-3 sites are 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 endangered list, has been seen on the station, and some species on the New Jersey endangered list, such as the swamp pink (Helonias bullata), 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: 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.

Significant agricultural lands under consideration include cranberry bogs located at the headwaters of Yellow Brook and Marsh Bog Brook, potentially affected by Site 19.

Ecological risk assessments were performed for the sites; 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 Explosive Safety Quantity Distance (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-1, OU-2 or OU-3. 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.

The sites were utilized for various purposes. The landfill west of "D" group (Site 4) is a 5-acre site that was used from 1943 to 1960 for the disposal of domestic and industrial wastes (Figure 1-2). At this site, wastes were burned in trenches and then buried. Industrial wastes disposed at Site 4 consist of demolition wastes, pesticide and herbicide containers, paint residues, and rinsewaters. Industrial wastes apparently comprise only a small portion of the approximately 10,200 tons of waste estimated to have been disposed at the site. Other wastes that may have been disposed in the landfill were discarded containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics, and asbestos.

The landfill west of the Army Barricades (Site 5) is a 5-acre site that was used from 1968 to 1978 for the disposal of domestic and industrial wastes (Figure 1-3). The majority of the waste was domestic waste, consisting of paper, glass, and plastics. Industrial wastes consisted of wood, pesticide containers, pesticide, rinsewaters, and discarded containers of paint, paint thinner, solvents, varnishes, shellacs, acids, alcohol's, caustics, and small amounts of asbestos.

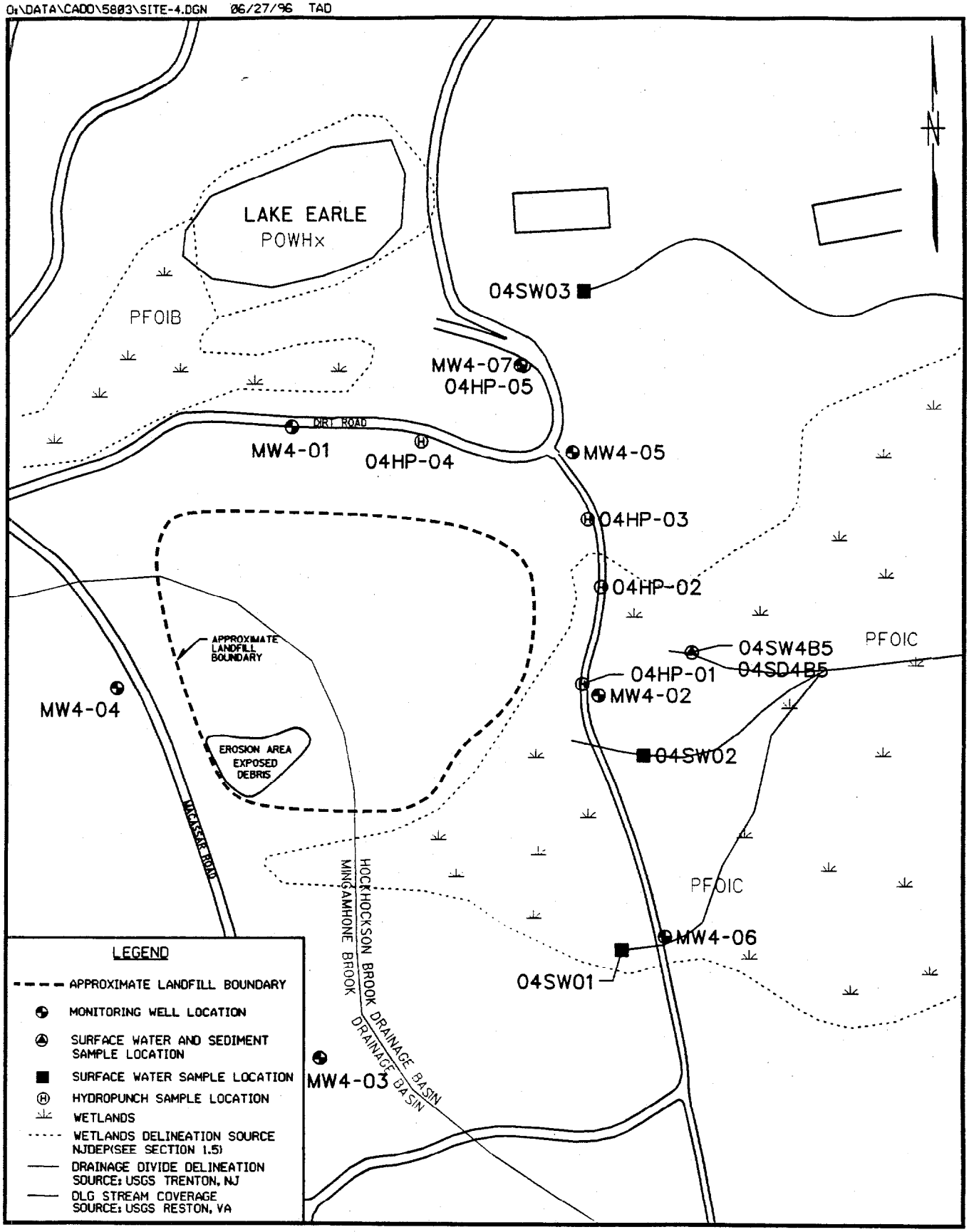

FIGURE 1-2

SITE 4 - LANDFILL WEST OF "D" GROUP

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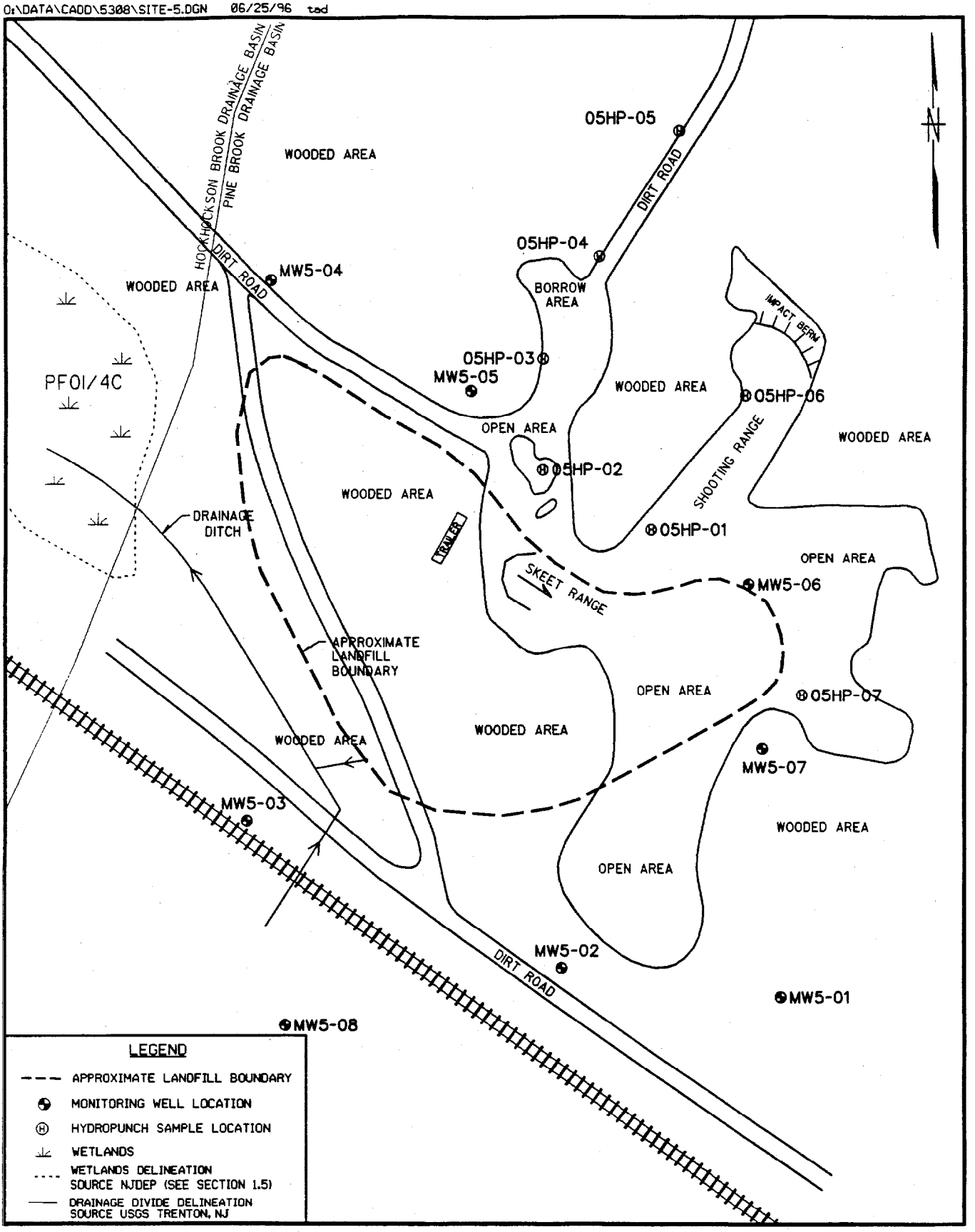

FIGURE 1-3

SITE 5 - LANDFILL WEST OF ARMY BARRICADES

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Site 19 is an ordnance maintenance area where paint chips and paint sludge were discharged to a topographic depression near Building S-34 (Figure 1-4). The site was in operation from the early 1940s until the early 1960s. Paint slurries and solvent residues were discharged into the open drainage swale. During construction at the site, a significant portion of the contaminated material may have been removed.

The site is a 300-foot circular area that is surrounded by woodlands. Half the site, from Building S-34 south to the site perimeter, is paved. The remainder has a gravel surface. The depression that received the sludge discharge is approximately 50 feet in diameter and 5 to 10 feet deep and is located in the center of the site south of a barricade. A small drainage ditch runs from the depression to the west, toward a wetlands area. General groundwater flow direction is toward the northwest.

The explosive "D" washout area (Site 26) is located behind Building GB-1 (Figure 1-5). For one year in the late 1960s, the site was used for the removal and recovery of ammonium picrate (known as explosive D) from artillery shells. The ammonium picrate was removed from the shells by washing with hot water. The explosive was water soluble, and the resulting solution flowed into a settling tank. Overflow from this settling tank flowed into an unlined percolation pit. Upon cooling, the explosive precipitated, and the precipitate was collected for reuse or disposal. According to a previous investigation (Hart, 1983), as much as 20,000 pounds of ammonium picrate could have been lost to surface water due to heavy rainfall before the percolation pit was cleaned.

Investigation has shown that the main issue of concern at Site 26 is not the explosive D operation but is related to a former process leach tank, where solvent compounds have been found in soil and groundwater. BG-1 reportedly has been used for the reconditioning and refurbishing of munition casings/shells. Solvents were used for degreasing metals surfaces. The spent solvents and wash waters were discarded into an unknown receptacle, possibly a collection tray at the formerly used, paint spray booth, which drained to a grease trap and subsequently into a process leach tank. Currently Building GB-1 is used for storage of equipment and boxes only. No industrial operations are currently performed in the building. Potable water is provided through the NWS Earle water distribution system via a 2-inch cold water service line to the building.

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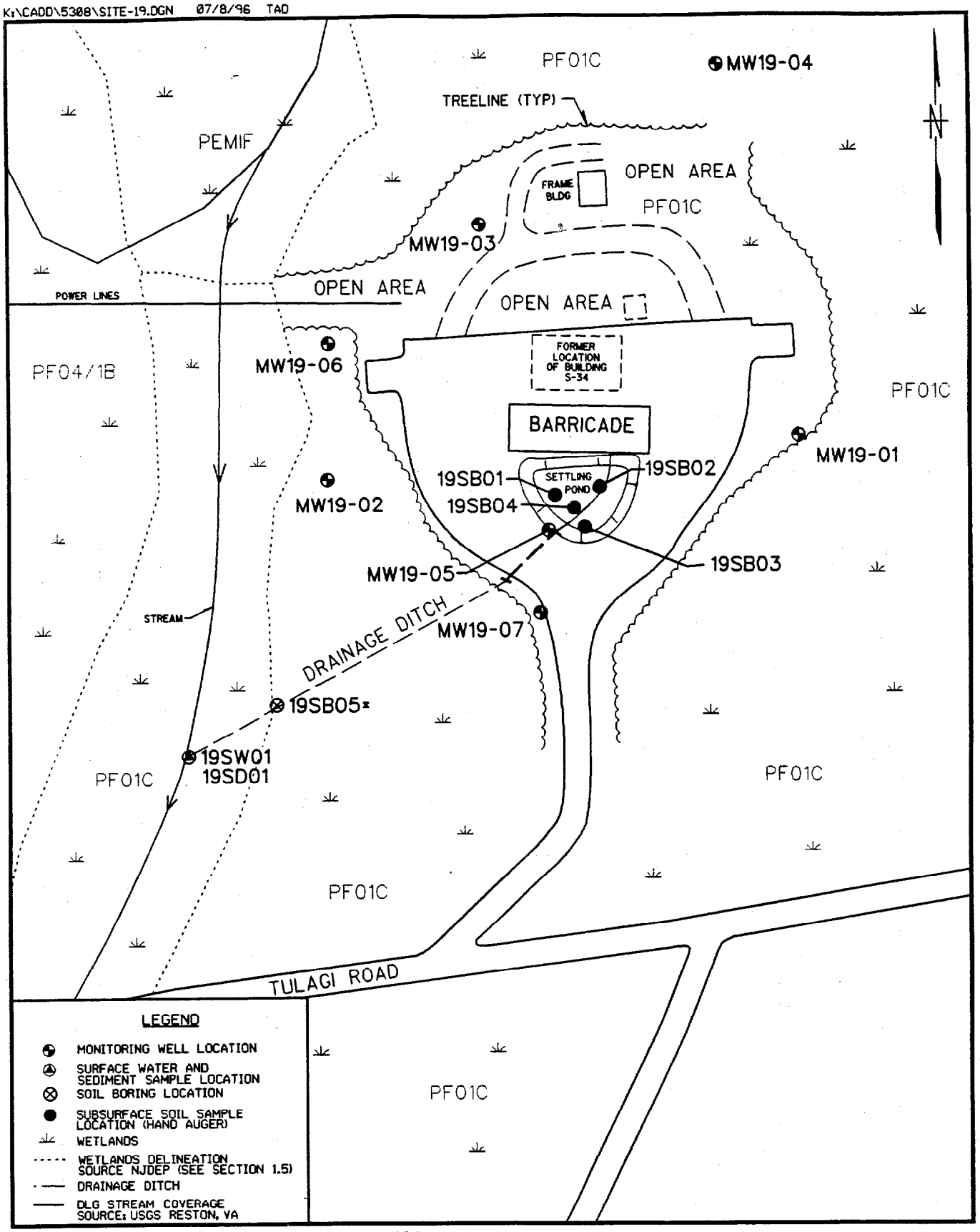

FIGURE 1-4

SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA

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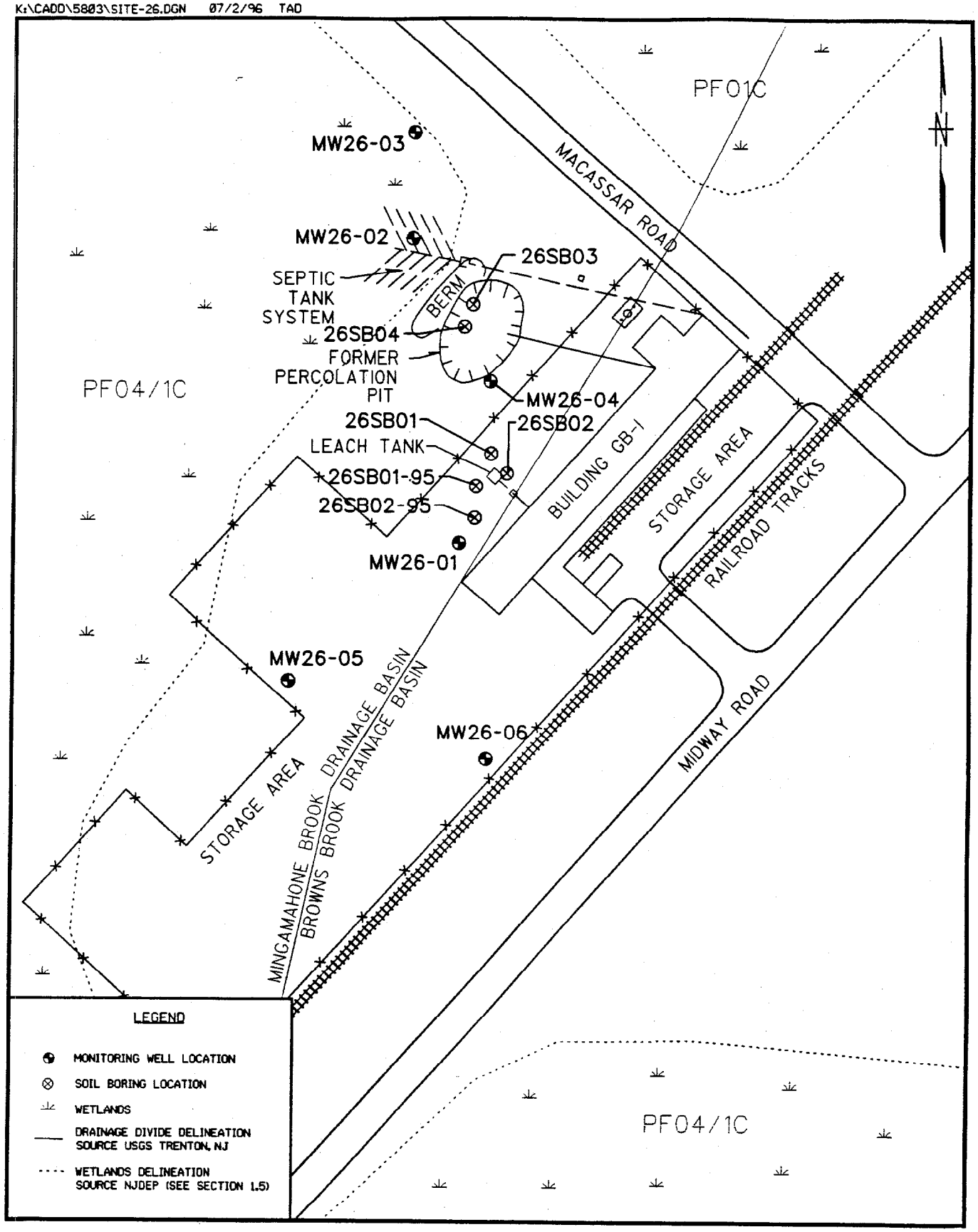

FIGURE 1-5

SITE 26 - EXPLOSIVE "D" WASHOUT AREA

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SCALE IN FEET

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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, Incorporated. Several documents prepared by Weston were submitted to the Navy, NJDEP, and 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 remedial investigation (RI) for 27 sites at NWS Earle. The RI included field investigations performed in 1995 and a review of data generated during previous investigations. 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 and that a feasibility study was required for the sites comprising OU-1, OU-2 and OU-3.

Results of the previous investigations for these sites 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 background media sampled was split between the Mainside (surface water

and sediment) and Waterfront (groundwater and subsurface soils) areas because surface water and sediment were not available at 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 southeast of Macedonia. This location is upgradient of the station 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 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 new 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.

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, combined, range between 35 and 135 feet in thickness, and 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.

TABLE 1-1
Background Monitoring Well Characteristics Summary
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) wellcasing.

(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
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-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 1-4 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 UTLs presented in these tables were compared to the individual maximum site-related results for corresponding wells grouped in the same interpreted aquifer.

TABLE 1-3
BACKGROUND WELLS AND UPGRADIENT WELLS GROUPED BY INTERPRETED AQUIFER
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

Statistical Evaluation of Background Groundwater Metals Data
Cohansey Sand, Kirkwood, and Vincentown Formations
CTO 231, 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	Normal	11	11	115	190	1.812	474
Beryllium	Normal	4	11	0.246	0.457	1.812	1.11
Cadmium	Normal	5	11	0.604	0.596	1.812	1.73
Calcium	Normal	11	11	4150	4900	1.812	13400
Chromium, Total	Normal	9	11	14.7	16.8	1.812	46.4
Cobalt	Normal	6	11	2.03	3.01	1.812	7.73
Copper	Normal	9	11	3.27	4.28	1.812	11.4
Iron	Normal	11	11	2100	2420	1.812	6670
Lead	Lognormal	3	11	1.03	0.557	1.812	2.97
Magnesium	Normal	11	11	4220	7800	1.812	19000
Manganese	Lognormal	11	11	17	0.888	1.812	91.4
Mercury	Normal	11	11	0.0585	0.0485	1.812	0.15
Nickel	Normal	10	11	5.99	7.83	1.812	20.8
Potassium	Lognormal	11	11	1080	0.797	1.812	4900
Selenium	Lognormal	1	11	2.38	0.265	1.812	3.94
Sodium	Normal	11	11	4220	2640	1.812	9220
Thallium	Lognormal	3	11	2.33	0.443	1.812	5.38
Vanadium	Normal	10	11	8.24	12.6	1.812	32.1
Zinc	Normal	6	9	89.3	135	1.86	354

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
CTO 231, NWS Earle, Colts Neck, New Jersey

Substance	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	2	2	308	0.343	6.314	4370
Barium	2	2	46	0.123	6.314	119
Beryllium	1	2	0.148	1.4	6.314	1.32 *
Calcium	2	2	2930	0.984	6.314	17587 *
Chromium, Total	1	2	2.68	2.42	6.314	52.83 *
Cobalt	2	2	15.4	0.856	6.314	80.81 *
Iron	2	2	459	0.61	6.314	1790 *
Magnesium	2	2	1950	0.116	6.314	4780
Manganese	2	2	217	0.175	6.314	843
Mercury	1	2	0.0097	2.23	6.314	0.17 *
Nickel	2	2	6.2	0.849	6.314	32.29 *
Potassium	2	2	1230	0.766	6.314	5819 *
Sodium	2	2	6050	0.353	6.314	92710
Vanadium	1	2	0.653	1.08	6.314	4.31 *
Zinc	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).

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TABLE 1-6
Statistical Evaluation of Background Groundwater Metals Data
Fill and Englishtown Formation
CTO 231, 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	Normal	3	3	2.65	3.77	2.92	15.4
Calcium	Normal	3	3	19000	7040	2.92	42760
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	Lognormal	3	3	12900	0.363	2.92	43930
Manganese	Lognormal	3	3	1590	0.73	2.92	18580
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	Lognormal	3	3	3380	0.103	2.92	4790
Sodium	Lognormal	3	3	49500	0.991	2.92	134326 *
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).

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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. 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. 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 4

1.3.2.1 Initial Assessment and Confirmation Study

The 1983 IAS consisted of interviews and on-site observations. Based on the potential for groundwater impacts and the documented disposal of hazardous wastes, Site 4 was recommended for a confirmation study. The 1986 site inspection (SI) included the installation and sampling of three monitoring wells and the sampling of two on-site springs.

During the 1993 SI, four surface water and sediment samples were collected from the spring-fed stream and drainage along the southeastern portion of the site. No seeps were encountered at the sides of the landfill. Sediment samples contained very low levels of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and elevated levels of metals and Aroclor 1260 (1.4 mg/kg). No other polychlorinated biphenyl (PCB) or pesticide compounds were found. The surface water samples were analyzed for VOCs and total petroleum hydrocarbons (TPH). No VOCs were detected that were not also identified in blanks. No TPH was detected.

1.3.2.2 Phase I Remedial Investigation

Phase I RI/FS activities were conducted by Weston in 1993 at NWS Earle. The OU-1, OU-2, and OU-3 sites were included for investigation. The RI/FS field investigation included test pit excavation, surface water and sediment sampling, and installation of three additional monitoring wells. No seeps were encountered at the edge of the landfill. Six test pits were excavated to characterize the waste materials. The waste consisted

TABLE 1-7

Statistical Evaluation of Background Surface Soil Metals Data
CTO 231, 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	Normal	4	4	3080	1680	2.353	7510
Antimony	- - -	0	4	- - -	- - -	- - -	- - -
Arsenic	Normal	4	4	6.71	6.17	2.353	23
Barium	Normal	4	4	11.3	13.6	2.353	47.1
Beryllium	Lognormal	1	4	0.112	1.48	2.353	5.55 *
Cadmium	Normal	1	4	0.333	0.159	2.353	0.751
Calcium	Lognormal	4	4	144	1.47	2.353	6810 *
Chromium	Normal	4	4	34.5	27.7	2.353	107
Cobalt	Normal	2	4	1.58	2.29	2.353	7.61
Copper	Normal	4	4	5.03	3.83	2.353	15.1
Iron	Normal	4	4	26200	26500	2.353	95800
Lead	Lognormal	4	4	11.4	1.35	2.353	397 *
Magnesium	Normal	4	4	289	233	2.353	901
Manganese	Normal	4	4	64.2	101	2.353	329
Mercury	Lognormal	4	4	0.0724	0.798	2.353	0.591
Nickel	Normal	2	4	2.59	3.12	2.353	10.8
Potassium	Lognormal	4	4	358	0.922	2.353	4050
Selenium	Normal	2	4	0.516	0.308	2.353	1.33
Silver	Normal	2	4	0.345	0.237	2.353	0.967
Sodium	Normal	4	4	39.2	32	2.353	123
Thallium	Normal	2	4	0.82	0.74	2.353	2.77
Vanadium	Lognormal	4	4	29.4	0.731	2.353	201
Zinc	Lognormal	3	4	4.69	1.74	2.353	461 *

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

CTO 231, 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	Normal	8	8	2690	1580	1.895	5870
Arsenic	Normal	8	8	6.64	5.21	1.895	17.1
Barium	Normal	8	8	8.96	10.2	1.895	29.5
Beryllium	Lognormal	2	8	0.0738	1.4	1.895	1.22
Cadmium	Normal	1	8	0.288	0.115	1.895	0.52
Calcium	Normal	8	8	289	286	1.895	864
Chromium	Normal	8	8	27.4	22.9	1.895	73.4
Cobalt	Normal	4	8	1.38	1.66	1.895	4.73
Copper	Normal	8	8	4.33	3.42	1.895	11.2
Iron	Normal	8	8	20400	19400	1.895	59500
Lead	Normal	8	8	12.2	13.6	1.895	39.5
Magnesium	Lognormal	8	8	172	1.11	1.895	1600
Manganese	Normal	8	8	46.3	71.1	1.895	189
Mercury	Normal	8	8	0.0648	0.0523	1.895	0.17
Nickel	Normal	4	8	2.38	2.45	1.895	7.3
Potassium	Lognormal	7	8	276	1.15	1.895	2780
Selenium	Normal	2	8	0.397	0.239	1.895	0.877
Silver	Normal	2	8	0.256	0.182	1.895	0.622
Sodium	Normal	8	8	39.7	31.7	1.895	103
Thallium	Normal	4	8	0.688	0.529	1.895	1.75
Vanadium	Lognormal	8	8	27.7	0.622	1.895	96.7
Zinc	Normal	6	8	15.7	17.2	1.895	50.2

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.

primarily of metal scrap such as steel banding, pipes, and empty metal trash barrels. Lumber, concrete, brick, and other construction debris were also encountered. No anomalous organic vapor readings were detected in any of the test pits. In two of the test pits, samples were collected and analyzed for full Target Compound List (TCL)/Target Analyte List (TAL) analytes and TPH. One SVOC compound [bis(2-ethylhexyl) phthalate] was detected in a sample from Test Pit 3. The pesticide 4,4'-DDT (13 ug/kg) and TPH (2,100 mg/kg) were detected in a sample from Test Pit 2. No other pesticides or PCBs were detected in either sample.

In 1993, groundwater samples were collected from all SI and RI/FS wells. One round was analyzed for full TCL/TAL compounds. 1,2-Dichloroethene (DCE) was detected in MW4-02 and MW4-05 at 20 ug/L and 7 ug/L, respectively, and trichloroethene (TCE) was found at 14 ug/L in MW4-05 during the first sampling round. A second and third round were analyzed for VOCs, drinking water metals, and landfill indicator parameters. VOCs such as methylene chloride and acetone, which are commonly associated with laboratory contamination, were detected in some samples. TCE at concentrations of 78 ug/L and 46 ug/L, respectively, and DCE at concentrations of 33 ug/L and 21 ug/L, respectively, exceeded the comparison regulatory standards in the sample from MW4-05 in the second and third sampling rounds. DCE at concentrations of 13 ug/L and 8 ug/L, respectively, was detected in MW4-02 during the second and third sampling rounds. Lead was detected at a concentration of 17.3 ug/L in a sample from MW4-04. Results of the landfill parameters indicated slightly elevated levels of Chemical Oxygen Demand (COD) and sulfates in the downgradient wells, MW4-02 and MW4-05, relative to the upgradient well, MW4-04.

1.3.2.3 Phase II Remedial Investigation

B&R Environmental conducted Phase II RI activities in 1995; the final report, including a human health risk assessment and ecological risk assessment, were performed for 27 sites at NWS Earle, including the four sites in OU-1, OU-2 and OU-3. Activities performed during this investigation of OU-1, OU-2, and OU-3 sites are summarized below.

Between June and October 1995, B&R Environmental conducted the following field investigation activities at Site 4:

- Sampling and analysis of groundwater samples from five hydropunch locations
- Sampling and analysis of surface water and sediment
- Drilling and installation of one shallow permanent monitoring well
- Measurement of static-water levels in the wells
- Sampling and analysis of groundwater from the newly installed well and existing wells

B&R Environmental conducted a survey to establish the horizontal locations and vertical elevations of hydropunch sample locations, surface water and sediment sample locations, surface soil sample locations, the newly installed monitoring well, and selected existing wells.

1.3.2.4 Summary of 1995 RI Results

Site 4 is an open area surrounded by woodlands. The landfill is primarily covered with a sandy soil and is not closed with an impermeable cap. Erosion of the cover is present on the eastern side of the landfill. The site is moderately vegetated with grasses and some scrub pines, although there are a few bare areas. The site is bordered by Macassar Road to the west and by an unpaved road to the north, east, and south. The ground surface slopes downward to the southeast from approximately 170 feet above Mean Sea Level (MSL) near MW4-01 to approximately 150 feet above MSL at MW4-06. Along the southeastern portion of the site, the fill face is approximately 25 feet high but tapers to the original ground surface. No seeps were encountered at the edge of the landfill. A broad, low-lying wetland extends from the eastern portion of the site beyond the unpaved boundary road. Surface water and groundwater flow is to the east and east-southeast toward the wetland, based on measured groundwater levels. A figure showing Site 4 in relation to the surroundings has been placed at the end of this section.

1.3.2.4.1 Site Geology, Hydrogeology, and Hydrology

Geology

Regional mapping places Site 4 within the outcrop area of the Cohansey Sand. The Cohansey Sand ranges between 0 and 30 feet in thickness and the soil borings are no more than 35 feet deep. The lithology of the sediments encountered in the on-site borings generally agrees with the published description of the Cohansey Sand. The thickness of the sediments penetrated in the on-site borings indicates the Cohansey Sand may have a regional thickness of greater than 30 feet. In general, the borings encountered alternating beds of light-colored, silty, fine- to coarse-grained sand with varying amounts of gravel. A 0.5-foot reddish-yellow clay seam was penetrated in one of the borings.

Hydrogeology

Groundwater in the Cohansey aquifer beneath the site occurs under unconfined conditions. Static-water-level measurements and water-table elevations were recorded in August and October 1995. Groundwater contour maps are presented in Figures 1-6 (August) and 1-7 (October). The direction of shallow groundwater flow in the aquifer, as indicated by both the August and October groundwater elevations, is toward the east and east-southeast. There does not appear to be a significant seasonal variation in groundwater flow direction.

The hydraulic conductivity calculated for MW4-04 is 4.48 x 10^{-4} cm/sec (1.27 ft/day).

1.3.2.4.2 Nature and Extent of Contamination

Sediment

One site-related sediment sample (04 SD 4B5) was collected at Site 4. Concentrations of metals in the site-related sediment sample were similar to background ranges. For organics, only nitrobenzene (66 ug/kg) was detected in the site-related sediment sample. This compound was not detected in background sediment samples. Tables 1-9 and 1-10 compare the results at background samples to samples collected at Site 4. The Site 4 sediment analyses included chemical oxygen demand (COD), chlorides, moisture, nitrates, TOC, and total phosphorus as phosphate. None of these indicator parameters exceeded the range detected in background samples to suggest any evidence of influence from the landfill on the wetlands. Figure 1-8 shows sample locations and concentrations of compounds that exceed applicable or relevant and appropriate requirements (ARARs) and other guidance to be considered (TBCs).

Groundwater

Six site-related groundwater samples (04 GW 01, 04 GW 02, and 04 GW 04 through 04 GW 07) were collected at Site 4. Concentrations of most site-related metals were similar to background levels (Table 1-11). The site-related samples showed the presence of all the metals found in background samples. Barium and zinc were detected in upgradient well sample 04 GW 01 and also in downgradient well 04 GW 05 at levels greater than background. Iron was detected in downgradient well sample 04 GW 02 at levels greater than background. Beryllium was detected at levels greater than background but near the instrument detection limit in upgradient well sample 04 GW 04 (1.6 ug/L). Results of organic analysis showed that 1,2-dichloroethene (19 ug/L to 25 ug/L) and TCE (1 ug/L to 55 ug/L) were each detected in two groundwater samples (Table 1-12). Chloroform (1 ug/L) and vinyl chloride (3 ug/L) were each detected in one groundwater sample. 04 GW 05 exhibited the highest levels of TCE, with the highest level of 1,2-DCE and vinyl chloride present in 04 GW 02. Neither of these compounds were detected in background groundwater samples (Table 1-12). Hydropunch samples indicate that VOCs had not migrated vertically in measurable quantities. The Site 4 groundwater sample analyses included

TABLE 1-9

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SEDIMENT AT SITE 4
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE BKGD CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM	3 / 3	839 - 3940	5492.67	1 / 1	1030	1030	NO	1030
ARSENIC	2 / 3	2.4 - 6.2	5.95	1 / 1	0.81	0.81	NO	0.81
BARIUM	3 / 3	3.9 - 10.6	14.07	1 / 1	10.8	10.8	NO	10.8
CALCIUM	3 / 3	179 - 518	685.33	1 / 1	334	334	NO	334
CHROMIUM	3 / 3	4.3 - 56	43.13	1 / 1	1.8	1.8	NO	1.8
COPPER	3 / 3	1.5 - 13	12.47	1 / 1	1.6	1.6	NO	1.6
IRON	3 / 3	228 - 7650	6578.67	1 / 1	1710	1710	NO	1710
LEAD	3 / 3	4.6 - 34.3	30.60	1 / 1	9.3	9.3	NO	9.3
MAGNESIUM	3 / 3	60.7 - 256	306.47	1 / 1	65.2	65.2	NO	65.2
MANGANESE	3 / 3	4.6 - 9.2	13.80	1 / 1	24.2	24.2	YES	24.2
SODIUM	3 / 3	26.6 - 116	115.27	1 / 1	50.1	50.1	NO	50.1
VANADIUM	3 / 3	5.9 - 42.7	36.93	1 / 1	3	3	NO	3
ZINC	3 / 3	14.2 - 26.9	37.33	1 / 1	4.4	4.4	NO	4.4

Note: Selected COPCs are indicated in boldface type.

TABLE 1-10
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SEDIMENT AT SITE 04
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
NITROBENZENE	NOT DETECTED	-	-	1 / 1	66	66

TABLE 1-11

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN GROUNDWATER AT SITE 4
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD?	REPRESENTATIVE CONCENTRATION
ALUMINUM*	11 / 11	287 - 7870	5097.82	6 / 6	107 - 2690	1229.67	NO	2690
BARIUM	11 / 11	2.6 - 518	229.60	6 / 6	12.6 - 961	256.17	YES	580.96
BERYLLIUM*	4 / 11	0.21 - 1.6	0.49	2 / 6	0.75 - 1.6	0.43	NO	1.6
CADMIUM*	5 / 11	0.6 - 1.9	1.21	4 / 6	0.44 - 0.84	0.49	NO	0.84
CALCIUM	11 / 11	506 - 17200	8306.55	6 / 6	506 - 55000	11841.00	YES	29314.88
CHROMIUM	NOT DETECTED	-	-	3 / 6	1.3 - 5.4	1.76	YES	3.35
COBALT	6 / 11	0.7 - 10.1	4.06	2 / 6	0.69 - 1.1	0.50	NO	0.77
COPPER*	9 / 11	0.79 - 13.5	6.53	6 / 6	1 - 18.3	5.62	NO	11.43
IRON	11 / 11	153 - 7690	4197.09	6 / 6	75.3 - 20900	5001.55	YES	11849.29
LEAD*	3 / 11	2.1 - 3	2.44	3 / 6	2.4 - 3	1.68	NO	3
MAGNESIUM	11 / 11	273 - 27400	8449.64	6 / 6	273 - 22000	4436.33	NO	11522.02
MANGANESE	11 / 11	3.3 - 65	46.18	6 / 6	12.8 - 306	69.77	YES	165.10
MERCURY	11 / 11	0.005 - 0.12	0.12	6 / 6	0.005 - 0.079	0.03	NO	0.079
NICKEL	10 / 11	0.81 - 25.5	11.98	5 / 6	1 - 4.6	2.15	NO	4.6
POTASSIUM	11 / 11	350 - 3245	2810.55	6 / 6	350 - 9080	2214.33	NO	5008.89
SODIUM	11 / 11	1850 - 11650	8449.09	6 / 6	2290 - 5210	3393.33	NO	4431.78
VANADIUM	10 / 11	0.69 - 42.25	16.48	1 / 6	7.1	1.44	NO	7.1
ZINC*	6 / 9	3.7 - 348	178.61	5 / 6	4 - 558	161.55	NO	363.17

Note: Selected COPCs are indicated in boldface type.
* - Indicates COPCs eliminated based on amended risk assessment.

TABLE 1-12
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN GROUNDWATER AT SITE 04
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

SUBSTANCE	BACKGROUND			SITE-RELATED		
	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
1,2-DICHLOROETHENE (TOTAL)	NOT DETECTED	-	-	2 / 6	19 - 25	25
CHLOROFORM	NOT DETECTED	-	-	1 / 6	1	1
TRICHLOROETHENE	NOT DETECTED	-	-	2 / 6	1 - 55	29.78
VINYL CHLORIDE	NOT DETECTED	-	-	1 / 6	3	3

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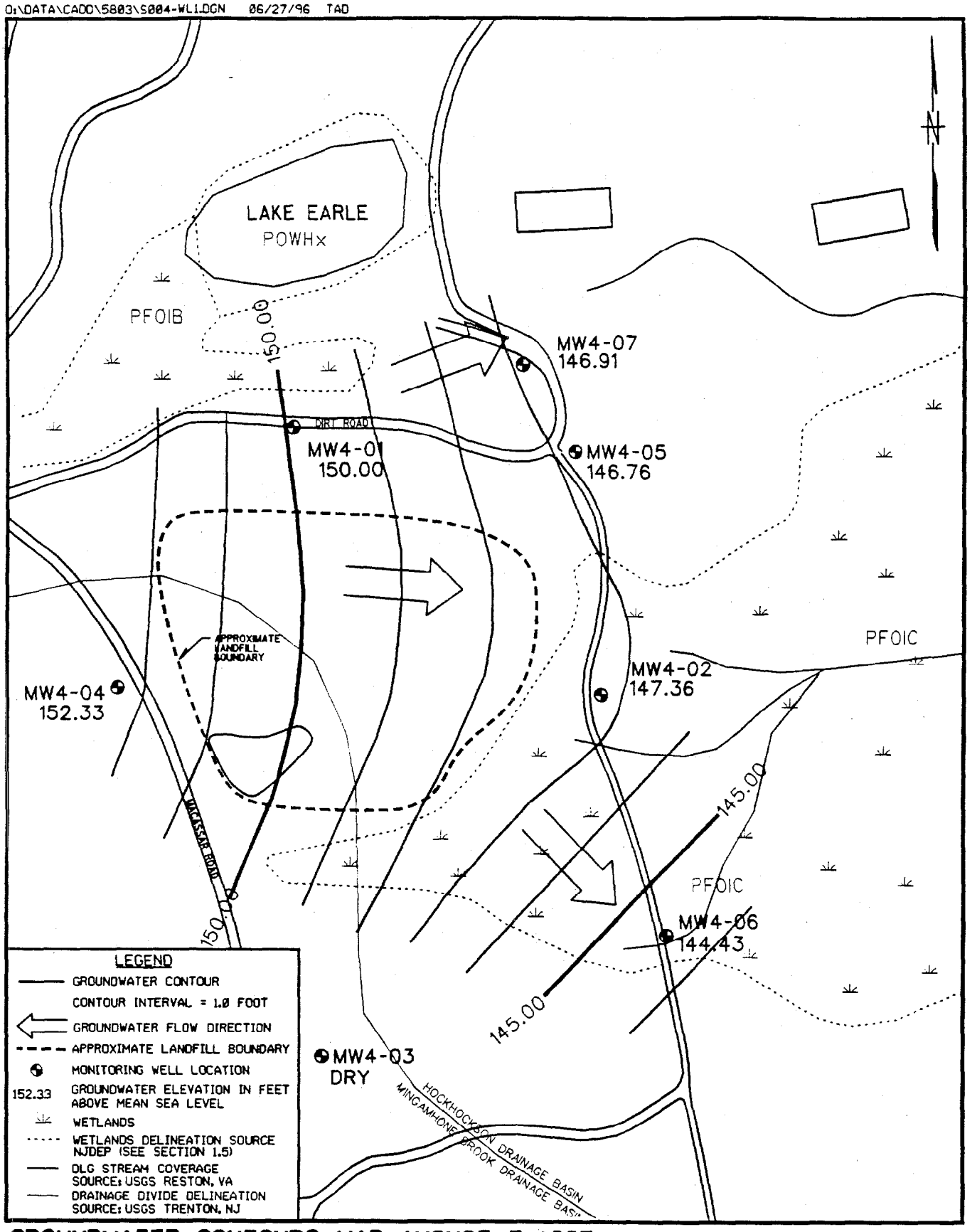

GROUNDWATER CONTOURS MAP AUGUST 7, 1995

SITE 4 - LANDFILL WEST OF "D" GROUP

FIGURE 1-6

0 200 400
SCALE IN FEET

Brown & Root Environmental

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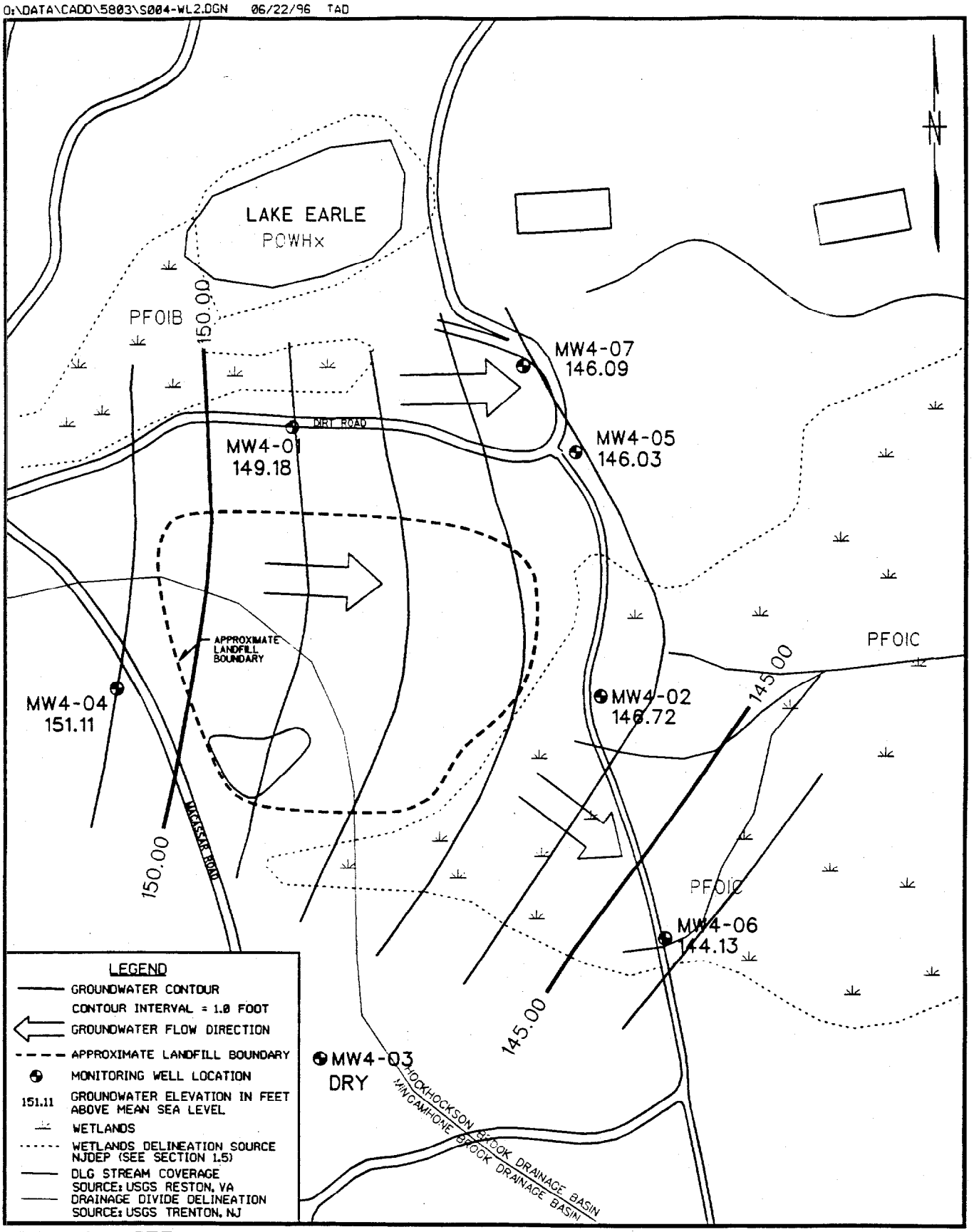

GROUNDWATER CONTOUR MAP OCTOBER 17, 1995

SITE 4 - LANDFILL WEST OF "D" GROUP

FIGURE 1-7

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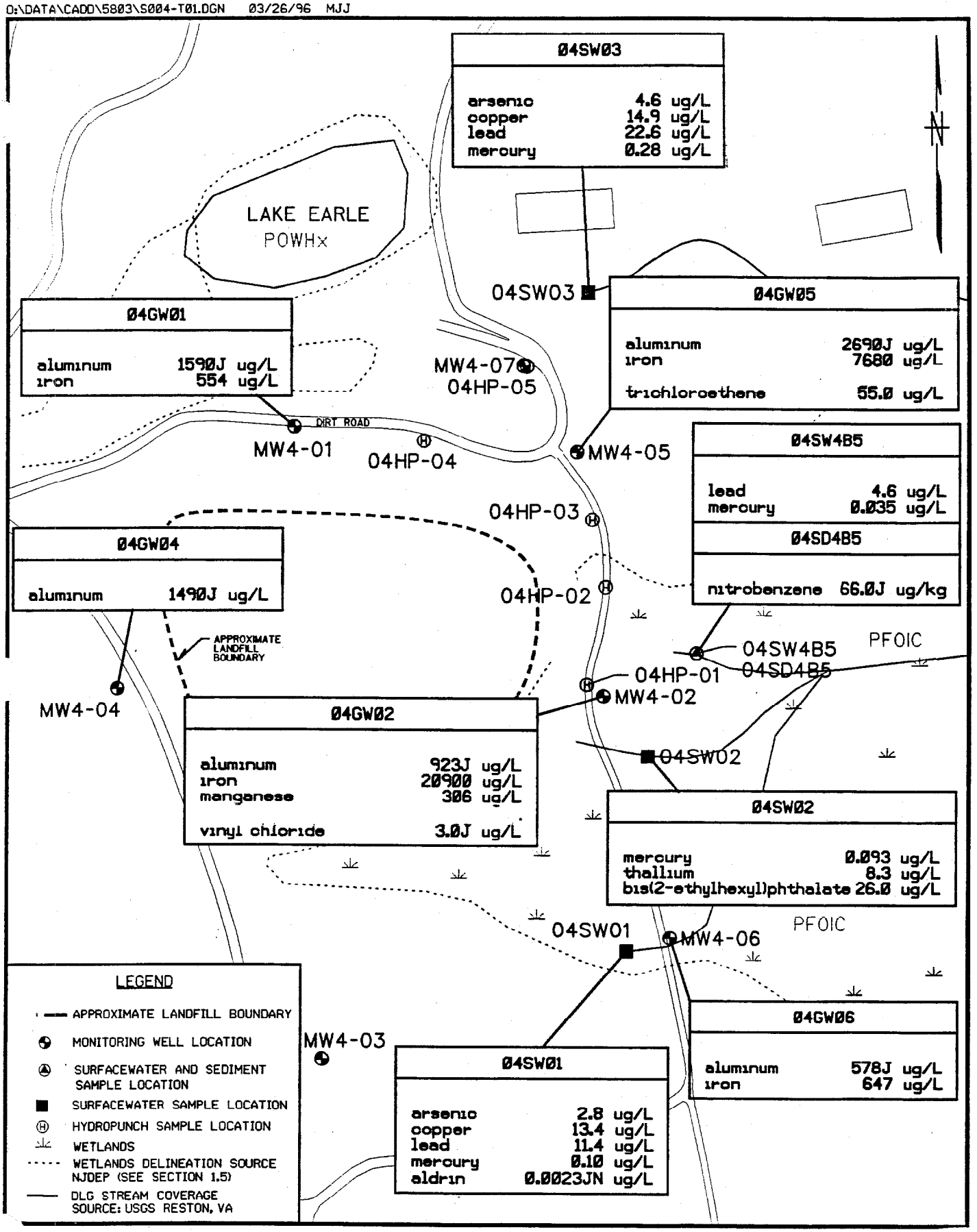

CONCENTRATIONS ABOVE SCREENING LEVELS
SITE 4 - LANDFILL WEST OF "D" GROUP

FIGURE 1-8

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ammonia nitrogen, BOD, COD, chlorides, sulfates, and TOC. Sample 04 GW 02 revealed levels of COD, sulfate, and TOC greater than those detected in upgradient sample 04 GW 04 and greater than background ranges. However, results are considerably below the concentration range associated with concentrated landfill leachate (Chian and DeWalle, 1976; Brunner and Keller, 1972; and ASCE, 1976). These findings are consistent with the generally low-level detections of these indicator parameters during the previous 1993 sampling investigation. Figure 1-8 shows sample locations and concentrations of compounds that exceed ARARs and TBCs.

Surface Water

Four site-related surface water samples (04 SW 01 through 04 SW 03 and 04 SW 4B5) were collected at Site 4. Metals detected in site-related surface water samples at concentrations notably greater than background ranges include the following: aluminum at 1,220 ug/L in 04 SW 01 and 04 SW 03; iron at 16,200 ug/L in 04 SW 02 and 9,020 ug/L in 04 SW 04; lead at 22.6 ug/L in 04 SW 03; and manganese at 383 ug/L in 04 SW 04 and 333 ug/L in 04 SW 02 (Table 1-13). Arsenic was detected in 04 SW 03 at a low level (near the instrument detection limit) but was not detected in background surface water samples (Table 1-13).

Aldrin (0.0023 ug/L), dieldrin (0.0008 ug/L), and bis(2-ethylhexyl) phthalate (26 ug/L) were each detected in a site-related surface water sample collected at Site 4. None of these compounds were detected in background surface water samples (Table 1-14).

The Site 4 surface water sample analyses included ammonia nitrogen, BOD, COD, chloride, nitrate, nitrite, sulfate, TOC, phosphate, and turbidity. Samples 04 SW 01 and 04 SW 03 had measured COD levels slightly greater than background ranges. However, these levels are in the lower end of the range associated with landfill leachate (Chian and DeWalle, 1976; Brunner and Keller, 1972; and ASCE, 1976). Figure 1-8 shows sample locations and concentrations of compounds that exceed ARARs and TBCs.

1.3.2.4.3 Contaminant Fate and Transport

Nitrobenzene was detected in one sediment sample at a low concentration. In contrast to most semivolatile compounds, nitrobenzene is considered to be water soluble and does not bind as strongly to organic matter in sediment. This compound is therefore considered fairly mobile in the environment. Sediment containing nitrobenzene may be subject to leaching to groundwater or surface water transport through erosional dispersion or leachate migration. Nitrobenzene, like other monocyclic aromatics, is considered susceptible to biodegradation in the environment. The rate of degradation depends on several factors including nutrients, oxygen, moisture, carbon source, pH, and the presence of appropriate acclimatized microorganisms.

TABLE 1-13

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SURFACE WATER AT SITE 4
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE BKGD CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM	3 / 3	265 - 409	705.33	4 / 4	193 - 1220	691.50	NO	1220
ARSENIC	NOT DETECTED	-	-	2 / 4	2.8 - 4.6	2.58	YES	4.6
BARIUM	3 / 3	16.3 - 34	53.73	4 / 4	23.2 - 52.9	35.08	NO	52.9
BERYLLIUM	2 / 3	0.22 - 0.33	0.41	2 / 4	0.22 - 0.24	0.15	NO	0.24
CALCIUM	3 / 3	462 - 10100	9128.00	4 / 4	3430 - 59500	24032.50	YES	59500
CHROMIUM	3 / 3	0.72 - 2.6	2.71	2 / 4	0.68 - 4.6	1.53	NO	3.94
COBALT	3 / 3	0.81 - 1.9	2.54	2 / 4	1 - 1.1	0.68	NO	1.1
COPPER	2 / 3	1.1 - 9.8	7.40	3 / 4	10.9 - 14.9	9.90	YES	14.9
IRON	3 / 3	160 - 702	1040.00	4 / 4	2030 - 16200	8480.00	YES	16200
LEAD	1 / 3	4.4	3.43	3 / 4	4.6 - 22.6	9.84	YES	22.6
MAGNESIUM	3 / 3	369 - 2770	2525.33	4 / 4	1060 - 15500	6665.00	YES	15500
MANGANESE	3 / 3	14 - 55.5	59.93	4 / 4	19.3 - 383	191.25	YES	383
MERCURY	2 / 3	0.023 - 0.028	0.04	4 / 4	0.035 - 0.28	0.13	YES	0.28
NICKEL	3 / 3	2.1 - 7.1	8.60	3 / 4	1 - 4.4	2.14	NO	4.4
POTASSIUM	2 / 3	251 - 1850	1482.33	4 / 4	940 - 4330	2580.00	YES	4330
SILVER	1 / 3	0.86	0.99	1 / 4	1	0.53	NO	1
SODIUM	NOT DETECTED	-	-	1 / 4	3930	3195.00	YES	3930
THALLIUM	2 / 3	3.5 - 5.5	7.00	1 / 4	8.3	3.20	NO	8.3
VANADIUM	2 / 3	0.89 - 0.9	1.32	3 / 4	1.1 - 9.7	3.23	YES	9.7
ZINC	3 / 3	7.6 - 29.4	32.67	3 / 4	17.3 - 35.4	20.38	NO	35.4

Note: Selected COPCs are indicated in boldface type.

TABLE 1-14
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SURFACE WATER AT SITE 04
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

SUBSTANCE	BACKGROUND			SITE-RELATED		
	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
ALDRIN	NOT DETECTED	-	-	1 / 1	0.0023	0.0023
BIS(2-ETHYLHEXYL)PHTHALATE	NOT DETECTED	-	-	1 / 1	26	26
DIELDRIN	NOT DETECTED	-	-	1 / 1	0.0008	0.0008

All detected organic groundwater contaminants are volatile and characteristically mobile in the environment (either through soil gas migration or groundwater transport) and may have originated at landfill source locations not identified in this investigation or from source locations that have since been depleted of these contaminants. The chlorinated ethenes detected in groundwater have been associated with degradation of PCE and TCE (Cline and Viste, 1983). 1,1-DCE and 1,2-DCE are associated with degradation of PCE and TCE (Cline and Viste, 1983) and may further degrade to vinyl chloride. Concentrations of the parent compounds (TCE and PCE) may diminish over time, depending upon the presence of contaminated source materials that could continue to leach new product into groundwater. TCE and 1,2-DCE concentrations neither increased nor decreased when the 1995 sampling results were compared to the 1993 results.

Arsenic and lead were detected at low levels in one site-related surface water sample. The presence of elevated levels of aluminum suggests that suspended solids, rather than dissolved metals, represent a significant portion of the total metals in this sample. Iron and manganese were also detected at elevated levels in two surface water samples. The corresponding sediment samples did not reveal elevated levels of metals.

1.3.2.4.4 Baseline Human Health Risk Assessment

The potential receptors considered for this site were future industrial, residential, and recreational receptors. The Reasonable Maximum Exposure (RME) cancer risk associated with the future residential (groundwater) exposure scenario was approximately 1E-04, the upper end of the target acceptable risk range. However, the RME estimate for the future residential receptor is probably overly conservative because a central tendency calculation shows that cancer risks are more likely to be within the mid-range of the target acceptable risk range of 1E-04 to 1E-06. Vinyl chloride (via ingestion of groundwater and inhalation during showering) was the major COPC that contributed to the cancer risk for this exposure scenario.

RME estimates for noncarcinogenic Hazard Indices (HIs) associated with the future residential (groundwater) exposure scenario exceeded 1.0, the cutoff point below which adverse noncarcinogenic effects are not expected to occur. Iron and barium (both via ingestion of groundwater) were the Chemicals of Potential Concern (COPCs) that exceeded 1.0 or contributed to the HI exceeding 1.0 for this exposure scenario. Central tendency risk estimates for residential exposure to groundwater yielded also yielded HIs greater than 1.0 for the same target organs and COPCs.

Lead groundwater concentrations at the site were below EPA guidelines. These lead concentrations are not expected to be associated with significant increases in blood-lead levels based on the results of the IEUBK Lead Model (v. 0.99). Lead surface water concentrations were greater than the guideline range; however, this would not adversely affect the future recreational receptor exposed to surface water because of very low ingestion rates.

1.3.2.4.5 Ecological Risk Assessment

The ecological risk assessment concluded that contaminants do not appear to be significantly migrating to surface water and sediment in the wetlands via overland runoff and/or groundwater to surface water discharge at a level of ecological concern. Significant contaminant inputs from future discharge are unlikely since the landfill has been inactive since 1960 and any effects of discharge would most likely have already occurred. Contaminant inputs to Lake Earle are not considered likely since surface drainage and groundwater do not flow toward the lake.

1.3.3 Site 5

1.3.3.1 Initial Assessment and Confirmation Study

The 1983 IAS consisted of interviews and on-site observations. Based on the potential for groundwater impacts and the documented disposal of industrial wastes, the site was recommended for a confirmation study. In 1986, four monitoring wells were installed and sampled at the site. No surface seeps were encountered at the edge of the landfill.

1.3.3.2 Phase I Remedial Investigation

During the 1993 Weston RI/FS, four test pits were excavated and four additional monitoring wells were installed. The test pits were excavated to characterize the wastes that had been disposed at the site. A layer of trash, ranging in thickness from 6 to 13 feet, was encountered in all four test pits. The trash consisted of foam rubber, glass, paper, plastic, metal scrap materials, lumber, concrete, bricks, and other construction debris. The cover material was thin to non-existent. Groundwater was not encountered in the test pits. No surface seeps were encountered at the edge of the landfill. Elevated organic vapor readings (HNu) were detected in one of the four test pits (TP5-1). Two soil samples were analyzed for full TCL/TAL analytes. Test pit TP5-1 showed chromium (117 mg/kg), toluene (22 ug/kg), and xylene (12 ug/kg). Several volatile and semivolatile compounds were detected below detection limits. No pesticides or PCBs were detected.

Groundwater samples were collected from all SI and RI/FS wells during the 1993 RI/FS and analyzed for TCL/TAL analytes, cyanide, and landfill indicator parameters. No surface seeps were encountered at the edge of the landfill. Chloroform was detected in samples from wells MW5-04 and MW5-08 (an upgradient well). Beryllium, chromium, cadmium, and, to a lesser extent, lead, were detected in samples from several wells. Lead and chromium levels were highest in the sample from MW5-06. VOCs, including DCE, TCE, and benzene, were also detected in the sample from MW5-06. Results of samples analyzed for landfill

parameters indicated elevated levels of sulfate. No distinction was made between the upgradient well (MW5-08) and downgradient wells for other landfill parameters.

1.3.3.3 Phase II Remedial Investigation

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

- Sampling and analysis of groundwater samples from seven hydropunch locations
- Sampling and analysis of groundwater from eight existing monitoring wells
- Measurement of static-water levels in the wells

A survey was conducted to establish the horizontal locations and vertical elevations of the hydropunch sample locations and selected existing wells.

1.3.3.4 Summary of Results

Site 5 is characterized as an open area moderately vegetated with grasses and scrub pines and surrounded by woodlands. A narrow forested wetland is located to the west of the railroad tracks. Loose silty sand (ranging in thickness from 1.5 feet to greater than 3 feet) from the surrounding area was used as the cover material. An impermeable cap was not used for closure. Railroad tracks run south of the southwestern boundary of the landfill and the wetland is located to the west of the landfill between the dirt access road and the railroad tracks. Topography across the site slopes gently to the southwest from approximately 115 feet to 105 feet above MSL. Groundwater flow is generally to the northeast (at a slight gradient), based on measured groundwater levels.

1.3.3.4.1 Site Geology, Hydrogeology, and Hydrology

Geology

Regional mapping places Site 5 within the outcrop area of the Kirkwood Formation. The Kirkwood Formation ranges between 60 and 100 feet in thickness. The lithology of the soils encountered in the on-site borings generally agrees with the published descriptions of the Kirkwood and Vincentown Formations. The on-site borings were no greater than 55 feet deep. Assuming a portion of the Kirkwood Formation was removed by erosion, it is possible that at least one of the soil borings penetrated the underlying Vincentown Formation. In general, the borings encountered brown and gray, very fine- to medium-grained sand and dark-colored silt (probably representative of the Kirkwood Formation) and olive and olive brown, slightly glauconitic, fine- to coarse-grained sand (probably representative of the Vincentown Formation). The Mainside area is located

above the updip limit of the Piney Point, Shark River, and Manasquan Formations; therefore, the glauconitic sand is interpreted to be part of the Vincentown Formation.

Hydrogeology

Based upon the boring log descriptions, well MW5-06 penetrated the Kirkwood Formation, wells MW5-02, MW5-03, MW5-05, MW5-07, and MW5-08 penetrated both the Kirkwood and Vincentown Formations, and wells MW5-01 and MW5-4 penetrated the Vincentown Formation.

Groundwater in the Kirkwood and Vincentown aquifer beneath the site occurs under unconfined conditions and the formations are interpreted to be hydraulically interconnected. Groundwater contour maps are presented in Figures 1-9 (August 1995 levels) and 1-10 (October 1995 levels). The direction of shallow groundwater flow in the aquifer is toward the northeast. There does not appear to be a significant seasonal variation in groundwater flow direction. The hydraulic conductivity's calculated for MW5-02 (Kirkwood and Vincentown Formation), MW5-06 (Kirkwood Formation), and MW5-07 (Vincentown Formation) are 3.18 x 10^{-4} cm/sec (0.90 ft/day), 6.46 x 10^{-4} cm/sec (1.83 ft/day), and 2.08 x 10^{-4} cm/sec (0.59 ft/day), respectively.

Hydrology

A small drainage ditch is located approximately 100 feet west of the dirt road that borders the western edge of the site, and water is present in the ditch only after periods of heavy rainfall. The closest surface water is a tributary of Hockhockson Brook, located approximately 1,000 feet east of Site 5. The site is located on the border of the Hockhockson Brook and Pine Brook watersheds. The topography of the site is flat, inhibiting off-site runoff; therefore, precipitation perches and infiltrates on the site. No surface seeps exist at the landfill.

1.3.3.4.2 Nature and Extent of Contamination

Eight site-related groundwater samples (05 GW 01 through 05 GW 08) were collected at Site 5. Figure 1-11 shows sample locations and concentrations of compounds that exceed ARARs and TBCs. Seven hydropunch samples were also taken as a screening tool to determine if existing groundwater monitoring wells were sufficient to characterize lateral extent of groundwater contamination.

Inorganics

Aluminum, cadmium, and cobalt were detected in sample 05 GW 07 at levels greater than background (Table 1-15). Iron and cadmium were also detected at levels greater than background in 05 GW 06, and aluminum was detected at levels greater than background in 05 GW 02. Beryllium was detected at levels greater than background but near the instrument detection limit in sample 05 GW 07 (1.6 ug/L).

TABLE 1-15

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN GROUNDWATER AT SITE 5
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD?	REPRESENTATIVE CONCENTRATION
ALUMINUM	11 / 11	287 - 7870	5097.82	8 / 8	468 - 42000	7829.38	YES	17212.11
ARSENIC	1 / 11	5.8 - 5.8	4.05	1 / 8	5.3	2.11	NO	2.94
BARIUM	11 / 11	2.6 - 518	229.60	8 / 8	11 - 65.5	30.83	NO	55.31
BERYLLIUM*	4 / 11	0.21 - 1.6	0.49	4 / 8	0.22 - 1.1	0.33	NO	0.60
CADMIUM	5 / 11	0.6 - 1.9	1.21	7 / 8	0.51 - 7.5	2.46	YES	4.51
CALCIUM	11 / 11	506 - 17200	8306.55	8 / 8	855 - 10300	3893.13	NO	10300
CHROMIUM	NOT DETECTED	-	-	8 / 8	4.7 - 33.4	11.34	YES	17.93
COBALT	6 / 11	0.7 - 10.1	4.06	5 / 8	3.8 - 29.6	7.84	YES	14.58
COPPER*	9 / 11	0.79 - 13.5	6.53	5 / 8	0.98 - 2	0.93	NO	1.79
IRON	11 / 11	153 - 7690	4197.09	8 / 8	331 - 59200	10316.75	YES	23714.16
LEAD	3 / 11	2.1 - 3	2.44	3 / 8	1.6 - 2.1	1.17	NO	1.78
MAGNESIUM	11 / 11	273 - 27400	8449.64	8 / 8	1170 - 6720	2792.50	NO	5497.59
MANGANESE	11 / 11	3.3 - 65	46.18	8 / 8	12.7 - 302	100.51	YES	302
MERCURY*	11 / 11	0.005 - 0.12	0.12	8 / 8	0.012 - 0.13	0.07	NO	0.13
NICKEL	10 / 11	0.81 - 25.5	11.98	7 / 8	2.6 - 102	25.68	YES	47.62
POTASSIUM	11 / 11	350 - 3245	2810.55	8 / 8	945 - 2850	1753.13	NO	2497.07
SODIUM	11 / 11	1850 - 11650	8449.09	8 / 8	3920 - 33300	8970.00	YES	15693.76
THALLIUM*	3 / 11	4 - 5.1	5.15	3 / 8	3.9 - 5.6	2.95	NO	4.75
VANADIUM	10 / 11	0.69 - 42.25	16.48	7 / 8	1.2 - 10.8	4.54	NO	10.80

Note: Selected COPCs are indicated in boldface type.
* - Indicates COPCs eliminated based on amended risk assessment.

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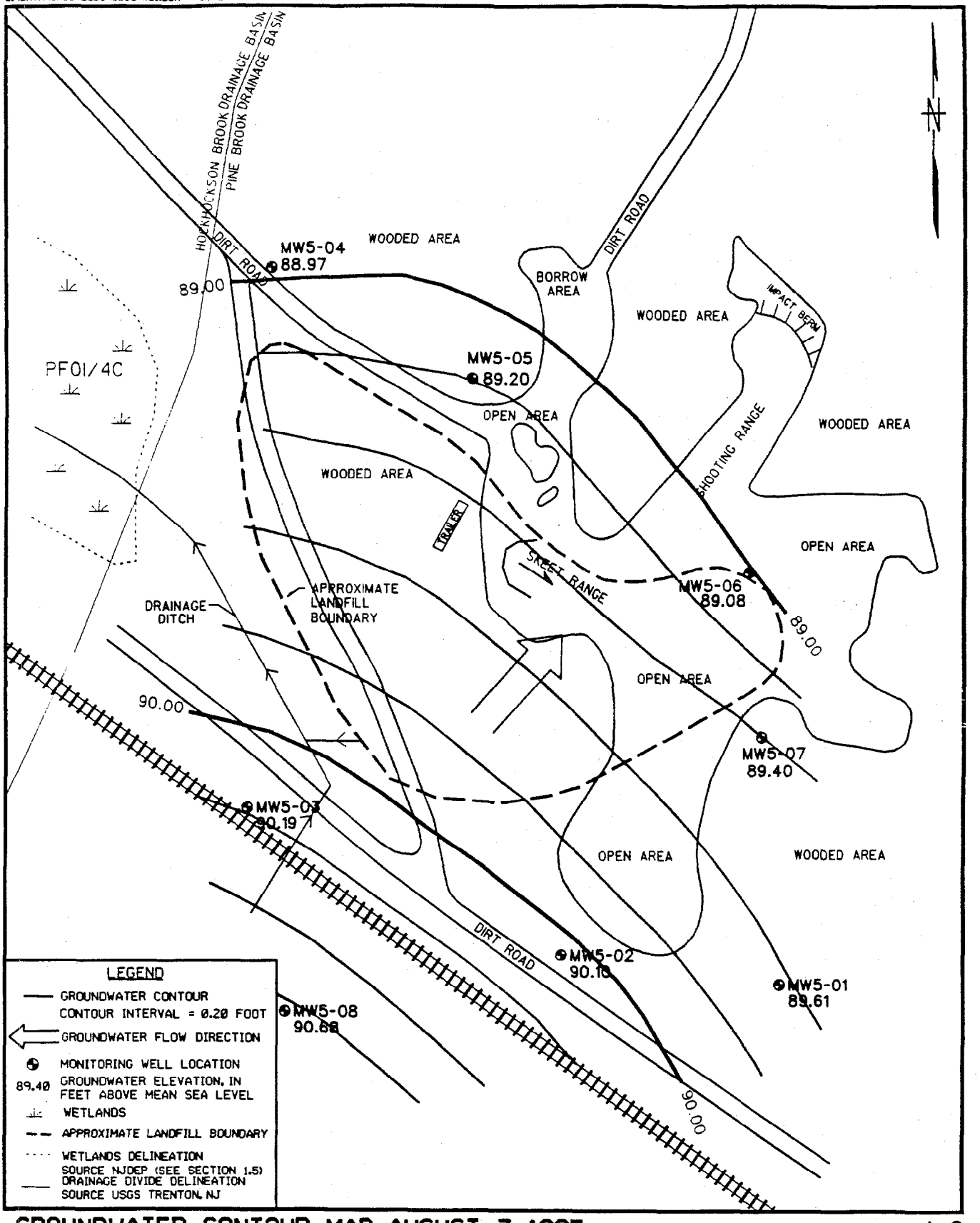

GROUNDWATER CONTOUR MAP AUGUST 7, 1995

SITE 5 - LANDFILL WEST OF ARMY BARRICADES

FIGURE 1-9

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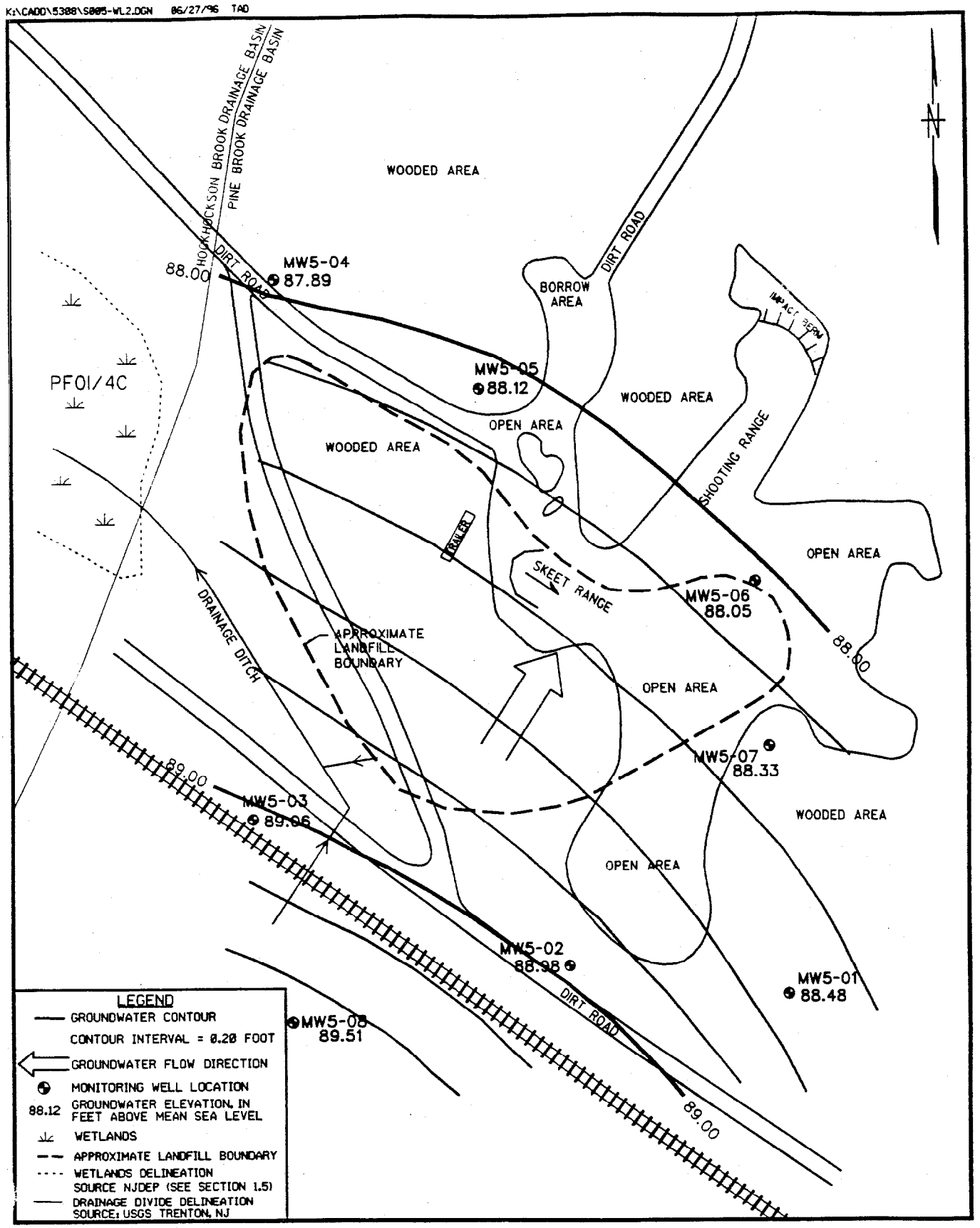

GROUNDWATER CONTOUR MAP OCTOBER 17, 1995

SITE 5 - LANDFILL WEST OF ARMY BARRICADES

FIGURE 1-10

0 150 300

SCALE IN FEET

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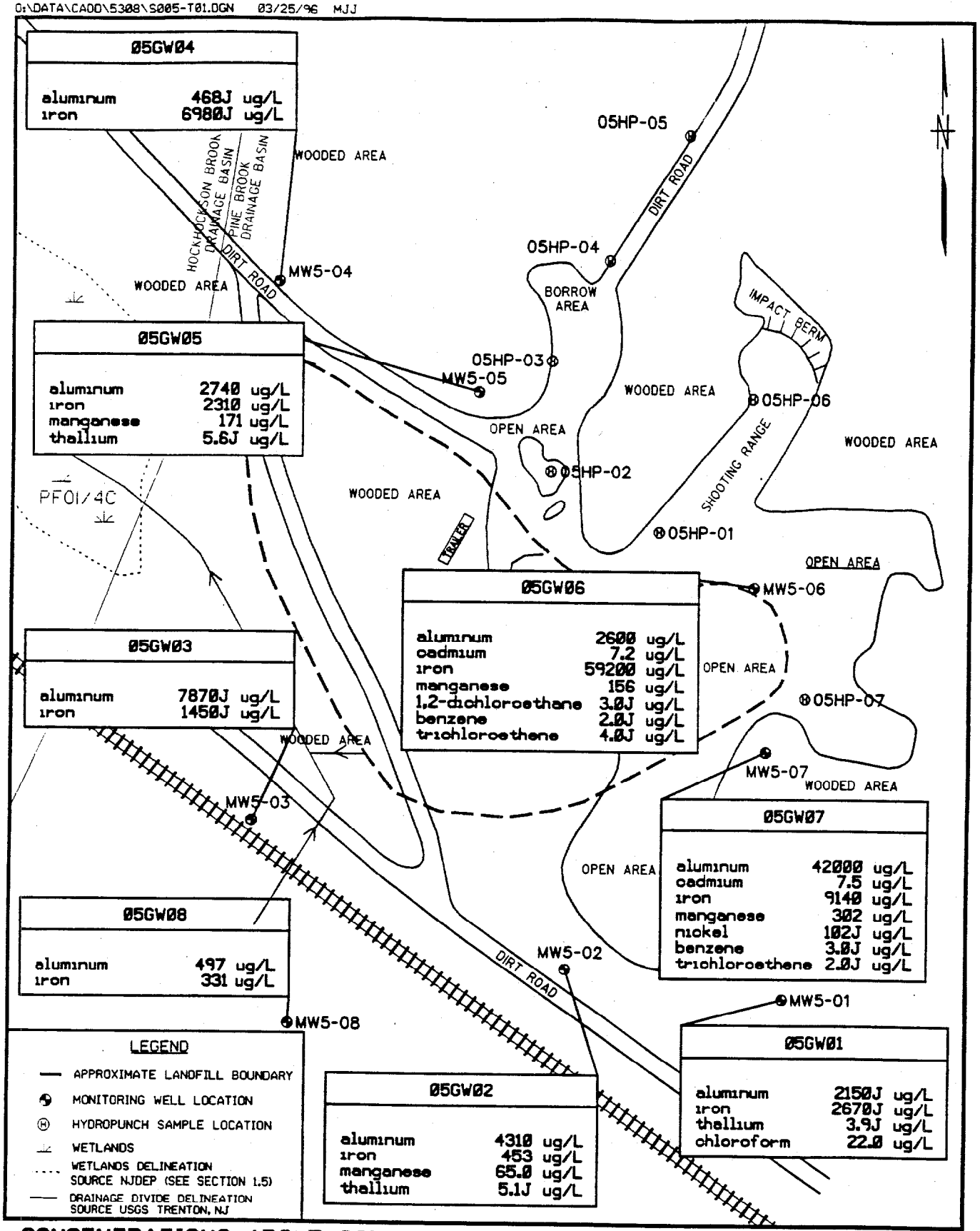

CONCENTRATIONS ABOVE SCREENING LEVLES

SITE 5 - LANDFILL WEST OF ARMY BARRICADES

FIGURE 1-11

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Thallium was detected at low levels in 05 GW 01 and 05 GW 02 but was not found in background samples.

Organics

1,2-DCA (2 ug/L to 3 ug/L), 1,2-DCE (2 ug/L to 9 ug/L), TCE (2 ug/L to 4 ug/L), and benzene (2 ug/L to 3 ug/L) were each detected in two groundwater samples collected (Table 1-16) at Site 5 (05 GW 06 and 06 GW 07). Sample 05 GW 06 also contained low levels of ethylbenzene (2 ug/L), xylenes (4 ug/L), methylene chloride (2 ug/L), and xylene (4 ug/L). Vinyl chloride (2 ug/L) was detected in the sample from 05 GW 05 and chloroform was detected at 22 ug/L in the sample from 05 GW 01. Low levels of volatile organics (xylene, ethybenzene, benzene, and 1,2-DCE) in the hydropunch samples generally confirm the presence of these VOCs, but the data quality of these hydropunch results does not allow their use in human health risk assessment. Hydropunch samples were used only for screening purposes, to guide additional well placement.

Miscellaneous Parameters

The Site 5 groundwater analyses consisted of BOD, COD, chlorides, sulfates, TOC, phosphates, and turbidity. Sulfate was detected in MW5-06 (downgradient) and MW5-07 (crossgradient and adjacent to the landfill) at concentrations greater than those found in upgradient wells MW5-03 and MW5-06 and greater than background groundwater levels. MW5-07 slightly exceeded the Secondary Maximum Contaminant Level (SMCL) for sulfate. These data confirm the presence of elevated sulfate levels also found during the previous 1993 sampling investigation. Other indicator parameters (BOD, COD, and TOC) were also present at slightly greater levels in downgradient versus upgradient wells; however, results are below the range associated with concentrated landfill leachate (Chian and DeWalle, 1976; ASCE, 1976; Brunner and Keller, 1972).

1.3.3.4.3 Contaminant Fate and Transport

VOCs and several inorganics were present in Site 5 groundwater samples. No soil samples were collected at the site during the 1995 RI. The chlorinated ethenes detected in groundwater have been associated with degradation of PCE and TCE (Cline and Viste, 1983). Several chlorinated ethenes (1,2-DCA, 1,2-DCE, TCE, and vinyl chloride), benzene, and other volatile aromatics were detected at low levels in groundwater downgradient of the landfill. All detected volatile organic groundwater contaminants exhibit relatively high solubility's, vapor pressure, and air-water partition coefficients (Henry's law constant). These compounds are characteristically mobile in the environment (either through soil gas migration or groundwater transport). Inorganics detected in the groundwater at levels above background were aluminum, arsenic, beryllium, cadmium, cobalt, and thallium.

TABLE 1-16
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN GROUNDWATER AT SITE 5
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

SUBSTANCE	BACKGROUND			SITE-RELATED		
	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
1,2-DICHLOROETHANE	NOT DETECTED	-	-	2 / 8	2 - 3	3
1,2-DICHLOROETHENE (TOTAL)	NOT DETECTED	-	-	2 / 8	2 - 9	7.34
BENZENE	NOT DETECTED	-	-	2 / 8	2 - 3	3
CHLOROFORM	NOT DETECTED	-	-	1 / 8	22	11.09
ETHYLBENZENE	NOT DETECTED	-	-	1 / 8	2	2
METHYLENE CHLORIDE	NOT DETECTED	-	-	1 / 8	2	2
TRICHLOROETHENE	NOT DETECTED	-	-	2 / 8	2 - 4	4
VINYL CHLORIDE	NOT DETECTED	-	-	1 / 8	2	2
XYLENE (TOTAL)	NOT DETECTED	-	-	1 / 8	4	4

For the classes of detected chemicals, environmental persistence varies considerably. Vinyl chloride and 1,2-DCE are associated with degradation of PCE and TCE (Cline and Viste, 1983). Concentrations of the parent compounds (TCE and PCE) may diminish over time, depending upon the presence of source materials that could continue to leach product into groundwater. Benzene and related alkyl-substituted aromatics are also considered susceptible to biodegradation in the environment.

1.3.3.4.4 Baseline Human Health Risk Assessment

The potential receptors considered for this site were future industrial receptors and residential receptors. The RME cancer risk associated with the future residential (groundwater) exposure scenario is greater than 1E-04, the upper end of the target acceptable risk range. Vinyl chloride (via ingestion of groundwater and inhalation during showering) and arsenic (via ingestion of groundwater) are the principal COPCs that contribute to this cancer risk. However, the RME estimate for the future residential receptor is probably overly conservative because a central tendency calculation shows that cancer risks are more likely to be within the mid-range of the target acceptable risk range of 1E-04 to 1E-06.

Noncarcinogenic Hazard Quotients (HQs) associated with the future residential (groundwater) exposure scenario exceeded 1.0, the cutoff point below which adverse noncarcinogenic effects are not expected to occur. Iron is the COPC that exceeded 1.0 for this exposure scenario. In addition, central tendency risk estimates for residential exposure to groundwater yielded HIs greater than 1.0 for the liver and digestive systems as target organs.

Lead groundwater concentrations at the site were below the EPA action level for public water supplies 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).

1.3.3.4.5 Ecological Risk Assessment

Some bare areas are present on the 5-acre inactive landfill, but the majority of the site is dominated by young pitch pines. Upland habitats surround most of the site and are dominated by mature white oak, chestnut oak, and mountain laurel. Soils in these areas are classified as Lakewood sand. A narrow forested wetland is located to the west, along the railroad tracks. Vegetation in the forested wetland is dominated by red maple and blackgum, and standing water in the wetland is rarely present. A small drainage ditch is located approximately 100 feet west of the dirt road that borders the western edge of the site, and water is present in the ditch only after periods of heavy rainfall. The closest surface water is a tributary of Hockhockson Brook, located approximately 1,000 feet east of Site 5. The site is located on the border of the Hockhockson Brook and Pine Brook watersheds. The topography of the site is flat, inhibiting off-site runoff; therefore, precipitation perches and infiltrates on the site.

The landfill provides fair terrestrial habitat, and the adjacent uplands and wetlands provide excellent habitat, mainly for terrestrial ecological receptors. Most species of mammals and birds found in the Mainside area are expected to utilize these areas, and the border of the site provides an "edge effect" that may attract a wide variety of terrestrial receptors. No sensitive habitats, other than the wetland, and no threatened or endangered species are known to be present on or around the site.

The major potential contaminant release pathway from the landfill is overland runoff. Precipitation runoff may carry constituents to nearby areas, but the flat nature of the site precludes significant overland migration to off-site areas, including the wetlands. Infiltrating precipitation may cause the contamination of subsurface soil and groundwater. Groundwater to surface water contaminant migration is limited since no surface water is present near the site and groundwater flows away from the wetlands and drainage ditch.

Some VOCs, SVOCs, and metals were detected in groundwater samples collected during 1993 RI/FS activities. Several metals and VOCs were detected in 1995 RI groundwater samples. Groundwater flows to the northeast, away from the wetland area. Data from two soil samples taken from 1993 RI/FS test pit samples were used for quantitative assessment. HQs for inorganics and organics in soils were indicative of low potential risk, with the exception of chromium. This metal was not detected significantly above background, and the elevated HQ is most likely due to the only Ecotoxicity Threshold value (ET) that was available for chromium; this ET is heavily conservative. Beryllium was conservatively retained as a final COPC since no suitable ET was available, but this metal was not detected significantly above background. HQs for terrestrial plants from exposure to contaminated surface soils were indicative of low potential risk, except for aluminum, chromium, and vanadium. Nonetheless, aluminum was lower than background, and chromium and vanadium were not detected significantly above background. Moreover, the only ETs available for these metal were heavily conservative. No ET was available for selenium, but selenium was only detected in one sample at a relatively low concentration. No terrestrial plant ETs were available for organics, but concentrations were low for all organics detected, and plants do not translocate most organics significantly.

In summary, off-site migration of contaminants to the surrounding wetland areas, upland areas, and Hockhockson Brook or Pine Brook watersheds via overland runoff of groundwater to surface water migration is limited. HQ values for some metals detected were moderately high but are mitigated by several factors. In addition, some cover material has been placed on the landfill, limiting potential exposure to soil contaminants. Extensive vegetation is present on the site and no signs of plant stress are evident. For these reasons, potential risks to ecological receptors at Site 5 are low.

1.3.4 Site 19

1.3.4.1 Initial Assessment and Confirmation Study

The 1983 IAS, which consisted of interviews and observations, concluded that significant paint-wastes disposal to surface soil occurred over approximately 10 years. The site was not recommended for confirmation study because it was believed that impacted soils were removed for construction of new barricade facilities in the early 1970s.

During the 1993 SI, three monitoring wells were installed, and soil, sediment, surface water, and groundwater samples were analyzed. Cadmium, lead, and zinc were detected at elevated concentrations in soil. The upgradient well contained a detectable level of cadmium.

1.3.4.2 Phase I Remedial Investigation

During the 1993 Weston RI/FS, 24 surface soil samples were collected. Four surface soil samples were analyzed for TAL inorganics, and 20 were analyzed for cadmium and lead. Four shallow soil boring samples were collected from the drainageway exiting the site and were analyzed for VOCs and TPH. Thirteen sediment samples were collected from the depression and adjoining drainage swale and analyzed for TAL inorganics. Low levels of volatiles and metals were detected in surface soil samples. Elevated levels of metals were detected in sediments at levels above regulatory guidelines, most notably from samples taken within the depression and drainage swale.

Three additional monitoring wells were also installed to further characterize groundwater conditions. Groundwater samples were collected from all six monitoring wells on site and analyzed for TCL organics and TAL inorganics. Samples from MW19-02 and MW19-06 were also analyzed for explosives. Two volatile compounds, methylene chloride and acetone, were detected in almost all samples and in blanks. These detections are likely due to laboratory/field contamination. DDE and DDT were detected in a sample from MW19-02 from one sampling round (of three). These compounds were not undetected in samples from later rounds. Metals were detected at all monitoring wells. Chromium, lead, and antimony exceeded primary drinking water standards.

It was clear from the Phase I RI results of surface soil/sediments in the process discharge settling basin (where paint wastes were disposed) and in the drainage ditch emptying from it that concentrations of metals, notably lead, were above regulatory levels and would require removal. The Phase II RI was implemented to determine the outer extent of contamination to facilitate planning for removal.

1.3.4.3 Phase II Remedial Investigation

Between June and October 1995, B&R Environmental conducted the following field investigation activities at Site 19:

- Sampling and analysis of surface water
- Sampling and analysis of sediment
- Sampling and analysis of surface and subsurface soil
- Drilling and installation of one shallow permanent monitoring well
- Sampling and analysis of groundwater from the newly installed well and existing wells
- Measurement of static-water levels in the wells

B&R Environmental conducted a survey to establish the horizontal locations and vertical elevations of the surface water and sediment sample locations, surface and subsurface soil sample locations, and the newly installed and selected existing monitoring wells.

1.3.4.4 Summary of Results

Site 19 is an ordnance maintenance area where paint chips and paint sludge were discharged to a topographic depression near Building S-34. The site was in operation from the early 1940s until the early 1960s. Paint slurries and solvent residues were discharged into the open drainage swale. During construction at the site, a significant portion of the contaminated material may have been removed. The site is a 300-foot circular area that is surrounded by woodlands. Half the site, from Building S-34 south to the site perimeter, is paved. The remainder has a gravel surface. The depression that received the sludge discharge is approximately 50 feet in diameter and 5 to 10 feet deep and is located in the center of the site, south of a barricade. A small drainage ditch runs from the depression to the west, toward a wetlands area. General groundwater flow direction is toward the west.

1.3.4.4.1 Site Geology, Hydrogeology, and Hydrology

Geology

Regional mapping places Site 19 within the outcrop area of the Kirkwood Formation. The Kirkwood Formation ranges between 60 and 100 feet in thickness. The 1995 soil borings are no more than 25 feet deep. The lithology of the sediments encountered in the on-site soil borings generally agrees with the published descriptions of the Kirkwood and Vincentown Formations. Assuming a portion of the Kirkwood Formation was removed by erosion, it is possible that the soil borings penetrated the underlying Vincentown Formation. In general, the borings encountered brown and yellowish-brown, fine- to medium-grained sand, silty sand, sandy silt, and silt (probably representative of the Kirkwood Formation) and glauconitic, fine- to

medium-grained sand (probably representative of the Vincentown Formation). Mainside is located above the up-dip limit of the Piney Point, Shark River, and Manasquan Formations; therefore, the glauconitic sand is interpreted to be part of the Vincentown Formation. Based upon the boring log descriptions, the wells penetrated the Kirkwood and Vincentown Formations.

Hydrogeology

Groundwater in the Kirkwood and Vincentown aquifer beneath the site occurs under unconfined conditions and the formations are interpreted to be hydraulically interconnected. Groundwater contour maps are presented in Figures 1-12 (August 1995 levels) and 1-13 (October 1995 levels). The direction of shallow groundwater flow in the aquifer, as indicated by both the August and October 1995 groundwater measurements, is toward the west. There does not appear to be significant seasonal variation in groundwater flow direction.

Based on boring log descriptions, the wells are screened across the contact between the Kirkwood and Vincentown Formations. The hydraulic conductivities calculated for MW19-04 and MW19-05 are 6.91×10^{-4} cm/sec (1.96 ft/day) and 1.06×10^{-3} cm/sec (3.00 ft/day), respectively.

Hydrology

A small drainage ditch runs from the depression to a stream approximately 500 feet to the southwest. The site is at a higher elevation than the stream. The stream is a tributary of Mingamahone Brook, and as a result, the site is located within the Mingamahone Brook watershed. Water is present in the drainage depression only after periods of heavy rainfall. The stream southwest of the site is surrounded by wetlands. The wetlands, including the stream, drain to the south. The stream is dammed near the power lines west of the site, which has created a small pond north of the dam.

1.3.4.4.2 Nature and Extent of Contamination

Nine site-related subsurface soil samples (19 SB 01-00 through 19 SB 04-00, 19 SB 01-03 through 19 SB 04-03, and 19 SB 05-02) were collected at Site 19 (Table 1-17 and 1-18). Figure 1-14 shows sample locations and concentrations of compounds that exceed ARARs and TBCs.

Sediment

One site-related sediment sample (19 SD 01) was collected at Site 19. The sample exhibited total chromium at a level seven times the upper range of background samples (Table 1-19). Aluminum, iron, manganese, and vanadium were detected at levels slightly greater than background (Table 1-19).

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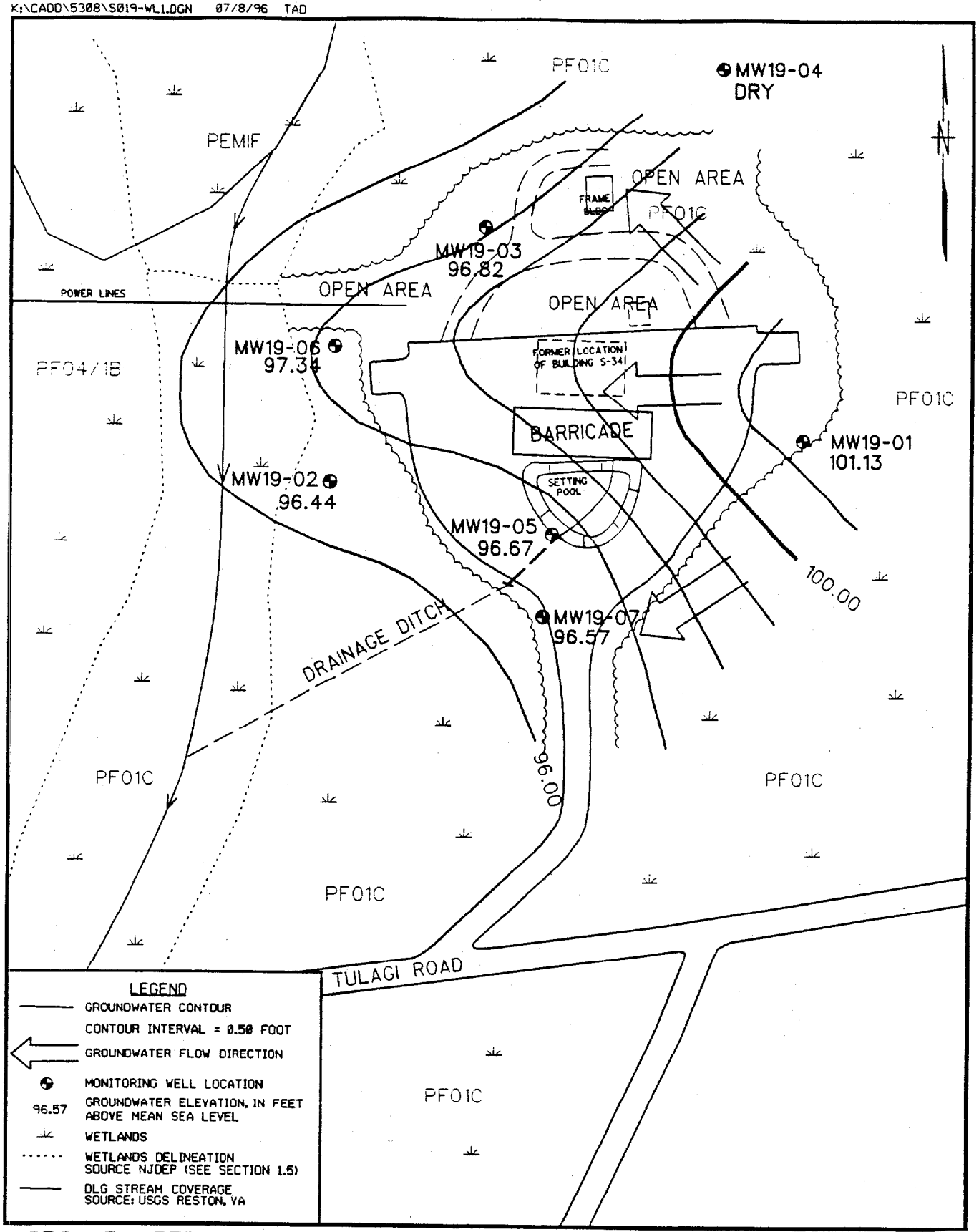

GROUNDWATER CONTOUR MAP AUGUST 7, 1995

SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA

FIGURE 1-12

0 100 200

SCALE IN FEET

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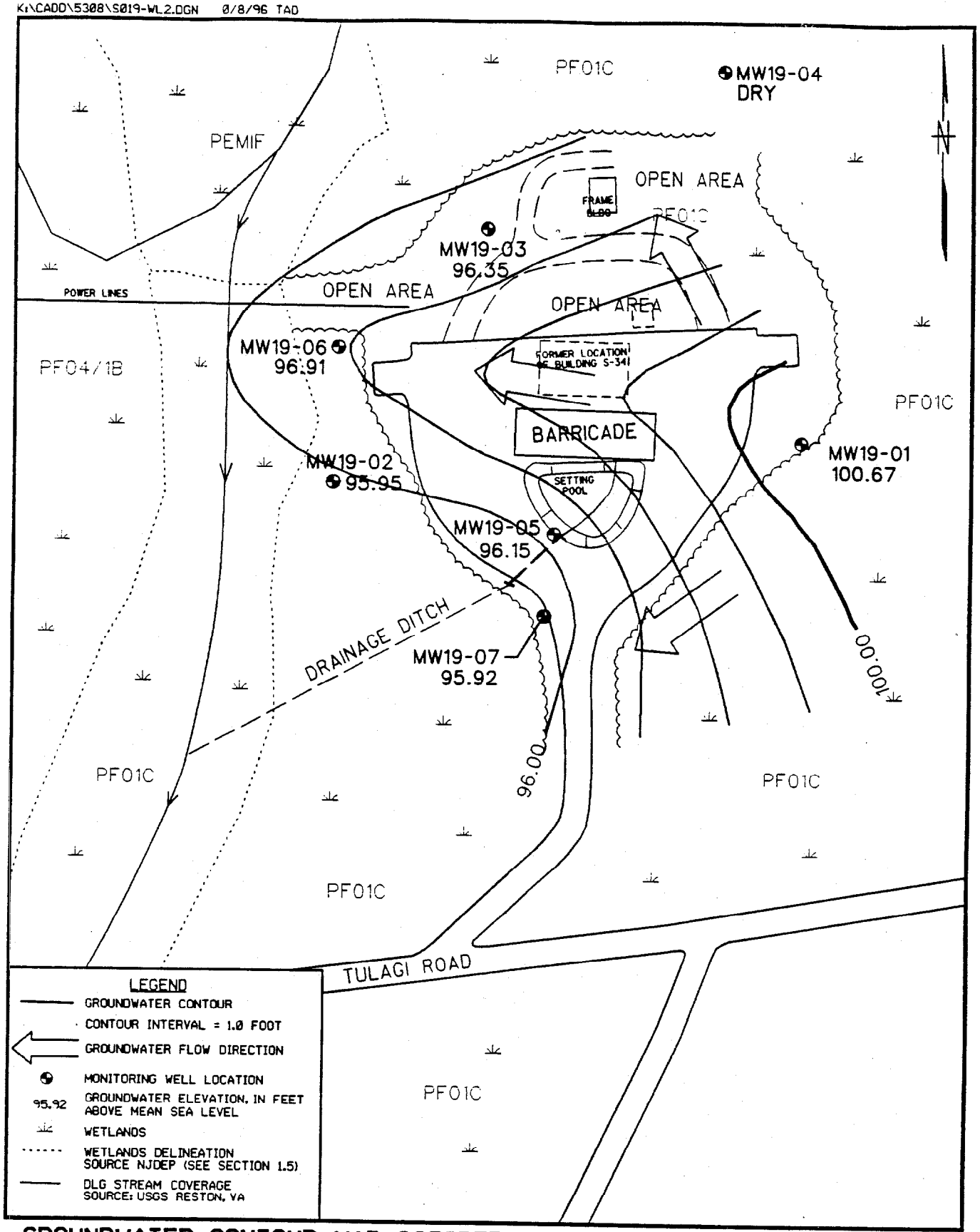

GROUNDWATER CONTOUR MAP OCTOBER 17, 1995

SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA

FIGURE 1-13

0 100 200

SCALE IN FEET

Brown & Root Environmental

TABLE 1-17

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SUBSURFACE SOILS AT SITE 19
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE BKGD CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM	8 / 8	675 - 5310	5370.00	9 / 9	562 - 3610	1551.89	NO	2496.73
ANTIMONY	NOT DETECTED	-	-	2 / 9	0.7 - 32.15	3.87	YES	10.44
ARSENIC	8 / 8	1.35 - 14.4	13.29	7 / 9	0.66 - 5.05	1.49	NO	2.43
BARIUM	8 / 8	0.92 - 31	17.92	9 / 9	3.3 - 303	122.39	YES	303
BERYLLIUM*	2 / 8	0.12 - 0.28	0.28	9 / 9	0.12 - 0.245	0.16	NO	0.19
CADMIUM	1 / 8	0.57	0.58	9 / 9	0.052 - 5.9	0.73	YES	1.93
CALCIUM	8 / 8	28.6 - 799	577.55	9 / 9	68.6 - 532	330.07	NO	532
CHROMIUM	8 / 8	4.7 - 59.5	54.73	9 / 9	6.4 - 528	73.29	YES	179.33
COBALT*	4 / 8	0.75 - 5	2.77	5 / 9	0.15 - 6.2	0.79	NO	2.05
COPPER*	8 / 8	0.97 - 8.6	8.66	9 / 9	1.2 - 14.75	4.84	NO	7.32
IRON	8 / 8	3745 - 62500	40871.25	9 / 9	874 - 4605	2423.22	NO	3657.94
LEAD	8 / 8	1.4 - 39.4	24.33	9 / 9	2.7 - 1345	156.07	YES	432.47
MAGNESIUM	8 / 8	18.5 - 619	504.05	9 / 9	61.3 - 436	177.37	NO	245.09
MANGANESE	8 / 8	2.6 - 214	92.51	5 / 9	1.4 - 2.9	2.66	NO	2.9
MERCURY*	8 / 8	0.03 - 0.17	0.13	7 / 9	0.014 - 0.19	0.04	NO	0.07
NICKEL	4 / 8	1.8 - 7.2	4.75	9 / 9	0.32 - 1.95	0.69	NO	0.99
POTASSIUM	7 / 8	95 - 792	793.35	9 / 9	58 - 495	222.79	NO	416.26
SELENIUM	2 / 8	0.57 - 0.93	0.79	1 / 9	0.71	0.33	NO	0.42
SILVER	2 / 8	0.37 - 0.67	0.51	2 / 9	0.14 - 0.23	0.10	NO	0.13
SODIUM	8 / 8	17.5 - 94.8	79.35	9 / 9	66.3 - 192.5	145.31	YES	181.54
THALLIUM	4 / 8	0.7 - 1.9	1.38	3 / 9	0.77 - 1.1	0.52	NO	0.70
VANADIUM	8 / 8	11.05 - 64	64.71	9 / 9	3.9 - 11.15	6.38	NO	8.22
ZINC	6 / 8	1.1 - 50.7	31.35	9 / 9	2.2 - 7760	930.48	YES	2518.16

Note: Selected COPCs are indicated in boldface type.
* - Indicates COPCs eliminated based on amended risk assessment.

TABLE 1-18
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SUBSURFACE SOIL AT SITE 19
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
TETRACHLOROETHENE	NOT DETECTED	-	-	4 / 8	4 - 4	4

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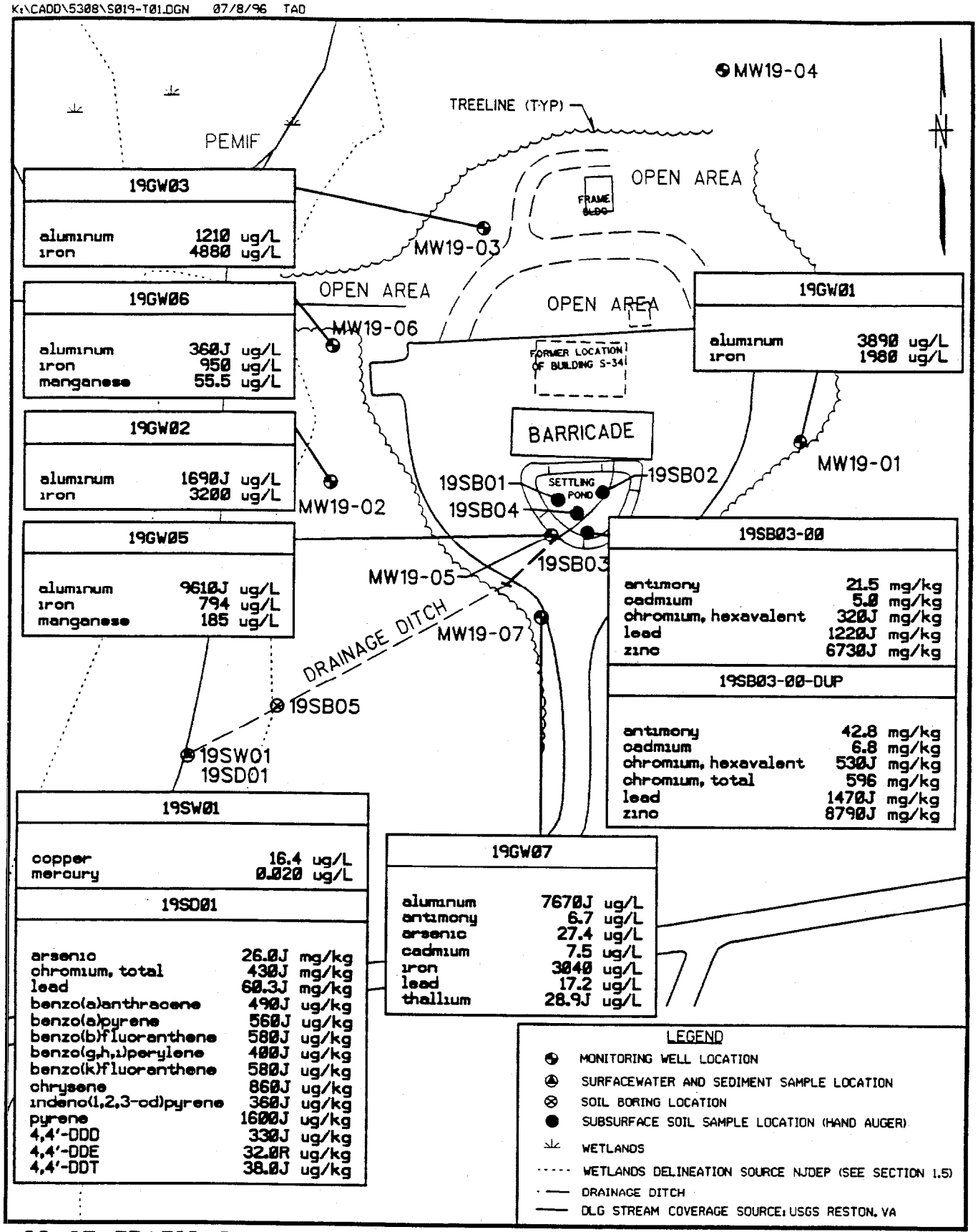


CONCENTRATIONS ABOVE SCREENING LEVELS

SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA

FIGURE 1-14

0 100 200

SCALE IN FEET

Brown & Root Environmental

TABLE 1-19

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SEDIMENT AT SITE 19
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE BKGD CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM	3 / 3	839 - 3940	5492.67	1 / 1	12600	12600	YES	12600
ARSENIC	2 / 3	2.4 - 6.2	5.95	1 / 1	26	26	YES	26
BARIUM	3 / 3	3.9 - 10.6	14.07	1 / 1	11.9	11.9	NO	11.9
BERYLLIUM	1 / 3	0.57	0.67	1 / 1	1.3	1.3	YES	1.3
CALCIUM	3 / 3	179 - 518	685.33	1 / 1	427	427	NO	427
CHROMIUM	3 / 3	4.3 - 56	43.13	1 / 1	430	430	YES	430
COPPER	3 / 3	1.5 - 13	12.47	1 / 1	14.2	14.2	YES	14.2
IRON	3 / 3	228 - 7650	6578.67	1 / 1	45200	45200	YES	45200
LEAD	3 / 3	4.6 - 34.3	30.60	1 / 1	60.3	60.3	YES	60.3
MAGNESIUM	3 / 3	60.7 - 256	306.47	1 / 1	1820	1820	YES	1820
MANGANESE	3 / 3	4.6 - 9.2	13.80	1 / 1	54.2	54.2	YES	54.2
MERCURY	1 / 3	0.068	0.05	1 / 1	0.076	0.076	YES	0.076
POTASSIUM	2 / 3	86.1 - 681	589.40	1 / 1	5500	5500	YES	5500
SODIUM	3 / 3	26.6 - 116	115.27	1 / 1	109	109	NO	109
VANADIUM	3 / 3	5.9 - 42.7	36.93	1 / 1	210	210	YES	210
ZINC	3 / 3	14.2 - 26.9	37.33	1 / 1	36.9	36.9	NO	36.9

Note: Selected COPCs are indicated in boldface type.

PAHs including benz(a)anthracene, benzo(a)pyrene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and fluoranthene were detected in background sediment samples at a range from 140 ug/kg to 1,800 ug/kg (Table 1-20). Similar PAHs were detected in the sediment sample collected at Site 19 at concentrations one to four times higher. 4,4'-DDT (19 ug/kg), 4,4'-DDD (4.9 ug/kg to 21 ug/kg), and gamma chlordane (0.095 ug/kg) were detected in background sediment samples. These pesticides were detected in the site-related sediment sample at levels of 38 ug/kg (4,4'-DDT), 330 ug/kg (4,4'-DDD), and 1.4 ug/kg (gamma chlordane). Toluene was detected in the site-related sample at 5.8 ug/kg and in a background sediment sample at 480 ug/kg (Table 1-20).

Groundwater

Six groundwater samples were collected at Site 19, 19 GW 01 through 19 GW 03 and 19 GW 05 through 19 GW 07. No organics were detected in Site 19 groundwater samples. Antimony, arsenic, cadmium, thallium, and zinc were detected at levels greater than background in one monitoring well, MW19-07, which is located adjacent to the drainage ditch approximately 60 feet south-southwest of the former disposal area (Table 1-21). Barium and zinc were detected at levels greater than background in monitoring well MW19-03. Extensive effort, using both NWS Earle area-specific/formation-specific data and information from the literature on the subject, was performed to evaluate the significance of metals in the groundwater (see Section 31 of the RI report). Although metals concentrations found in two wells at Site 19 may not exceed natural background after taking into account the presence of suspended solids (metals undissolved in the sample) and natural variability of site soils and hydrologic conditions which determine metals concentrations in local groundwater, it has been assumed that the metals found in groundwater are site related, and therefore, the proposed remedial alternatives must consider groundwater issues.

Surface Water

One surface water sample was collected at Site 19, 19 SW 01. Concentrations of metals in the site-related surface water sample were similar to the range of background samples (Table 1-22). Beta-BHC (0.0068 ug/L) and endosulfan I (0.001 ug/L) were each detected in one site-related surface water sample, 19 SW 01, which was located in the surface water discharge pathway approximately 300 feet southwest of the disposal area. These pesticides were not detected in background surface water samples (Table 1-23).

1.3.4.4.3 Contaminant Fate and Transport

Hexavalent chromium was found at an elevated level in one near-surface soil sample at Site 19 and may have the potential to impact groundwater. Levels of chromium in groundwater observed in the current investigation were similar to background. Historical groundwater data, while indicating substantially greater chromium levels at one location, are not viewed as representing only dissolved metals and are suspected to reflect a high level of suspended solids. Chromium was detected at elevated levels in sediment from the toe

TABLE 1-20
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SEDIMENT AT SITE 19
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'-DDD	2 / 3	4.9 - 21	21	2 / 2	5.5 - 330	330
4,4'-DDE	1 / 3	1.7	1.7	1 / 2	18	18
4,4'-DDT	1 / 3	19	19	2 / 2	35 - 38	38
ALPHA-CHLORDANE	NOT DETECTED	-	-	1 / 2	1.2	1.2
BENZO(A)ANTHRACENE	2 / 3	140 - 560	560	1 / 1	490	490
BENZO(A)PYRENE	2 / 3	160 - 590	590	1 / 1	560	560
BENZO(B)FLUORANTHENE	2 / 3	150 - 490	490	1 / 1	580	580
BENZO(G,H,I)PERYLENE	2 / 3	130 - 380	380	1 / 1	400	400
BENZO(K)FLUORANTHENE	2 / 3	150 - 470	470	1 / 1	580	580
CHRYSENE	2 / 3	250 - 940	940	1 / 1	860	860
FLUORANTHENE	2 / 3	300 - 1800	1800	1 / 1	2000	2000
GAMMA-CHLORDANE	1 / 3	0.095	0.095	2 / 2	1 - 1.4	1.4
HEPTACHLOR EPOXIDE	NOT DETECTED	-	-	1 / 2	0.57	0.57
INDENO(1,2,3-CD)PYRENE	2 / 3	110 - 310	310	1 / 1	360	360
PHENANTHRENE	2 / 3	200 - 1900	1900	1 / 1	730	730
[illegible]RENE	2 / 3	350 - 1900	1900	1 / 1	1600	1600
[illegible]LUENE	1 / 3	480	480	1 / 1	17	17

TABLE 1-21

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN GROUNDWATER AT SITE 19
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM*	11 / 11	287 - 7870	5097.82	6 / 6	360 - 9610	4071.67	NO	9610.00
ANTIMONY	NOT DETECTED	-	-	1 / 6	6.7	2.24	YES	5.31
ARSENIC	1 / 11	5.8 - 5.8	4.05	2 / 6	3.5 - 27.4	6.25	YES	14.80
BARIUM*	11 / 11	2.6 - 518	229.60	6 / 6	16.7 - 753	159.92	NO	399.78
BERYLLIUM*	4 / 11	0.21 - 1.6	0.49	2 / 6	0.75 - 1	0.33	NO	1.00
CADMIUM	5 / 11	0.6 - 1.9	1.21	6 / 6	0.73 - 7.5	2.54	YES	4.61
CALCIUM	11 / 11	506 - 17200	8306.55	6 / 6	1330 - 17200	7795.00	NO	17200.00
CHROMIUM	NOT DETECTED	-	-	6 / 6	3.9 - 43.1	22.32	YES	43.10
COBALT*	6 / 11	0.7 - 10.1	4.06	6 / 6	0.95 - 15.6	3.89	NO	8.62
COPPER*	9 / 11	0.79 - 13.5	6.53	3 / 6	4.8 - 17.5	4.84	NO	10.30
IRON*	11 / 11	153 - 7690	4197.09	6 / 6	794 - 4880	2474.00	NO	4880.00
LEAD	3 / 11	2.1 - 3	2.44	5 / 6	1.6 - 17.2	4.78	YES	9.93
MAGNESIUM	11 / 11	273 - 27400	8449.64	6 / 6	921 - 27400	6351.50	NO	14940.75
MANGANESE	11 / 11	3.3 - 65	46.18	6 / 6	8.1 - 185	54.43	YES	109.27
MERCURY*	11 / 11	0.005 - 0.12	0.12	6 / 6	0.007 - 0.12	0.06	NO	0.12
NICKEL*	10 / 11	0.81 - 25.5	11.98	6 / 6	4.8 - 25.4	9.42	NO	15.96
POTASSIUM	11 / 11	350 - 3245	2810.55	6 / 6	831 - 1540	1104.50	NO	1395.95
SELENIUM	1 / 11	5.3 - 5.3	4.96	1 / 6	27.2	6.37	YES	27.20
SILVER	NOT DETECTED	-	-	1 / 6	1	0.56	YES	0.76
SODIUM	11 / 11	1850 - 11650	8449.09	6 / 6	3640 - 48100	11976.67	YES	26563.35
THALLIUM	3 / 11	4 - 5.1	5.15	1 / 6	28.9	6.32	YES	28.90
VANADIUM	10 / 11	0.69 - 42.25	16.48	5 / 6	2.3 - 15.6	6.38	NO	15.60
ZINC	6 / 9	3.7 - 348	178.61	4 / 6	7.6 - 694	204.52	YES	452.49

Note: Selected COPCs are indicated in boldface type.
* - Indicates COPCs eliminated based upon amended risk assessment.

TABLE 1-22

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SURFACE WATER AT SITE 19
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE BKGD CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM	3 / 3	265 - 409	705.33	1 / 1	229	229	NO	229
BARIUM	3 / 3	16.3 - 34	53.73	1 / 1	24.9	24.9	NO	24.9
BERYLLIUM	2 / 3	0.22 - 0.33	0.41	1 / 1	0.15	0.15	NO	0.15
CALCIUM	3 / 3	462 - 10100	9128.00	1 / 1	5470	5470	NO	5470
COPPER	2 / 3	1.1 - 9.8	7.40	1 / 1	16.4	16.4	YES	16.4
IRON	3 / 3	160 - 702	1040.00	1 / 1	1140	1140	YES	1140
LEAD	1 / 3	4.4	3.43	1 / 1	3.1	3.1	NO	3.1
MAGNESIUM	3 / 3	369 - 2770	2525.33	1 / 1	1490	1490	NO	1490
MANGANESE	3 / 3	14 - 55.5	59.93	1 / 1	11.9	11.9	NO	11.9
MERCURY	2 / 3	0.023 - 0.028	0.04	1 / 1	0.02	0.02	NO	0.02
NICKEL	3 / 3	2.1 - 7.1	8.60	1 / 1	1.2	1.2	NO	1.2
POTASSIUM	2 / 3	251 - 1850	1482.33	1 / 1	499	499	NO	499
ZINC	3 / 3	7.6 - 29.4	32.67	1 / 1	22	22	NO	22

Note: Selected COPCs are indicated in boldface type.

TABLE 1-23
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SURFACE WATER AT SITE 19
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

SUBSTANCE	BACKGROUND			SITE-RELATED		
	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
BETA-BHC	NOT DETECTED	-	-	1 / 1	0.0068	0.0068
ENDOSULFAN I	NOT DETECTED	-	-	1 / 1	0.001	0.001

of the drainage pathway, which suggests that migration of chromium has occurred through the surface water drainage pathway.

Certain metals (notably lead and zinc) were detected at elevated levels in one subsurface soil but were not found at elevated levels in subsurface soil collected in the drainage ditch or in the wetland sediment sample. Therefore, impacts of lead and zinc migration appear limited to surficial drainage ditch sediments. Historical data indicate that these metals were detected at elevated levels in groundwater, but the ratio of suspended versus dissolved metal concentrations is suspected to be high. One monitoring well exhibited levels of antimony, arsenic, cadmium, lead, thallium, and zinc greater than background. Of these metals, only zinc was found at elevated levels in samples from other media collected at the site. Data does not present evidence of a trend toward the presence of elevated levels of metals in groundwater.

Trace levels of PCE were detected only in several subsurface soils collected at the shallow depth. This compound is considered highly mobile but was not detected in groundwater. The low levels detected may suggest only low-level contamination is present.

Less mobile contaminant species (PAHs and pesticides) were found only in sediment and not groundwater. These compounds exhibit a high affinity for soils/sediments and are not expected to migrate significantly except through erosional dispersion. These substances were not detected at elevated levels in the subsurface soils associated with the source area.

1.3.4.4.4 Baseline Human Health Risk Assessment

Subsurface soil, sediment, groundwater, and surface water were sampled at Site 19. The potential receptors for this site were future industrial, residential, and recreational receptors.

The RME cancer risks associated with future residential (subsurface soil and groundwater) exposure scenarios exceeded 1E-04, the upper end of the target risk range. Arsenic (via ingestion of groundwater) was the major COPC that contributed to the cancer risks for these exposure scenarios. However, these RME estimates are probably overly conservative because a central tendency calculation shows that cancer risks are more likely to be within the mid-range of the target acceptable risk range.

RME estimates for noncarcinogenic HIs associated with future industrial (groundwater) and future residential (groundwater) exposure scenarios exceeded 1.0, the cutoff point below which adverse noncarcinogenic effects are not expected to occur. Thallium and arsenic (both via ingestion of groundwater) were the COPCs that exceeded 1.0 or contributed to the HI exceeding 1.0 for these exposure scenarios. The RME estimates of non-cancer risk from exposure to groundwater for the future industrial receptor are probably overly conservative because associated central tendency non-cancer HIs are less than 1.0. However, central

tendency risk estimates for residential exposure to groundwater yielded HIs greater than 1.0 for the target organs liver, kidney, skin, and central nervous system (thallium and arsenic were the principal COPCs).

Lead was detected in subsurface soil and groundwater at the site at levels greater than the EPA screening guidelines. Based on the results of the IEUBK Lead Model (v. 0.99), the maximum detected soil concentration and the representative groundwater concentration might be expected to be associated with significant increases in blood-lead levels (i.e., above 10 ug/dL) in 16 percent of children from a population exposed under similar conditions.

Because sampling was biased to fill in data gaps and questions remaining after earlier studies, the conclusions of this risk assessment conditionally assume that other areas (i.e., surface soils/sediments in the drainage depression and ditch) will be remediated.

1.3.4.4.5 Ecological Risk Assessment

Most of Site 19 is paved or graveled, affording little ecological habitat. Forested upland areas surround most of the site and provide excellent terrestrial habitat. A tributary of Mingamahone Brook is located about 500 feet west of the site and is surrounded by wetlands. The upland and wetland areas are expected to be utilized by a wide variety of ecological receptors. The major contaminant release pathway from the depression behind the barricade is overland runoff, primarily to the wetlands via a drainage ditch. Groundwater-to-surface water contaminant migration is possible, but the levels of metals in the drainage depression indicate that runoff is much more significant.

The Phase II SI at the site indicated that levels of several metals, including cadmium, lead, and zinc were elevated in site sediments and soils. Soil samples collected as part of 1993 RI/FS activities at the site contained elevated levels of several metals, mainly lead, and low levels of some VOCs in the depression behind the barricade and in the drainage ditch southwest of the site.

In RI/FS groundwater samples, low levels of some VOCs and pesticides were detected, and elevated levels of metals were detected. Groundwater samples were also collected during 1995 RI sampling activities at Site 19. Several metals concentrations were elevated in sample MW10-07, located approximately 60 feet south-southwest of the site. Slightly elevated levels of barium and zinc were detected in well MW19-03, located in the open area northwest of the site. In 1995 RI subsurface soil samples taken in the barricade depression and drainage depression, antimony, chromium, cadmium, lead, and zinc were elevated. A low level of PCE was also detected. Also as part of 1995 RI activities, a surface water and sediment sample was taken where the drainage ditch meets the stream to confirm results from the 1993 RI/FS. Concentrations of metals were similar to background in the surface water sample, and low levels of two pesticides were detected. In the

sediment sample, a high concentration of chromium was detected, along with slightly elevated concentrations of aluminum, iron, manganese, and vanadium. Low levels of some organics, including some PAHs and pesticides, were also detected. Several sediment samples were taken in the depression and ditch as part of 1993 RI/FS activities and were used for quantitative assessment. HQs for most inorganics were indicative of low potential risk. However, HQs for chromium, lead, and zinc were indicative of moderate potential risk; each of these inorganics exceeded most conservative ET values. Aluminum and vanadium were conservatively retained as final COPCs since no suitable ET values were available, but these elements were detected in concentrations similar to background.

The results of 1993 RI/FS sediment samples, along with subsurface soil and sediment samples from other studies at Site 19, indicate that contaminants, primarily inorganics, have migrated from the site to the drainage ditch that leads to the stream and wetlands. Results of groundwater sampling indicate that contaminant impacts to groundwater, mainly inorganics, may have occurred. Although no extensive groundwater contaminant migration has been documented, groundwater at the site flows towards the wetlands. Surface-water concentrations of metals in a surface water/sediment sample taken from the stream in the wetlands west-northwest of Site 19, upstream of the confluence with the drainage ditch from Site 19, were low, suggesting limited groundwater to surface water migration. Future groundwater to surface water migration is possible, but available data indicate that overland migration of sediments via the drainage ditch poses a much greater potential risk to the stream and wetlands. The sediment samples taken in the drainage ditch indicate that contaminant concentrations decrease as the drainage ditch gets closer to the stream, and only an elevated detection of chromium was present at the confluence.

1.3.5 Site 26

1.3.5.1 Initial Assessment and Confirmation Study

The 1983 IAS, which consisted of interviews and site observations, concluded that there was a minimal probability of impact, based on the presumption that material would have been lost as a direct discharge to surface water and would no longer be present. The site was not recommended for a confirmation study.

During the 1993 SI, three monitoring wells were installed. Groundwater samples were analyzed for picric acid and pH. Picric acid was not detected, and pH was within expected levels.

1.3.5.2 Phase I Remedial Investigation

During the 1993 Weston RI/FS, four soil samples were collected from the percolation pit. Lead was detected at elevated levels defined in three samples. All other metals were within normal background ranges. Picric acid was detected in one sample. No other explosive compounds were detected.

One monitoring well was installed near the percolation pit. Groundwater samples from all SI and RI/FS wells were collected and analyzed for TCL/TAL analytes and explosive compounds. TCE was detected in the sample from MW26-01 at elevated levels (660 ug/L). Other VOCs, such as dichloroethanes (related to TCE as impurities or breakdown products) were also present. The source of TCE may be associated with the process leaching system of Building GB-1. Low concentrations of several explosive compounds were detected in samples from wells MW26-01 and MW26-04.

1.3.5.3 Phase II Remedial Investigation

Between June and October 1995, B&R Environmental conducted the following field investigation activities at Site 26:

- Soil gas survey at 68 locations
- Sampling and analysis of subsurface soil samples from four soil borings
- Drilling and installation of two shallow permanent monitoring wells
- Sampling and analysis of groundwater from the newly installed well and existing wells
- Measurement of static-water levels in the wells

B&R Environmental conducted a survey to establish the horizontal locations and vertical elevations of the soil gas grid corners, soil boring locations, selected existing monitoring wells, and the newly installed wells.

1.3.5.4 Addendum Remedial Investigation

B&R Environmental collected groundwater samples from 28 locations (26HP01 through 26HP28) between October 16 and 25, 1996. The samples were collected at multiple depths at each location. Sixty-four groundwater samples, including one field duplicate sample, were analyzed for TCL VOCs using a mobile laboratory. To confirm mobile laboratory results, 14 of the samples were also analyzed for TCL VOCs by IEA.

Lithologic profiling was performed at eight locations (26CPT00, 26HP01, 26HP02, 26HP05, 26HP08, 26HP10, 26HP21, and 26HP22) between October 16 and 25, 1996. The maximum depth of any profile was 100 feet.

1.3.5.5 Results

Site 26, which is approximately 200 by 200 feet in size, is situated at the intersection of Macassar and Midway Roads. Two railway lines adjacent to the site run toward the northeast. The ground surface at the site is relatively flat, approximately 150 feet above MSL. The percolation pit is located in the center of the site and measures approximately 30 feet in diameter and 10 feet in depth. A tile-lined open pipe runs from Building GB-1 to the percolation pit. A process leaching system north of the western end of Building GB-1, consisting of a grease trap and a cesspool-type leach tank approximately 10 ft. by 10 ft. and six feet deep, was used for process waste disposal. The bottom of the leach tank is situated about 3 to 4 feet above high water table level. The seasonal high groundwater table is approximately 10 to 14 feet below ground surface in the area. The sides of the leach tank appear to be porous, possibly partially constructed of cement block masonry units arranged on their sides for effective drainage.

1.3.5.5.1 Site Geology, Hydrogeology, and Hydrology

Geology

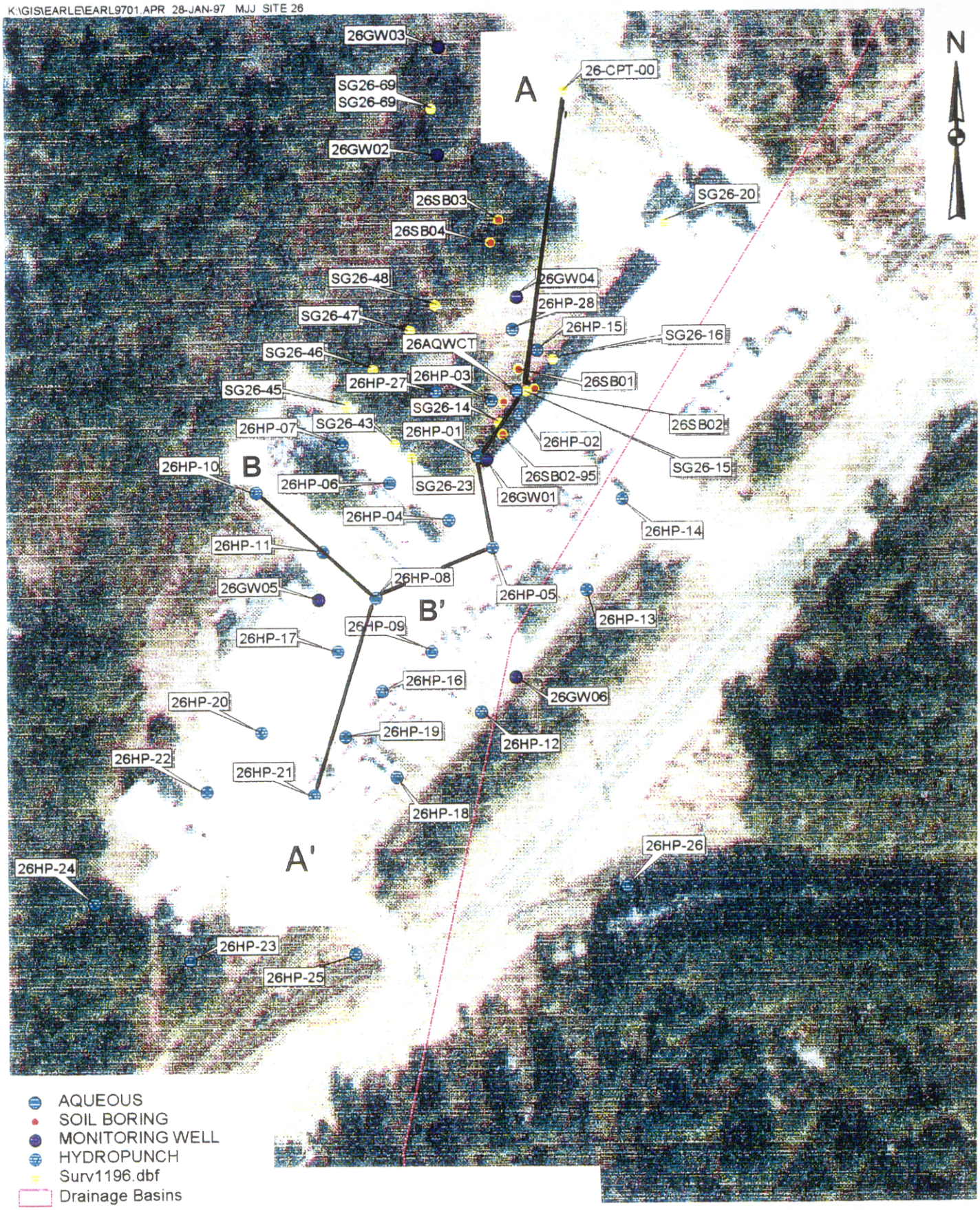
Regional mapping places Site 26 in the outcrop area of the Kirkwood Formation; upland gravel may be present at the site. The upland gravel has a maximum thickness of 10 feet, the Kirkwood Formation ranges between 60 to 100 feet in thickness. The soil borings are no more than 24 feet deep and the CPT lithologic profile locations are no more than 100 feet deep. The lithology of the sediments encountered in the on-site borings generally agrees with the published description of the upland gravel and the Kirkwood Formation. In general, the borings encountered light yellowish-brown sand and gravel (probably representative of the upland gravel) and brownish-yellow, brown and gray, fine- to medium-grained and medium- to coarse-grained sand (probably representative of the Kirkwood Formation). Based on CPT lithologic profiling, the upper approximate 25-foot section penetrated was a sand. Silty clay and clayey silt was penetrated from approximately 25 to 45 feet and sand was penetrated from approximately 45 to 70 feet. A clayey silt was penetrated from approximately 80 to 87 feet in one of the locations. Lithologic profile diagrams for the site are provided in Figures 1-15, 1-16, and 1-17.

Based upon the boring log descriptions, wells MW26-02, MW26-03, MW26-05, and MW26-06 penetrated the upland gravel and the Kirkwood Formation, and wells MW26-01 and MW26-04 penetrated the Kirkwood Formation.

Hydrogeology

Groundwater in the Kirkwood aquifer beneath the site occurs under unconfined conditions. Groundwater contour maps are presented in Figures 1-18 (August 1995 levels) and 1-19 (October 1995 levels). The

K:\GIS\EARLE\EARL9701.APR 28-JAN-97 MJJ SITE 26



CROSS-SECTION LOCATIONS

SITE 26 - EXPLOSIVE "D" WASHOUT AREA

80 0 80 160 Feet

1-70

FIGURE

1-15

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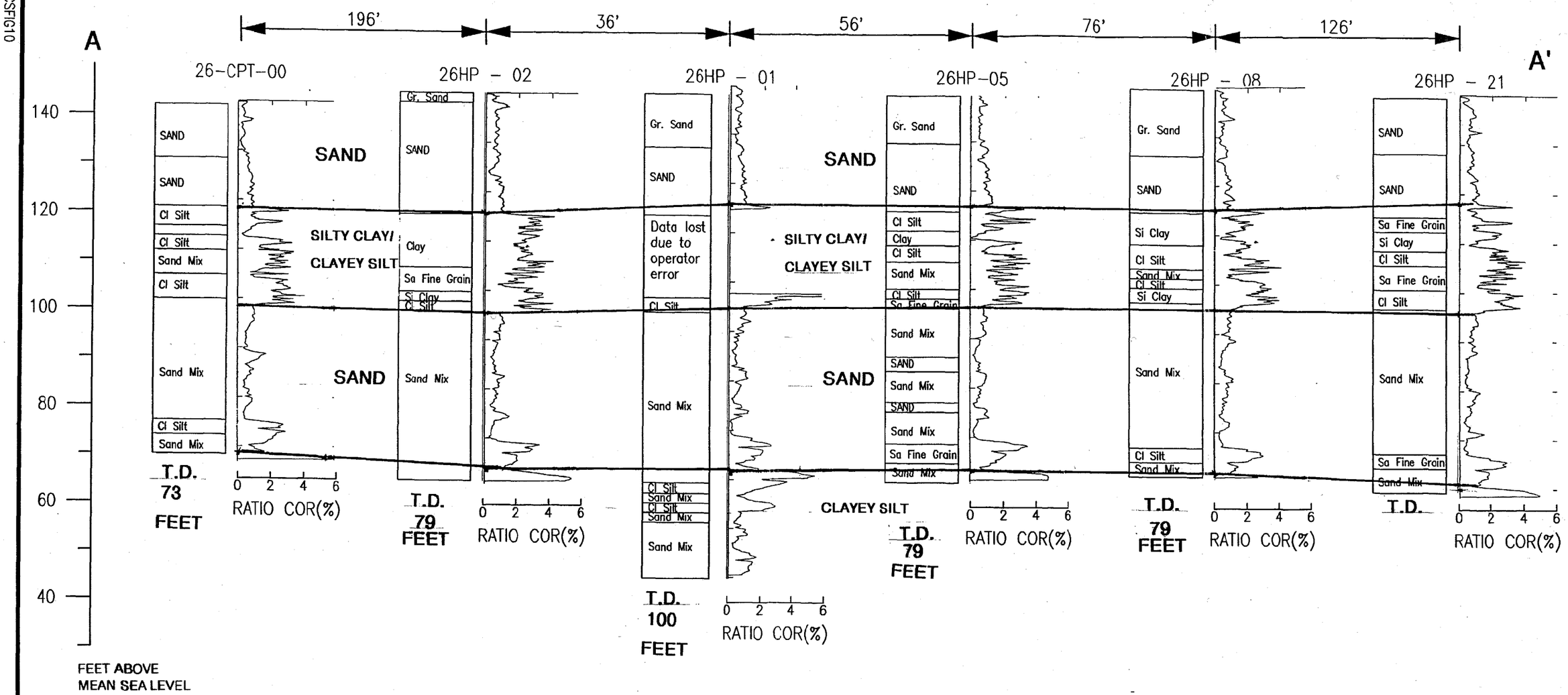
C:\DWG\EARLE\GCSFIG10

STRIKE SECTION A – A'



VERTICAL SCALE 1" = 20'
NOT TO HORIZONTAL SCALE
T.D. = TOTAL DEPTH

NO.	DATE		BY	CHK'D	APP'D	REFERENCES

DRAWN BY A.S.M DATE 2/3/'97
CHECKED BY
COST/SCHED.-AREA
SCALE

Brown & Root Environmental

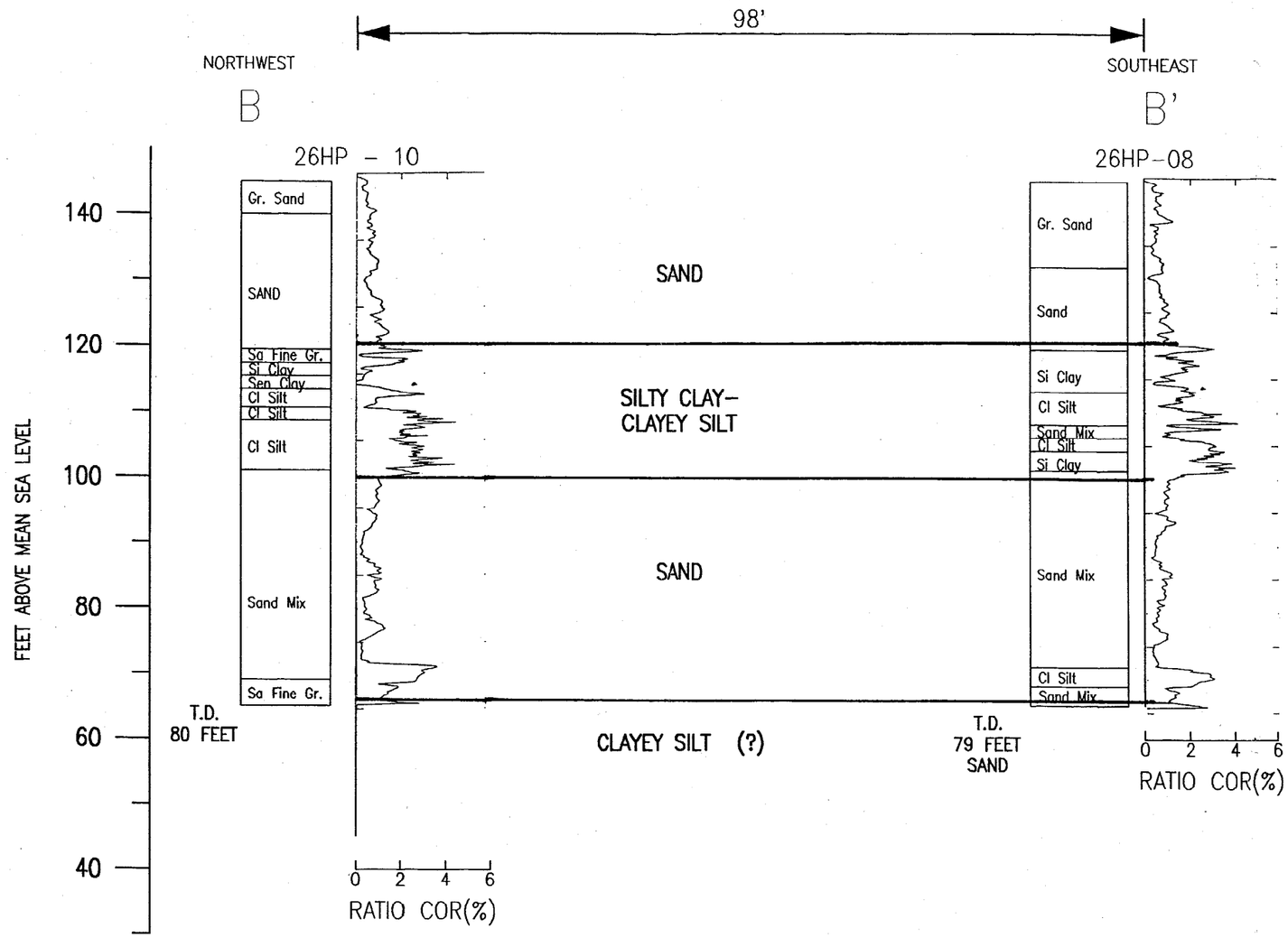
GEOLOGIC CROSS SECTIONS
SITE 26 – EXPLOSIVE "D" WASHOUT AREA
NWS EARLE, COLTS NECK, N.J.

CONTRACT NO. CTO 231
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-16
REV.

00535BB3Z

C:\DWG\EARLE\GCSFIG11

DIP SECTION B – B'



VERTICAL SCALE 1" = 20'
NOT TO HORIZONTAL SCALE
T.D. = TOTAL DEPTH

NO.	DATE		BY	CHK'D	APP'D	REFERENCES

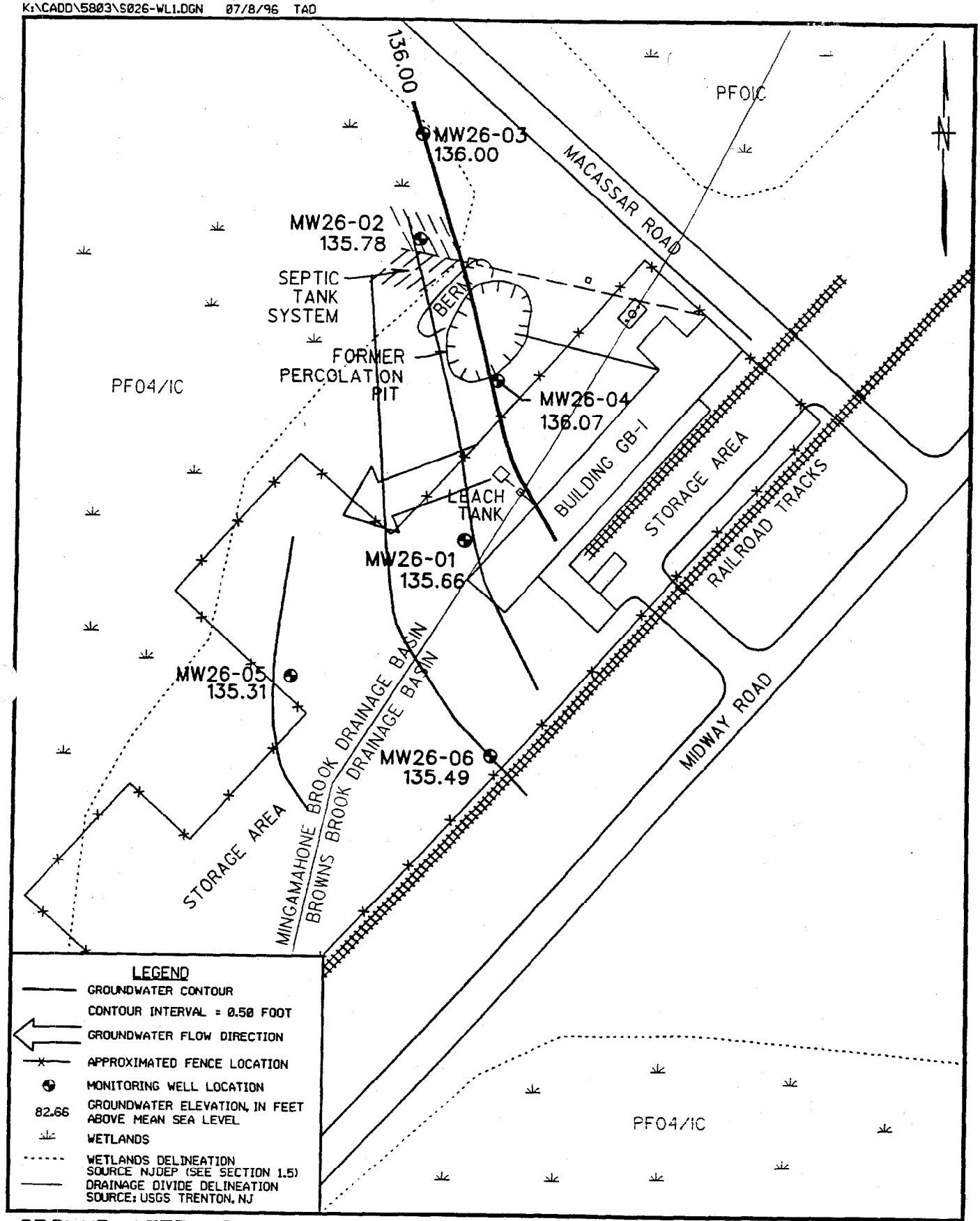
DRAWN BY A.S.M DATE 2/3/'97
CHECKED BY
COST/SCHED.–AREA
SCALE

Brown & Root Environmental

GEOLOGIC CROSS SECTIONS
SITE 26 – EXPLOSIVE "D" WASHOUT AREA
N W S EARLE, COLTS NECK, N.J.

CONTRACT NO. CTO 231
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-17
REV.

K:\CADD\5803\S026-WL1.DGN 07/8/96 TAD



GROUNDWATER CONTOUR MAP AUGUST 7, 1995
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 1-18

0 80 160
SCALE IN FEET

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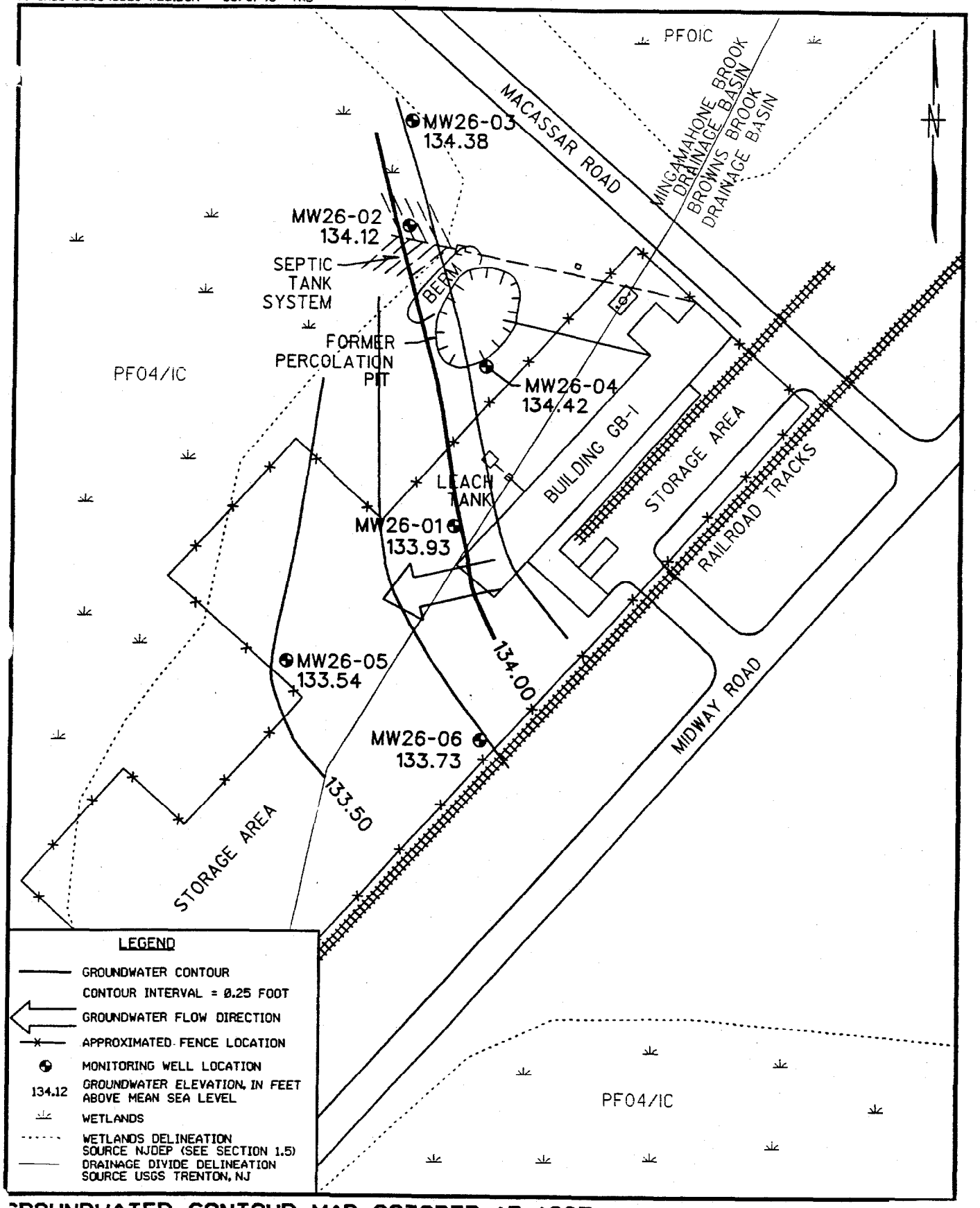
K:\CADD\5803\S026-WL2.DGN 06/8/96 TAD



GROUNDWATER CONTOUR MAP OCTOBER 17, 1995

SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 1-19

0 80 160

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direction of shallow groundwater flow in the aquifer, as indicated by both the August and October groundwater measurements, is toward the southwest. There does not appear to be a significant seasonal variation in groundwater flow direction.

Based on boring log descriptions, the wells are screened in the Kirkwood Formation. The hydraulic conductivity's calculated for MW26-01, MW26-03, and MW26-04 are 3.85×10^{-4} cm/sec (1.09 ft/day), 1.92×10^{-3} cm/sec (5.44 ft/day), and 7.09×10^{-4} cm/sec (2.01 ft/day), respectively.

Based on pore pressure plots, the water table was encountered at approximately 10 feet and a lower water bearing zone was encountered at approximately 43 feet bgs. The clayey silty zone penetrated between approximately 25 and 45 feet bgs shows a sharp rise in pre-pressure indicating this zone probably serves as a semi-confining layer. Two pieces of evidence corroborate the findings of the cone penetrometer pore pressure plots, confirming the presence of the semi-confining layer. Efforts to obtain groundwater samples using the direct-push sampler from within the clay and silt zone yielded no water, and the tool screen was found to be smeared with a plastic, clayey soil after attempts to obtain groundwater samples from the clay and silt zone. This indicates the possibility of clay soils. Also, the vertical distribution of chlorinated compounds detected in groundwater samples indicated contaminant concentrations orders of magnitude lower below the postulated clay layer than above it, indicating that the clay layer is acting as an aquitard.

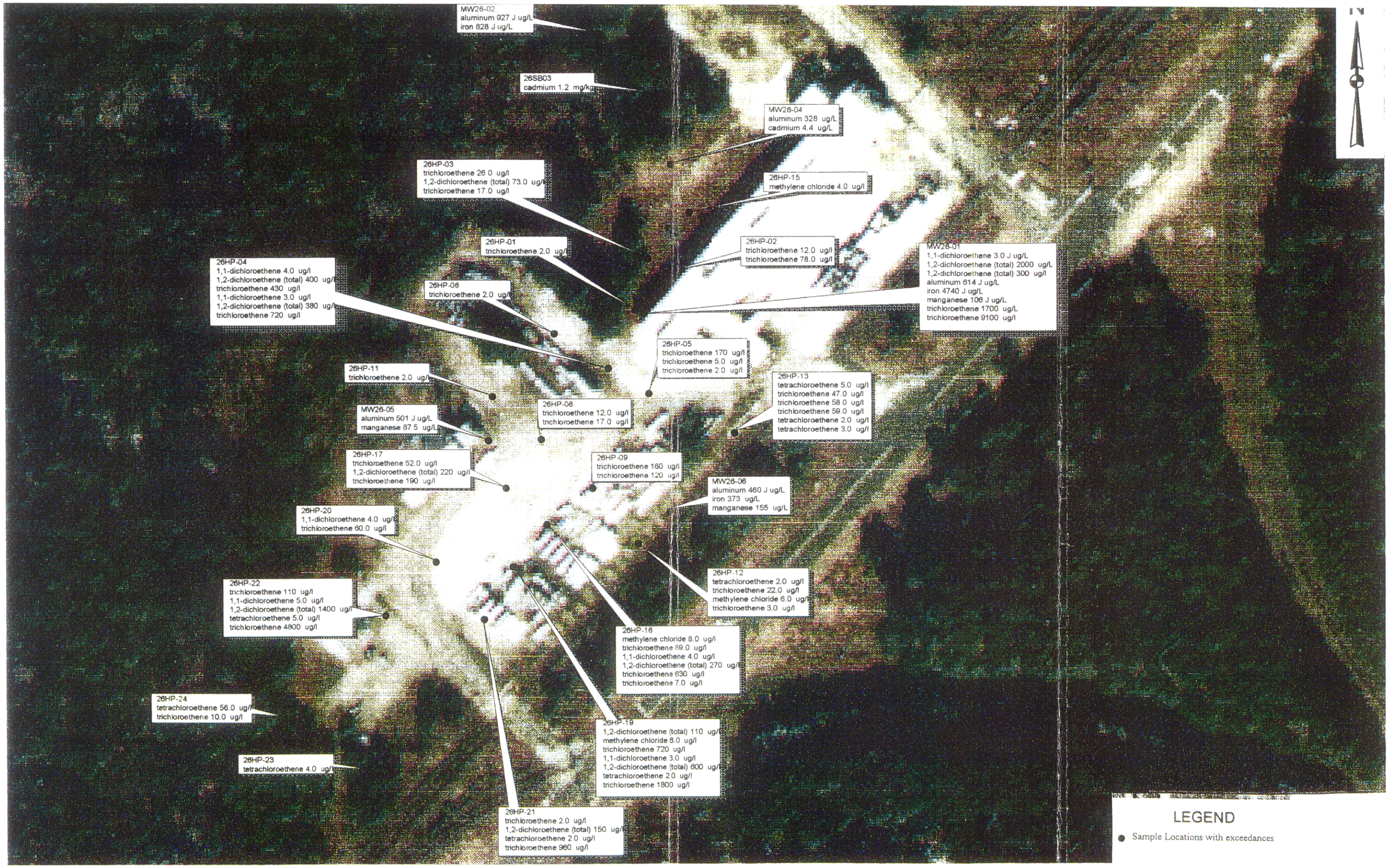
Hydrology

The septic system is surrounded by wooded upland areas. The upland areas are dominated by pitch pine, blackjack oak, blueberry, and *Clethra* sp. NJDEP Geographic Information System data initially indicated the presence of wetlands where the wooded upland areas are located. However, on-site inspection revealed that no wetlands are present in the area. Soils in this area contain no evidence of saturation, no wetland hydrology is present, and no streams or watercourses exist near the site. The closest wetlands are located approximately 300 yards to the northwest. The East Branch of Mingamahone Brook is located approximately 300 yards southwest of Site 26, and the site is in the Mingamahone Brook watershed. Depth to groundwater ranges approximately from 10 to 14 feet below ground surface at Site 26.

1.3.5.5.2 Nature and Extent of Contamination

Subsurface Soils

Site-related subsurface soil samples (26 SB 01-02, 26 SB 02-04, 26 SB 03-06, 26 SB 04-02, and 26 SB 04-06) were collected at Site 26. Figure 1-20 shows sample locations and concentrations of compounds that exceed ARARs and TBCs.



CONCENTRATIONS ABOVE SCREENING LEVELS
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

60 0 60 120 Feet

FIGURE 1-20

APR 07-FEB-96 MJJ Site 26 Tag 2

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00535B04Y

Concentrations of most metals in site-related subsurface soil samples were within the same ranges as background samples (Table 1-24). Antimony was detected at low levels (near the instrument detection limit) in two site-related subsurface soil samples but was not found in background samples. Barium was detected in one site-related sample, 26 SB 02-04, at levels greater than the concentration range associated with background samples.

Explosives and volatile organics were analyzed for but were not detected in the first round of subsurface soil samples at Site 26.

In the two soil borings taken in December 1995 to further investigate TCE near the Leach Tank (26SB01-95 and 26SB02-95), TCE (2.0J ug/kg and 74.0 mg/kg respectively) and 1,2-dichloroethane (3.0 ug/kg and 140 ug/kg respectively) were found at concentrations above New Jersey soil criteria (Table 1-25).

Groundwater

Six site-related groundwater samples (26 GW 01 through 26 GW 06) were collected at Site 26. Figure 1-20 shows sample locations and concentrations of compounds that exceed ARARs and TBCs.

Concentrations of most metals in site-related groundwater samples were within ranges similar to background samples (Table 1-26). Zinc was detected in four site-related groundwater samples (26 GW 01 through 26 GW 03, and 26 GW 05) at levels greater than the concentration range associated with background samples. Barium was found at elevated levels in samples 26 GW 01 through 26 GW 03 and cadmium and silver were detected in sample 26 GW 04 at levels greater than background ranges. However, considering the natural acidity of pine barren soils and the fact that overlying soils also contained (normal) quantities of the same metals (e.g., barium), the relatively low levels of metals were concluded to not represent a serious threat to human health or the environment.

TCE (1 ug/L to 1,700 ug/L) was detected in two groundwater samples collected at Site 26 (Table 1-27). 1,1-DCE (3 ug/L), 1,2-DCE (2,000 ug/L), chloroform (1 ug/L), and PCE (1 ug/L) were each detected in one groundwater sample collected at Site 26. Sample 26 GW 01 contained the highest levels of TCE, 1,1-DCE, and 1,2-DCE. This monitoring well is located near a leach tank along the northwestern end of Building GB-1. Trace levels of TCE, PCE, and chloroform were also detected in 26 GW 06, which is located approximately 90 feet south of the southwestern corner of Building GB-1. Explosives were analyzed for but not detected in groundwater samples collected at Site 26.

In order to confirm the levels of contamination exhibited in 26 GW 01, this well was sampled for VOCs during the 1996 RI Addendum. Results showed 1,2-DCE (300 ug/L), TCE (9,100 ug/L), and PCE (3 ug/L).

TABLE 1-24

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN SUBSURFACE SOILS AT SITE 26
NWS EARLE, COLTS NECK, NEW JERSEY
(mg/kg)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE BKGD CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD	REPRESENTATIVE CONCENTRATION
ALUMINUM	8 / 8	675 - 5310	5370.00	6 / 6	557 - 3350	1655.83	NO	3350
ANTIMONY	NOT DETECTED	-	-	2 / 6	0.61 - 0.66	0.40	YES	0.55
ARSENIC	8 / 8	1.35 - 14.4	13.29	4 / 6	0.59 - 3.1	1.32	NO	3.1
BARIUM	8 / 8	0.92 - 31	17.92	6 / 6	1.1 - 213	37.38	YES	108.16
BERYLLIUM	2 / 8	0.12 - 0.28	0.28	6 / 6	0.13 - 0.25	0.16	NO	0.20
CADMIUM	1 / 8	0.57	0.58	6 / 6	0.04 - 1.2	0.40	NO	0.80
CALCIUM	8 / 8	28.6 - 799	577.55	6 / 6	28.7 - 169	88.92	NO	169
CHROMIUM	8 / 8	4.7 - 59.5	54.73	6 / 6	2.2 - 7.8	4.83	NO	7.8
COPPER	8 / 8	0.97 - 8.6	8.66	5 / 6	0.52 - 2.3	1.00	NO	2.3
IRON	8 / 8	3745 - 62500	40871.25	6 / 6	961 - 6550	3220.17	NO	6550
LEAD	8 / 8	1.4 - 39.4	24.33	6 / 6	0.55 - 2.3	1.36	NO	2.3
MAGNESIUM	8 / 8	18.5 - 619	504.05	6 / 6	17.3 - 59	41.37	NO	59
MANGANESE	8 / 8	2.6 - 214	92.51	6 / 6	0.97 - 1.9	1.36	NO	1.74
MERCURY	8 / 8	0.03 - 0.17	0.13	1 / 6	0.064	0.01	NO	0.03
NICKEL	4 / 8	1.8 - 7.2	4.75	6 / 6	0.24 - 0.78	0.42	NO	0.68
POTASSIUM	7 / 8	95 - 792	793.35	5 / 6	77.7 - 185	114.75	NO	185
SILVER	2 / 8	0.37 - 0.67	0.51	4 / 6	0.64 - 2.4	0.91	YES	2.4
SODIUM	8 / 8	17.5 - 94.8	79.35	6 / 6	98.6 - 160	130.43	YES	157.27
THALLIUM	4 / 8	0.7 - 1.9	1.38	3 / 6	0.7 - 0.92	0.59	NO	0.92
VANADIUM	8 / 8	11.05 - 64	64.71	6 / 6	1.2 - 8.1	4.27	NO	8.1
ZINC	6 / 8	1.1 - 50.7	31.35	4 / 6	1.6 - 89.3	17.89	NO	46.93

Note: Selected COPCs are indicated in boldface type.

TABLE 1-25
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN SUBSURFACE SOIL AT SITE 26
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/kg)

SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
1,2-DICHLOROETHENE (TOTAL)	NOT DETECTED	-	-	2 / 8	3 - 140	53.99
METHYLENE CHLORIDE	NOT DETECTED	-	-	1 / 8	2 - 2	2
TRICHLOROETHENE	NOT DETECTED	-	-	2 / 8	2 - 74	30.03

TABLE 1-26

OCCURRENCE AND DISTRIBUTION OF INORGANICS IN GROUNDWATER AT SITE 26
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

	BACKGROUND			SITE-RELATED				
SUBSTANCE	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	2 X AVERAGE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	AVERAGE CONCENTRATION	MEAN > 2 X BKGD?	REPRESENTATIVE CONCENTRATION
ALUMINUM	11 / 11	287 - 7870	5097.82	6 / 6	328 - 927	539.33	NO	792.03
BARIUM	11 / 11	2.6 - 518	229.60	6 / 6	13.2 - 518	267.78	YES	465.70
CADMIUM*	5 / 11	0.6 - 1.9	1.21	4 / 6	0.42 - 4.4	1.04	NO	2.40
CALCIUM	11 / 11	506 - 17200	8306.55	6 / 6	3540 - 17800	8440.00	YES	17800
CHROMIUM	NOT DETECTED	-	-	3 / 6	1.2 - 1.4	0.89	YES	1.40
COBALT	6 / 11	0.7 - 10.1	4.06	5 / 6	0.92 - 5.8	2.69	NO	5.80
COPPER*	9 / 11	0.79 - 13.5	6.53	6 / 6	0.81 - 13.8	6.22	NO	13.80
IRON*	11 / 11	153 - 7690	4197.09	6 / 6	90.8 - 4740	1172.47	NO	2627.87
LEAD*	3 / 11	2.1 - 3	2.44	1 / 6	2.6	1.06	NO	1.92
MAGNESIUM	11 / 11	273 - 27400	8449.64	6 / 6	636 - 2170	1415.50	NO	2170
MANGANESE	11 / 11	3.3 - 65	46.18	6 / 6	3.3 - 155	62.23	YES	155.00
MERCURY*	11 / 11	0.005 - 0.12	0.12	6 / 6	0.012 - 0.11	0.05	NO	0.11
NICKEL	10 / 11	0.81 - 25.5	11.98	2 / 6	0.81 - 1	0.55	NO	0.94
POTASSIUM	11 / 11	350 - 3245	2810.55	6 / 6	362 - 3640	1385.17	NO	3640
SILVER	NOT DETECTED	-	-	1 / 6	3.3	0.94	YES	3.06
SODIUM	11 / 11	1850 - 11650	8449.09	6 / 6	2360 - 12500	4875.00	NO	8019.92
VANADIUM	10 / 11	0.69 - 42.25	16.48	3 / 6	0.81 - 1.6	0.71	NO	1.60
ZINC*	6 / 9	3.7 - 348	178.61	5 / 6	100 - 326	202.69	YES	326

Note: Selected COPCs are indicated in boldface type.
* - Indicates COPCs eliminated based on amended risk assessment.

TABLE 1-27
OCCURRENCE AND DISTRIBUTION OF ORGANICS IN GROUNDWATER AT SITE 2[illegible]
NWS EARLE, COLTS NECK, NEW JERSEY
(ug/L)

SUBSTANCE	BACKGROUND			SITE RELATED		
	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION	FREQUENCY OF DETECTION	RANGE OF POSITIVE DETECTION	REPRESENTATIVE CONCENTRATION
1,1-DICHLOROETHENE	NOT DETECTED	-	-	1 / 6	3	3
1,2-DICHLOROETHENE (TOTAL)	NOT DETECTED	-	-	1 / 6	[illegible]	2000
CHLOROFORM	NOT DETECTED	-	-	1 / 6	1	1
TETRACHLOROETHENE	NOT DETECTED	-	-	1 / 6	1	1
TRICHLOROETHENE	NOT DETECTED	-	-	2 / 6	1 - 1[illegible]0	856.35

OREGW26T.XLS 3/18/96 11:33 AM

To further delineate the extent of groundwater contamination at Site 26, samples were collected by direct-push methodology and analyzed in the field for VOCs. Confirmation samples submitted to a fixed-based lab indicated that the field results were reliable. VOCs detected in these samples showed TCE in 39 samples (0.06 to 4,800 ug/L), 1, 1-DCE in 32 samples (0.03 to 5 ug/L), 1, 2-DCE in 23 samples (0.1 to 1,400 ug/L), PCE in 20 samples (0.4 to 56 ug/L), methylene chloride in 11 samples (0.8 to 8 ug/L), ethylbenzene in three samples (4 to 16 ug/L), carbon tetrachloride in two samples (0.002 ug/L), and xylene in one sample (20 ug/L). In addition, carbon disulfide was detected in seven of the eight confirmation samples (5 to 46 ug/L). Carbon disulfide was not a field parameter.

The highest levels of contaminants are in the area of the process leach tank and extend southward approximately 400 feet to sample location 26 HP 24, which was the farthest downgradient sampling point for the site. The extent of horizontal migration may be further than this location, as evidenced by the highest levels of PCE at Site 26 (56 ug/L) and TCE (10 ug/L) at a level above ARARs. The highest levels of TCE at the site extend southwestward from MW26-01 to sample locations 26 HP 21 and 26 HP 22. In general, samples from each location showed higher levels of VOCs at depths above the semi-confining clay layer. Figures 1-21a through 1-21d show the groundwater TCE concentrations at varying depths below ground surface. Figures 1-22a through 1-22e show DCE concentration in groundwater at varying depths below ground surface.

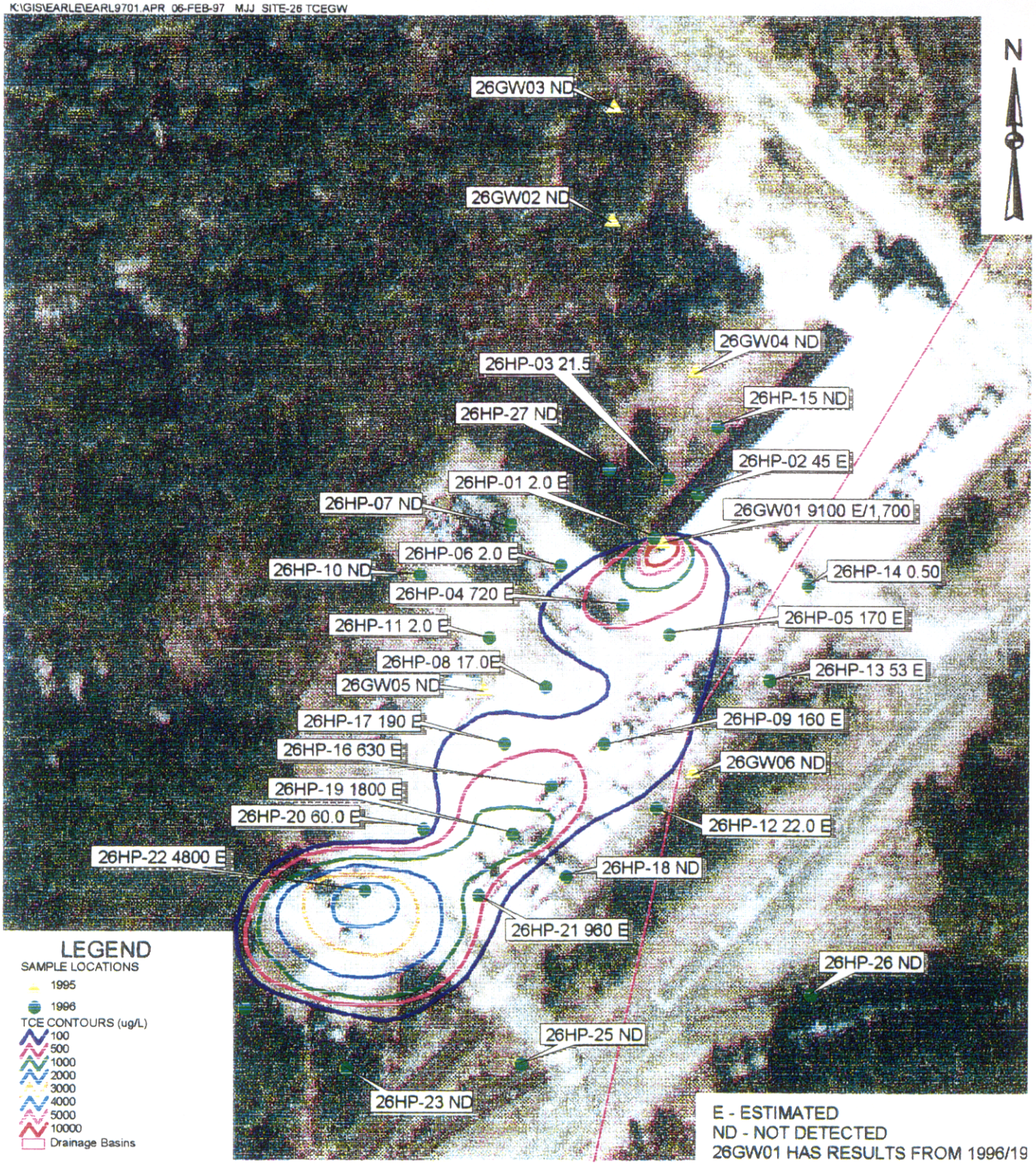
Conceptual Site Model

Figure 1-24 shows the conceptual site model. Apparently, over a period of years, liquid process wastes containing chlorinated VOCs from industrial operations performed in Building GB-1 were disposed, by way of a drain in Building GB-1, to the process leach tank system. Liquid wastes would have passed through the permeable walls and bottom of the process leach tank to enter the subsurface soil environment. Chlorinated VOCs (DNAPLs) disposed in this way would have migrated down to the semi-permeable clay layer barrier. After encountering the clay layer barrier the DNAPL would have continued to migrate downward, but at a much slower rate. VOC compounds would also have migrated downgradient (to the southwest) with the slow rate of horizontal groundwater flow.

1.3.5.5.3 Contaminant Fate and Transport

Analytical results for groundwater sampled at Site 26 indicate significant levels of TCE and associated degradation products in one monitoring well and trace levels of TCE, PCE, and chloroform in another well. Barium was detected in one subsurface soil sample at a level greater than the range associated with background samples. Zinc was detected in four site-related groundwater samples at levels that are greater than the concentration range associated with background samples. Barium was found at similarly elevated

K:\GIS\EARLE\EARL9701.APR 06-FEB-97 MJJ SITE-26 TCEGW



COMPOUNDS IN GROUNDWATER TCE (ug/L) SHALLOW ZONE (<25')
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

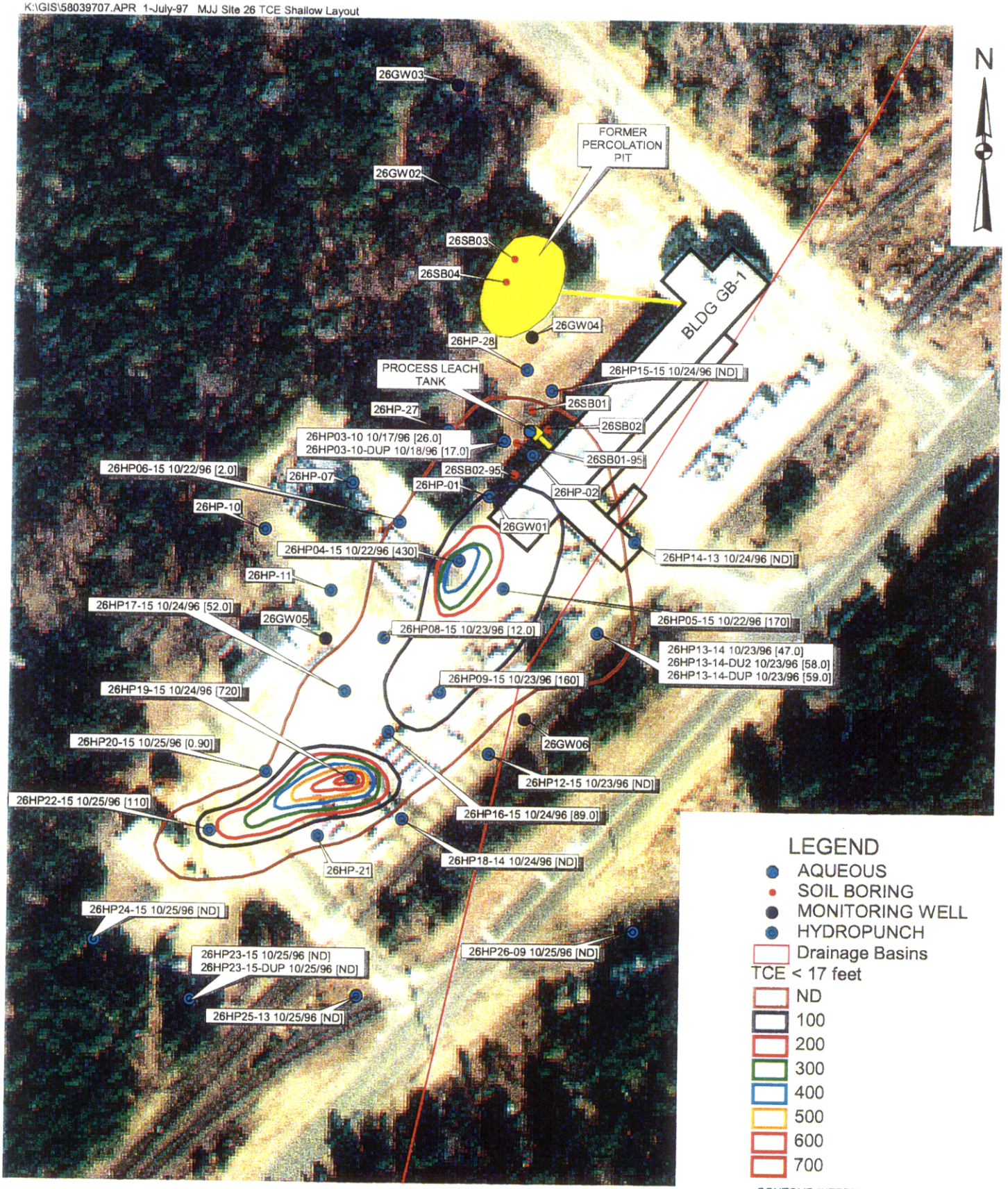
80 0 80 160 Feet

FIGURE 1-21

Brown & Root Environmenta

00535 B35Y

K:\GIS\58039707.APR 1-July-97 MJJ Site 26 TCE Shallow Layout



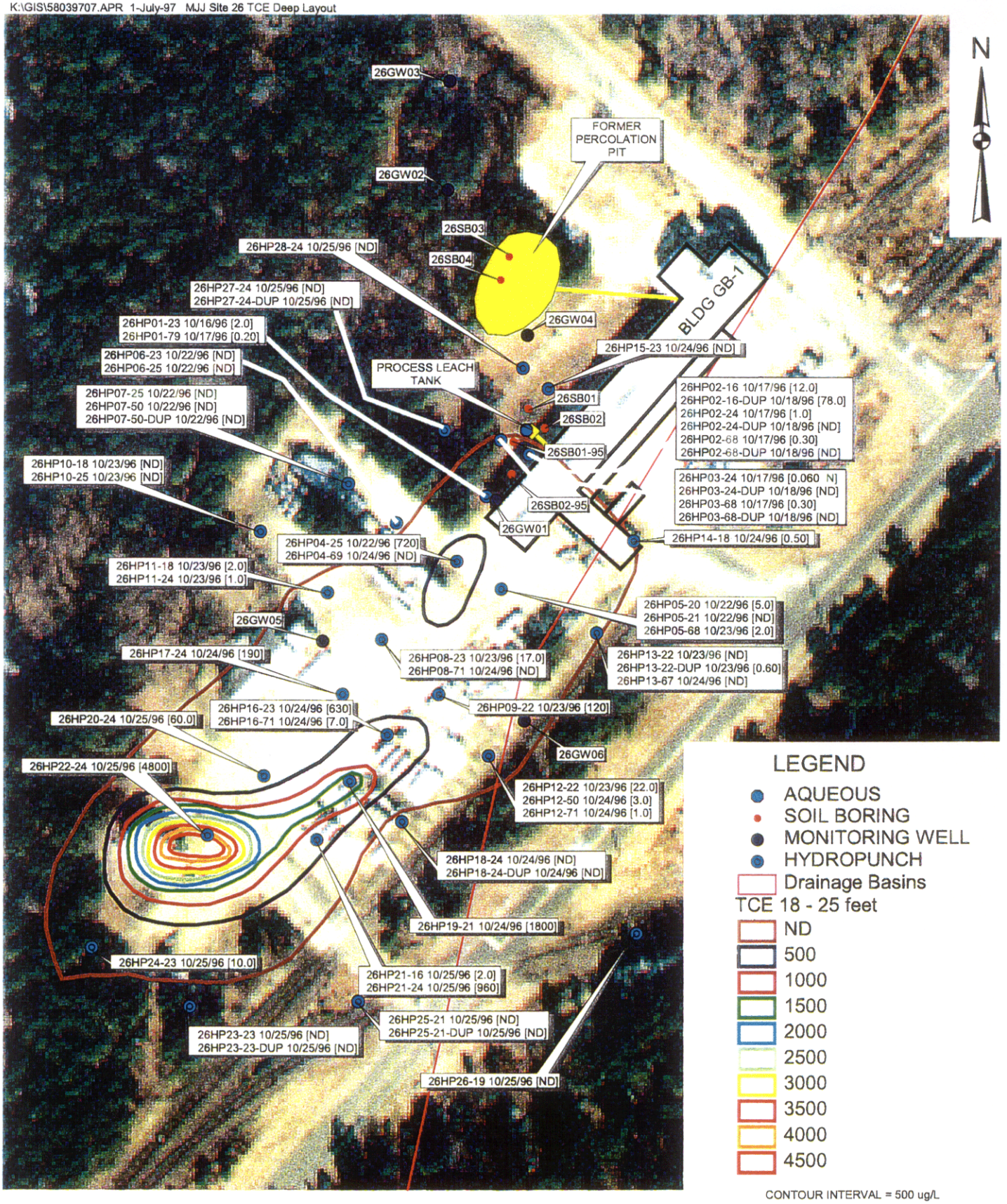
TCE IN GROUNDWATER (< 17 FEET)
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

80 0 80 160 Feet

FIGURE 1-2

Brown & Root Environmental

K:\GIS\58039707.APR 1-July-97 MJJ Site 26 TCE Deep Layout



CONTOUR INTERVAL = 500 ug/L

TCE IN GROUNDWATER (18-25 FEET)
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

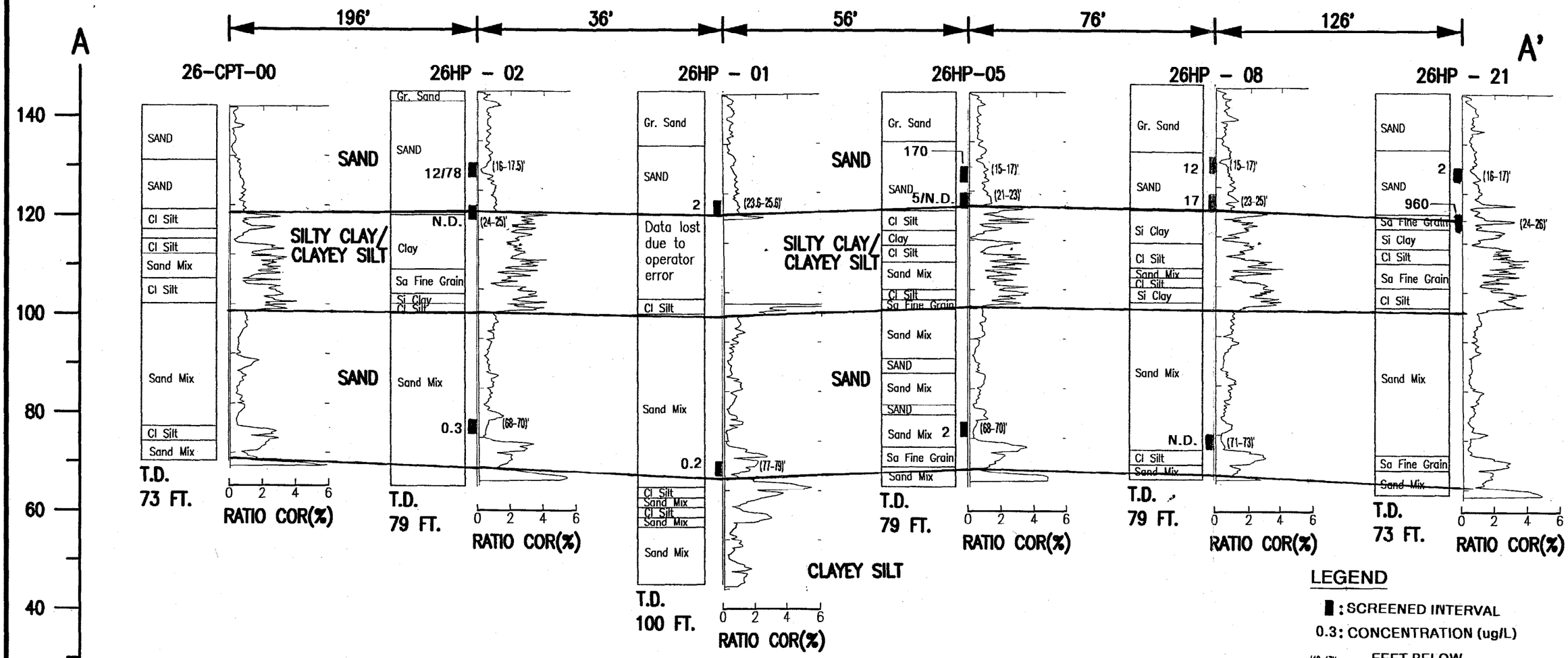
80 0 80 160 Feet

FIGURE 1-2

Brown & Root Environmental

C:\DWG\EARLE\GCSFIG10

STRIKE SECTION A – A'



LEGEND

▮ : SCREENED INTERVAL

0.3 : CONCENTRATION (ug/L)

(16-17)' : FEET BELOW GROUND SURFACE

VERTICAL SCALE 1" = 20'
NOT TO HORIZONTAL SCALE
T.D. = TOTAL DEPTH
N.D. = NOT DETECTED

NO.	DATE		BY	CHK'D	APP'D	REFERENCES

DRAWN BY A.S.M DATE 7/3/97
CHECKED BY RET
COST/SCHED.-AREA
SCALE AS SHOWN

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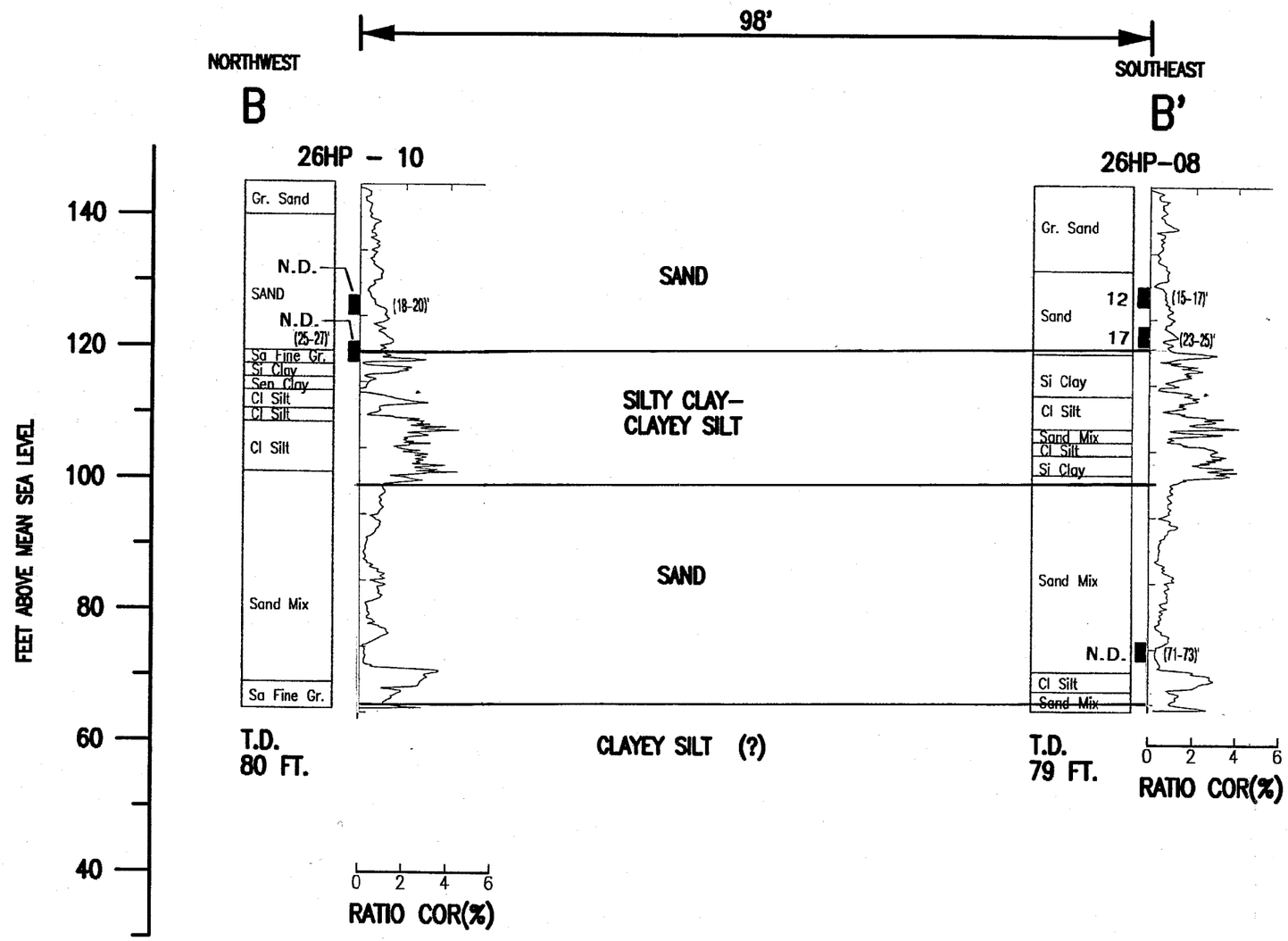
CONCENTRATION OF TCE IN GROUNDWATER (ug/L)
SITE 26 – EXPLOSIVE "D" WASHOUT AREA
N.W.S. EARLE, COLTS NECK, N.J.

CONTRACT NO. CTO 231
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-21c
REV.

00535 B B6Z

C:\DWG\EARLE\GCSFIG11

DIP SECTION B – B'



LEGEND

■ : SCREENED INTERVAL

0.3 : CONCENTRATION (ug/L)

(16-17)' : FEET BELOW GROUND SURFACE

VERTICAL SCALE 1" = 20'
NOT TO HORIZONTAL SCALE
T.D. = TOTAL DEPTH
N.D. = NOT DETECTED

NO.	DATE		BY	CHK'D	APP'D	REFERENCES

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CHECKED BY RET
COST/SCHED.–AREA
SCALE

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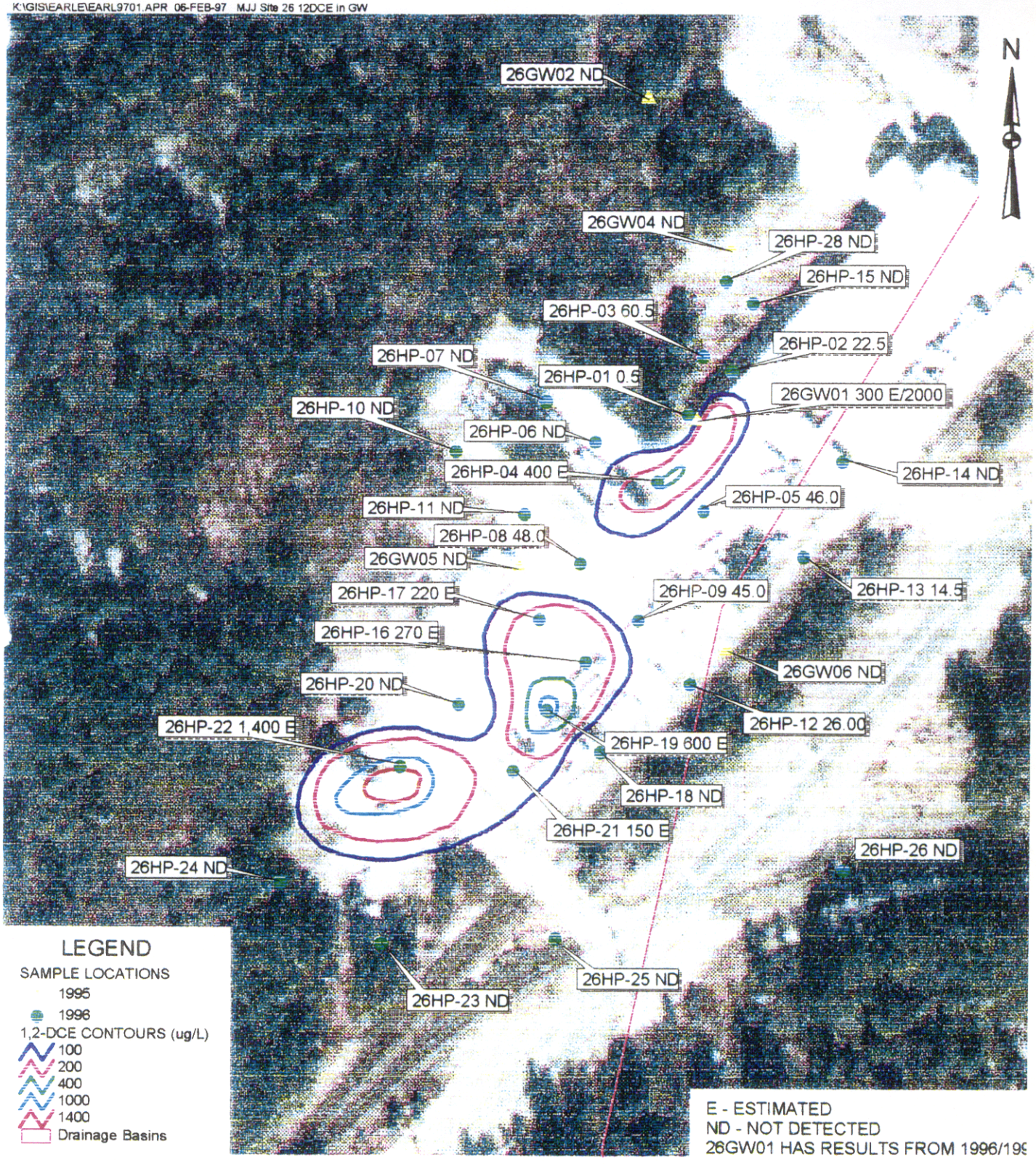
CONCENTRATION OF
TCE IN GROUNDWATER (ug/L)
SITE 26 – EXPLOSIVE "D" WASHOUT AREA
N.W.S. EARLE, COLTS NECK, N.J.

CONTRACT NO. CTO 231
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-21d
REV.

K:\GIS\EARLE\EARL9701.APR 06-FEB-97 MJJ Site 26 12DCE in GW



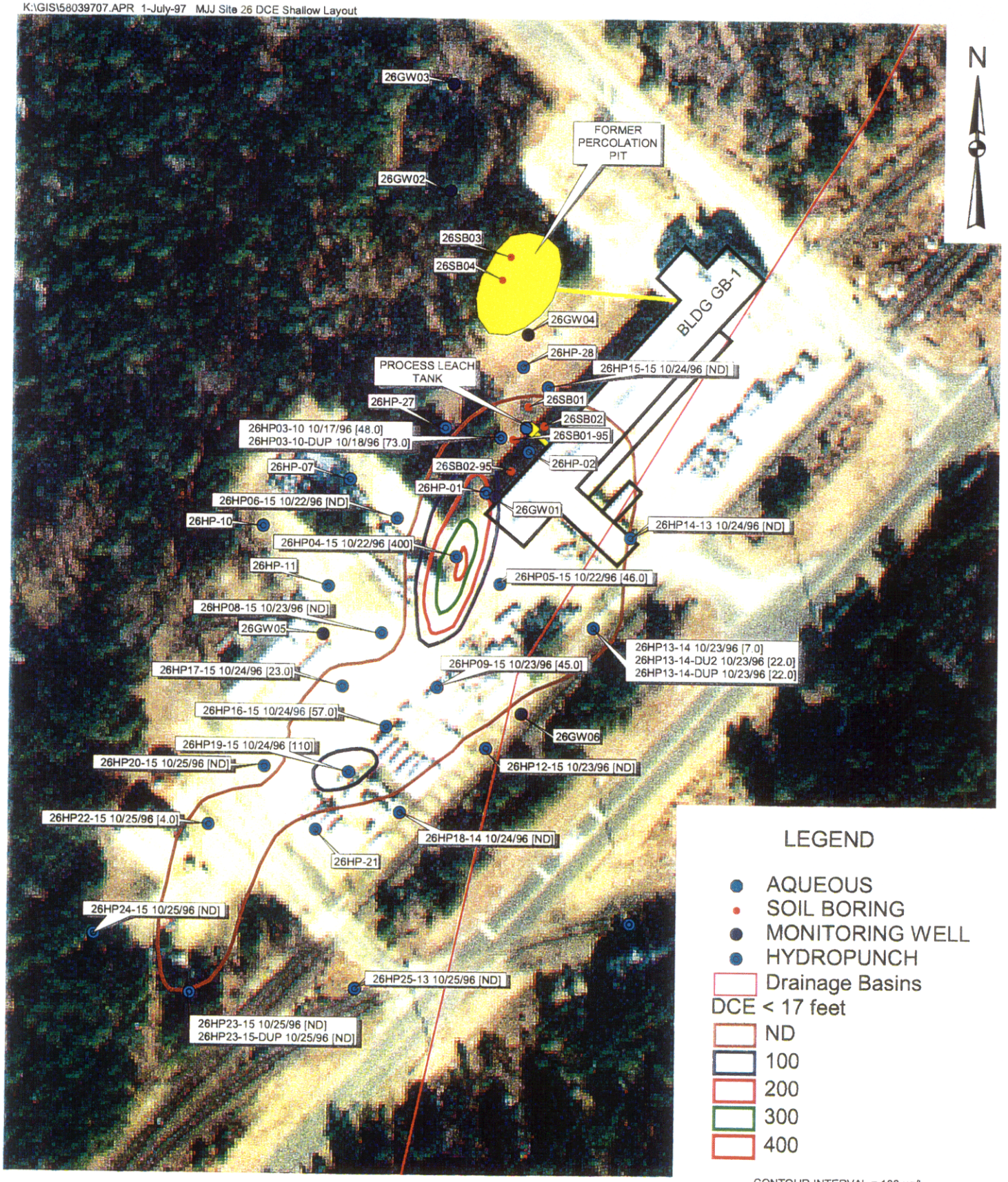
COMPOUNDS IN GROUNDWATER 1,2-DCE (ug/L) SHALLOW ZONE (<25')
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

80 0 80 160 Feet

FIGURE 1-22

Brown & Root Environmental

K:\GIS\58039707.APR 1-July-97 MJJ Site 26 DCE Shallow Layout



CONTOUR INTERVAL = 100 ug/L

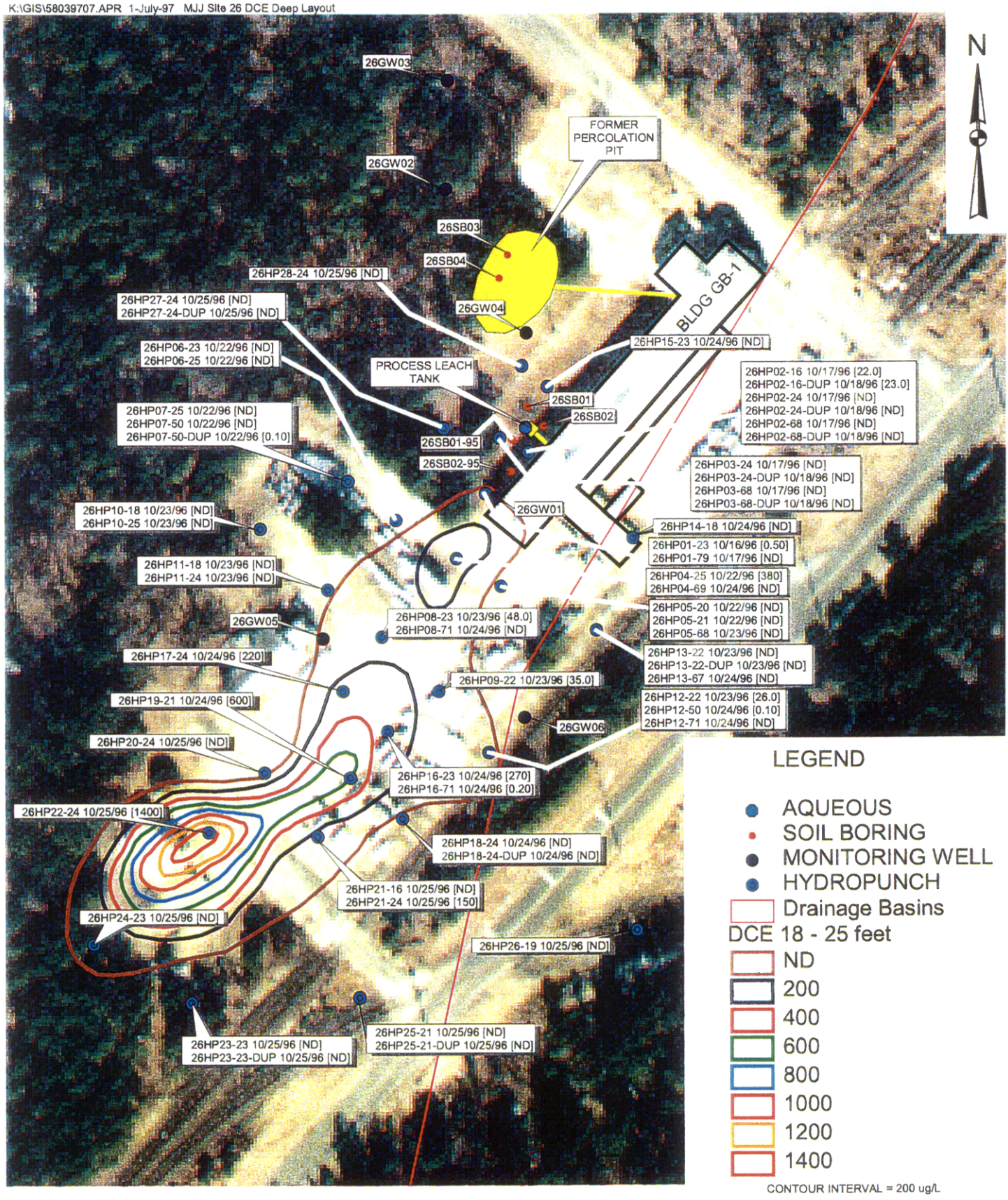
1,2-DCE IN GROUNDWATER (< 17 FEET)
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

80 0 80 160 Feet

FIGURE 1-22

Brown & Root Environmental

K:\GIS\58039707.APR 1-July-97 MJJ Site 26 DCE Deep Layout



1,2-DCE IN GROUNDWATER (18-25 FEET)
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

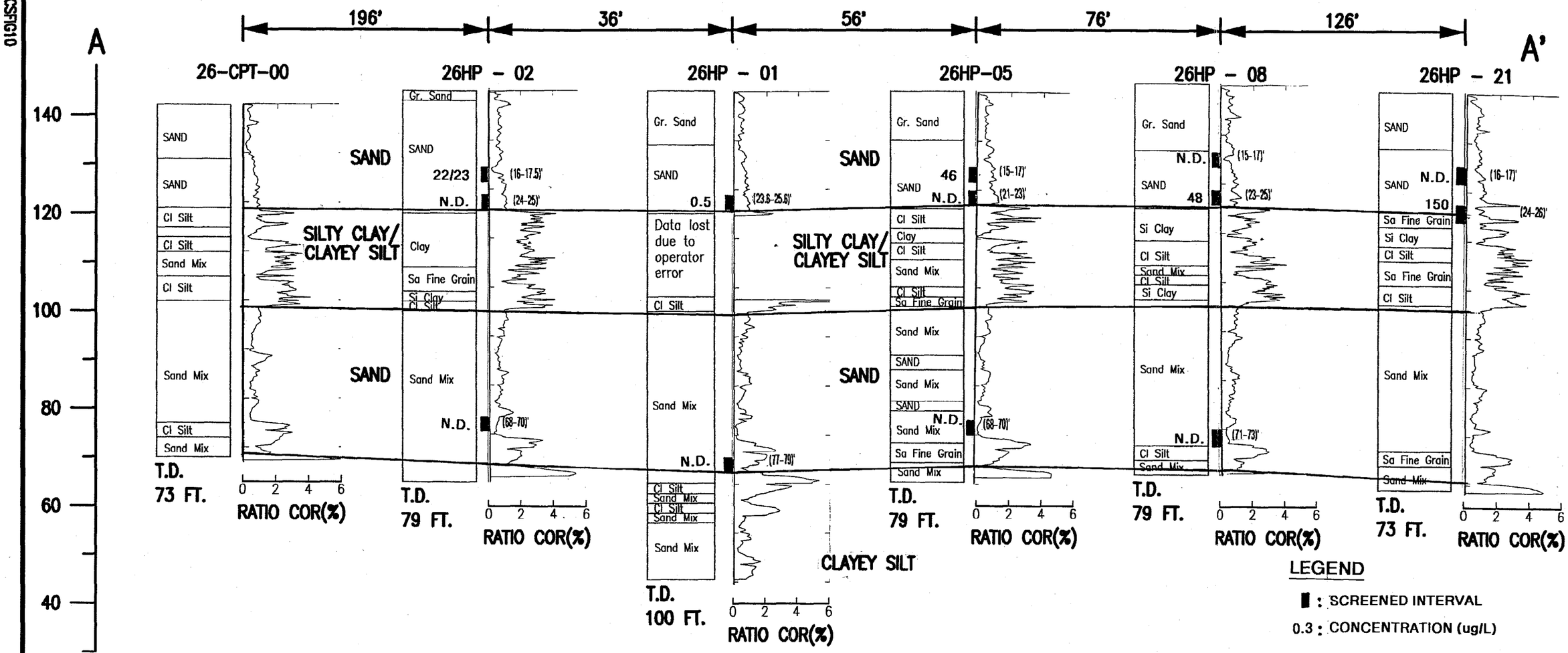
80 0 80 160 Feet

FIGURE 1-2

Brown & Root Environmental

C:\DWG\EARLEY\GCSFIG10

STRIKE SECTION A – A'



LEGEND

▮ : SCREENED INTERVAL

0.3 : CONCENTRATION (ug/L)

(16-17)' : FEET BELOW GROUND SURFACE

VERTICAL SCALE 1" = 20'
NOT TO HORIZONTAL SCALE
T.D. = TOTAL DEPTH
N.D. = NOT DETECTED

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SCALE AS SHOWN

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CONCENTRATION OF
1,2-DCE IN GROUNDWATER (ug/L)
SITE 26 – EXPLOSIVE "D" WASHOUT AREA
N.W.S. EARLE, COLTS NECK, N.J.

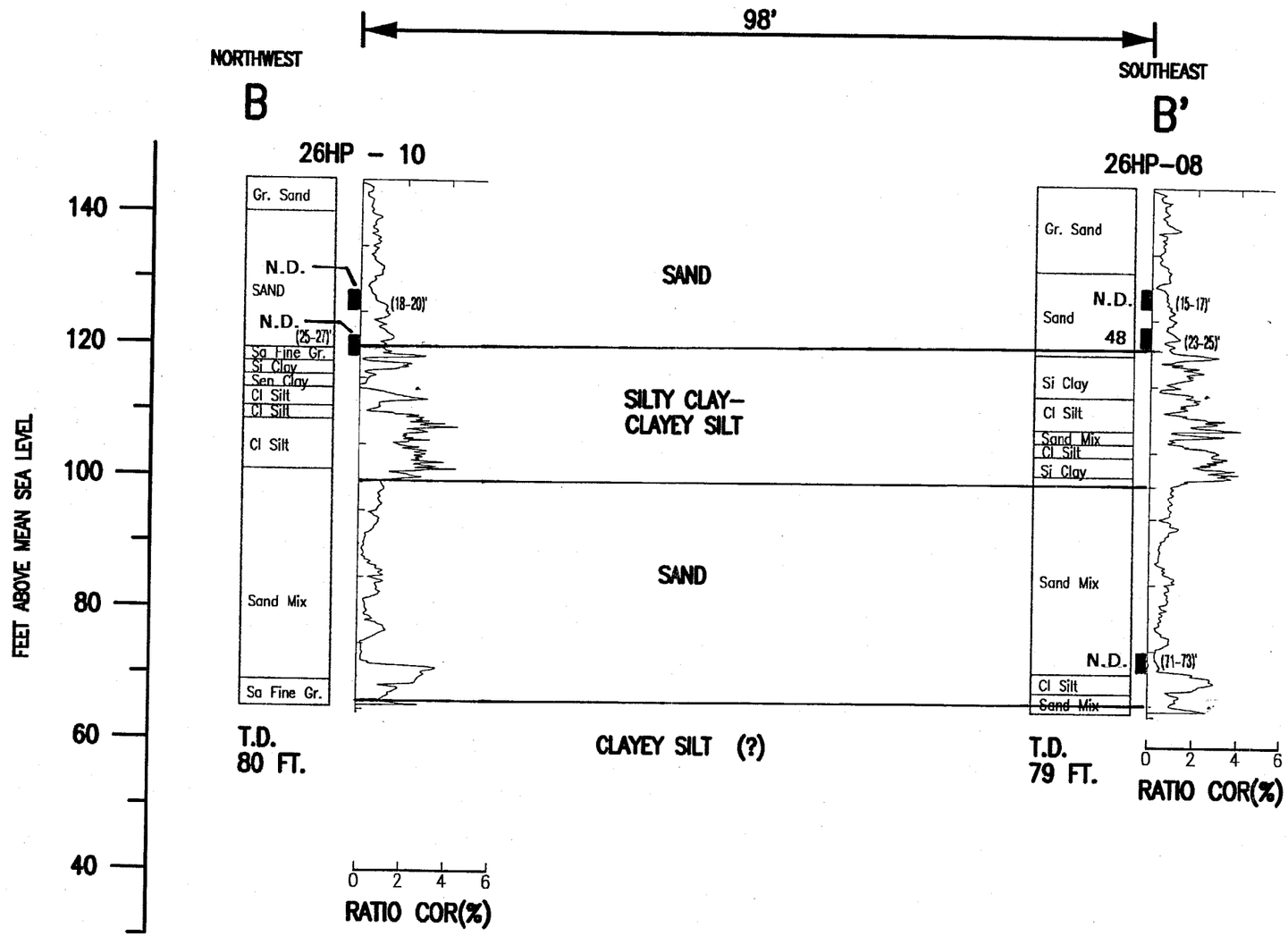
1-91

CONTRACT NO. CTO 231
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-22c
REV.

00535BB82

C:\DWG\EARLE\GCSFIG11

DIP SECTION B – B'



LEGEND

▮: SCREENED INTERVAL

0.3: CONCENTRATION (ug/L)

(16-17)': FEET BELOW GROUND SURFACE

VERTICAL SCALE 1" = 20'
NOT TO HORIZONTAL SCALE
T.D. = TOTAL DEPTH
N.D. = NOT DETECTED

NO.	DATE		BY	CHK'D	APP'D	REFERENCES

DRAWN BY A.S.M DATE 7/3/97
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COST/SCHED.–AREA
SCALE

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CONCENTRATION OF
1,2–DCE IN GROUNDWATER (ug/L)
SITE 26 – EXPLOSIVE "D" WASHOUT AREA
N.W.S. EARLE, COLTS NECK, N.J.

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OWNER NO.
APPROVED BY DATE
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DRAWING NO. FIGURE 1-22d
REV.

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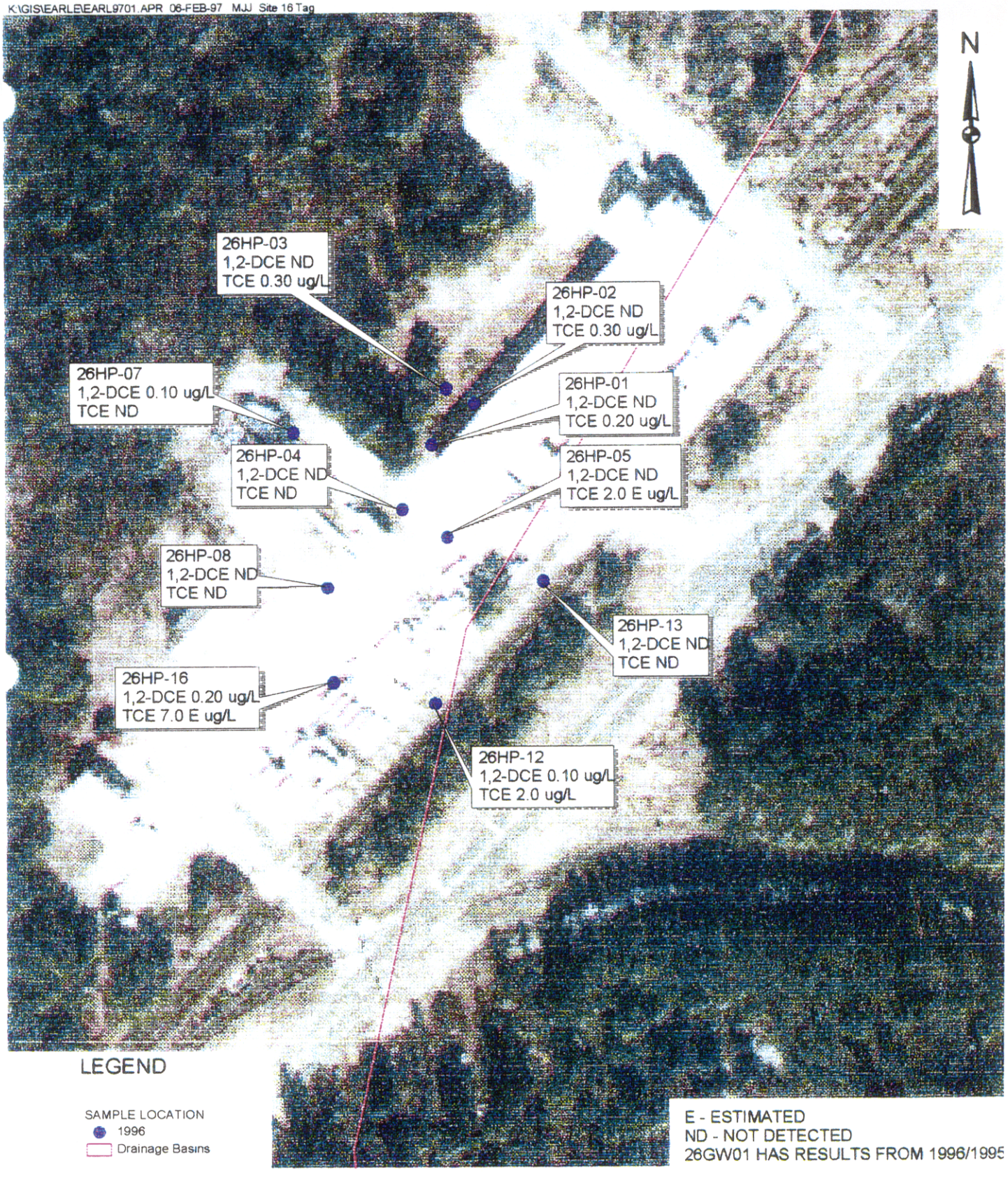
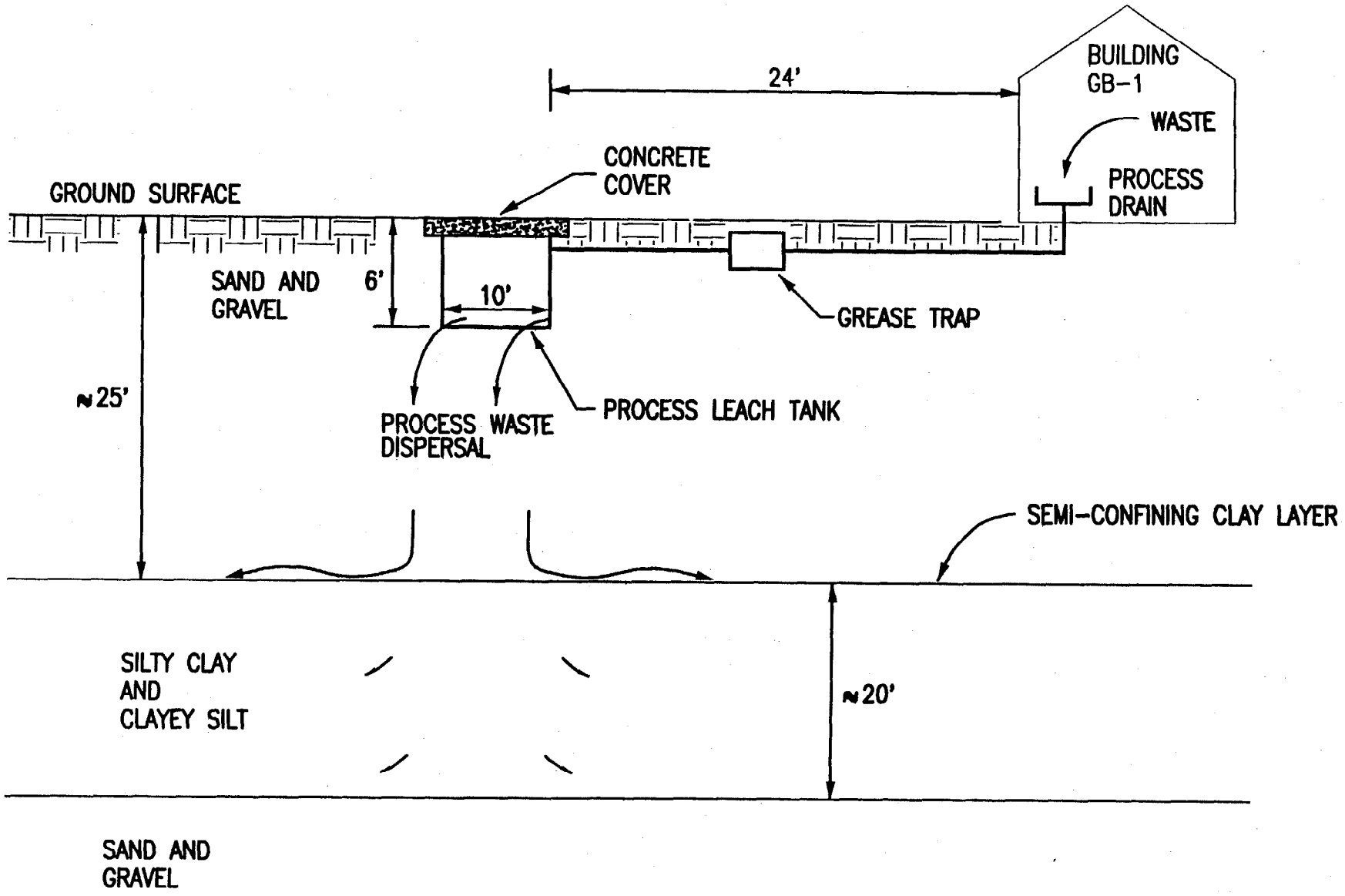


COMPOUNDS IN GROUNDWATER LOWER ZONE (45-79')
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

80 0 80 160 Feet

FIGURE 1-23

Brown & Root Environmental



SITE CONCEPTUAL MODEL

GROUNDWATER CONTAMINATION ROUTE

SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 1-24

NOT TO SCALE

Brown & Root Environmental

C:\DWG\EARLE\FIG10 - 9

levels in three groundwater samples, and cadmium and silver were detected in sample 26 GW 04 at low levels that are greater than background.

Direct-push groundwater sampling analytical results indicate a plume of VOCs (approximate dimensions of 400 feet by 160 feet) above GWQC exists in the shallow groundwater at Site 26 above the semi-confining "clay" layer.

The organic compounds detected in the groundwater are volatile and characteristically mobile in the environment (either through soil gas migration or groundwater transport). The detected chlorinated VOCs all possess specific gravities greater than 1, which indicates that a product source will tend to sink to the bottom of an aquifer rather than float on the water table. The inorganic compounds, on the other hand, have a strong tendency to adsorb onto soil/sediment particles, a factor that greatly reduces their mobility.

1.3.5.5.4 Baseline Human Health Risk Assessment

Subsurface soil and groundwater were sampled at Site 26. The potential receptors for this site were future industrial and residential receptors.

The RME cancer risks associated with future residential (subsurface soil and groundwater) exposure scenarios exceeded 1E-04, the upper end of the target risk range. In addition, CTE cancer risks also exceeded 1E-04. TCE and 1,1-DCE (via groundwater ingestion and inhalation during showering) and arsenic (via ingestion of and dermal contact with soil) are 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 scenarios exceeded 1.0, the cutoff point below which adverse noncarcinogenic effects are not expected to occur. TCE and 1,2-DCE were the COPCs that exceeded 1.0 or contributed to the HI exceeding 1.0 for these exposure scenarios. In addition, CTE risk estimates for residential and industrial exposure to groundwater yielded HIs greater than 1.0; affected target organs include liver, cardiovascular system, and central nervous system.

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

1.3.5.5.5 Ecological Risk Assessment

Site 26 is relatively small and consists of turfgrass or developed areas, providing little ecological habitat. Wooded uplands are present northwest of the site. These upland areas provide excellent habitat for a wide variety of terrestrial organisms. No wetlands, other sensitive habitats, or threatened or endangered species of any kind exist in the vicinity of Site 26.

No significant contaminant migration pathways to the upland habitats exist at the site. Overland runoff of contaminants from the percolation pit is unlikely since water percolates through and is not expected to overflow the edges of the pit. Water in the leaching tank/grease trap area is not expected to migrate via overland runoff to the upland areas since water tends to settle in this area, and the wooded areas are a few feet higher on grade than the area next to Building GB-01. Groundwater discharge of contaminants to surface water is also insignificant since no wetlands or other surface waters are present near the site. Groundwater contaminants are not expected to migrate several hundred yards to the nearest substantial surface waters because of the relatively slow groundwater flow velocity.

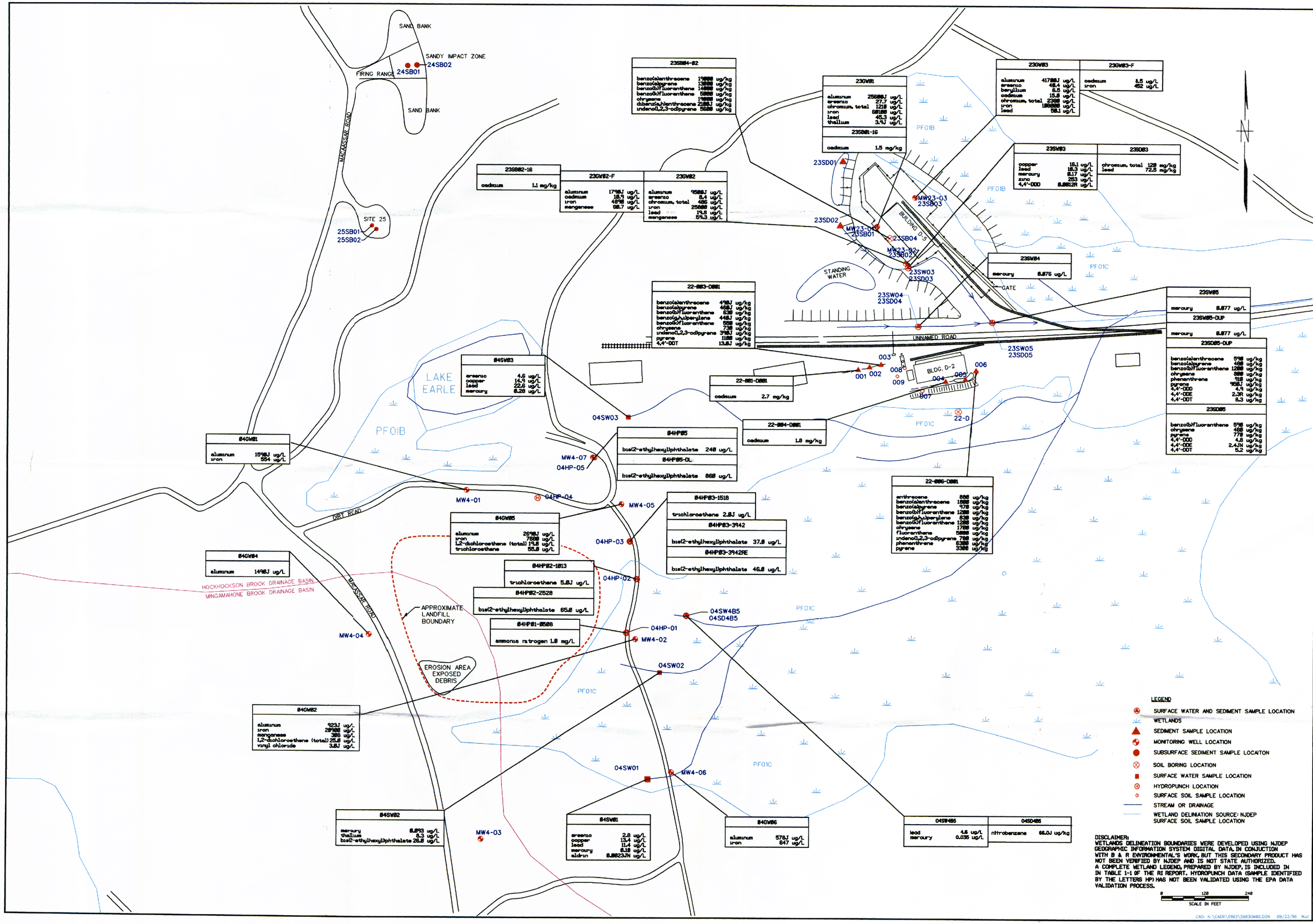
1.4 GROUNDWATER FATE AND TRANSPORT MODELING

As part of the FS, computer modeling of the contaminant plumes associated with each NWS Earle site was prepared to help assess the duration until 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 Sites 4, 5, and 19. The representative metals concentrations developed for use in the risk assessment were employed as the input values for modeling at Sites 4 and 5. For Site 19, the MW19-05 and MW-19-07 data were used as input values, since these are believed to be more representative of contaminants associated with the settling pond. The available VOC data for Site 26 were sufficient for use in this initial modeling effort and, therefore, estimates of VOC

presence and associated concentrations were prepared. The modeling results are presented in Appendix A and are discussed in Section 2 for each site.


SAND BANK
SANDY IMPACT ZONE
24SB02
24SB01
FIRING RANGE
SAND BANK
MACASSAR ROAD
SITE 25
25SB01
25SB02
23SB84-B2
benzo(a)anthracene 1900B ug/kg
benzo(a)pyrene 1300B ug/kg
benzo(b)fluoranthene 1400B ug/kg
benzo(k)fluoranthene 600B ug/kg
chrysene 1900B ug/kg
dibenzo(a,h)anthracene 210BJ ug/kg
indeno(1,2,3-cd)pyrene 560B ug/kg
23GW01
aluminum 25600J ug/L
arsenic 27.7 ug/L
chromium, total 121B ug/L
iron 68100 ug/L
lead 45.3 ug/L
thallium 3.9J ug/L
23SB01-16
cadmium 1.5 mg/kg
23GW03
aluminum 41700J ug/L
arsenic 48.4 ug/L
beryllium 5.5 ug/L
cadmium 15.8 ug/L
chromium, total 230B ug/L
iron 100000 ug/L
lead 58.1 ug/L
23GW03-F
cadmium 8.5 ug/L
iron 452 ug/L
23SB82-16
cadmium 1.1 mg/kg
23GW02-F
aluminum 1790J ug/L
cadmium 18.9 ug/L
iron 4890 ug/L
manganese 68.7 ug/L
23GW02
aluminum 9500J ug/L
arsenic 8.4 ug/L
chromium, total 486 ug/L
iron 25800 ug/L
lead 19.8 ug/L
manganese 51.3 ug/L
23SW03
copper 16.1 ug/L
lead 18.3 ug/L
mercury 0.17 ug/L
zinc 253 ug/L
4,4'-DDD 0.00121 ug/L
23SD03
chromium, total 128 mg/kg
lead 72.5 mg/kg
23SD01
23SD02
MW23-03
23SB03
MW23-04
23SB01
23SB04
MW23-02
23SB02
23SW03
23SD03
23SW04
23SD04
23SW05
23SD05
BUILDING 0.5
STANDING WATER
GATE
PF01B
PF01C
23SW04
mercury 0.076 ug/L
23SW05
mercury 0.077 ug/L
23SW05-DUP
mercury 0.077 ug/L
23SD05-DUP
benzo(a)anthracene 590 ug/kg
benzo(a)pyrene 460 ug/kg
benzo(b)fluoranthene 1200 ug/kg
chrysene 880 ug/kg
phenanthrene 910 ug/kg
pyrene 950J ug/kg
4,4'-DDD 4.9 ug/kg
4,4'-DDE 2.3B ug/kg
4,4'-DDT 8.3 ug/kg
23SD05
benzo(b)fluoranthene 590 ug/kg
chrysene 460 ug/kg
pyrene 770 ug/kg
4,4'-DDD 4.8 ug/kg
4,4'-DDE 2.4JN ug/kg
4,4'-DDT 5.2 ug/kg
22-083-D001
benzo(a)anthracene 490J ug/kg
benzo(a)pyrene 460J ug/kg
benzo(b)fluoranthene 630 ug/kg
benzo(g,h,i)perylene 440J ug/kg
benzo(k)fluoranthene 500 ug/kg
chrysene 730 ug/kg
indeno(1,2,3-cd)pyrene 390J ug/kg
pyrene 1100 ug/kg
4,4'-DDT 13.8J ug/kg
UNNAMED ROAD
BLDG. D-2
001
002
003
004
005
006
007
008
009
22-D
22-081-D001
cadmium 2.7 mg/kg
22-084-D001
cadmium 1.8 mg/kg
22-086-D001
anthracene 880 ug/kg
benzo(a)anthracene 1800 ug/kg
benzo(a)pyrene 970 ug/kg
benzo(b)fluoranthene 1200 ug/kg
benzo(g,h,i)perylene 830 ug/kg
benzo(k)fluoranthene 1200 ug/kg
chrysene 1700 ug/kg
fluoranthene 5000 ug/kg
indeno(1,2,3-cd)pyrene 700 ug/kg
phenanthrene 5300 ug/kg
pyrene 3300 ug/kg
LAKE EARLE
04SW03
84SW03
arsenic 4.6 ug/L
copper 14.9 ug/L
lead 22.6 ug/L
mercury 0.28 ug/L
84GW01
aluminum 1590J ug/L
iron 554 ug/L
84HP05
bis(2-ethylhexyl)phthalate 240 ug/L
84HP05-DL
bis(2-ethylhexyl)phthalate 860 ug/L
MW4-07
04HP-05
MW4-01
04HP-04
MW4-05
84HP03-1518
trichloroethene 2.8J ug/L
84HP03-3942
bis(2-ethylhexyl)phthalate 37.0 ug/L
84HP03-3942RE
bis(2-ethylhexyl)phthalate 46.0 ug/L
04HP-03
84GW05
aluminum 2590J ug/L
iron 7600 ug/L
1,2-dichloroethene (total) 17.0 ug/L
trichloroethene 55.0 ug/L
84GW04
aluminum 1490J ug/L
HOCKHOCKSON BROOK DRAINAGE BASIN
MINGAMAHONE BROOK DRAINAGE BASIN
DIRT ROAD
84HP02-1013
trichloroethene 5.0J ug/L
04HP-02
84HP02-2528
bis(2-ethylhexyl)phthalate 65.0 ug/L
APPROXIMATE LANDFILL BOUNDARY
84HP01-0508
ammonia nitrogen 1.8 mg/L
04HP-01
MW4-02
04SW4B5
04SD4B5
MW4-04
EROSION AREA EXPOSED DEBRIS
04SW02
84GW02
aluminum 923J ug/L
iron 29200 ug/L
manganese 386 ug/L
1,2-dichloroethene (total) 25.0 ug/L
vinyl chloride 3.0J ug/L
04SW01
MW4-06
84SW02
mercury 0.093 ug/L
thallium 8.3 ug/L
bis(2-ethylhexyl)phthalate 26.0 ug/L
MW4-03
84SW01
arsenic 2.8 ug/L
copper 13.4 ug/L
lead 11.4 ug/L
mercury 0.18 ug/L
zinc 0.00823JN ug/L
84GW06
aluminum 578J ug/L
iron 847 ug/L
04SW05
lead 4.6 ug/L
mercury 0.035 ug/L
04SD05
nitrobenzene 66.0J ug/kg
LEGEND
SURFACE WATER AND SEDIMENT SAMPLE LOCATION
WETLANDS
SEDIMENT SAMPLE LOCATION
MONITORING WELL LOCATION
SUBSURFACE SEDIMENT SAMPLE LOCAITON
SOIL BORING LOCATION
SURFACE WATER SAMPLE LOCATION
HYDROPUNCH LOCATION
SURFACE SOIL SAMPLE LOCATION
STREAM OR DRAINAGE
WETLAND DELINIATION SOURCE: NJDEP
SURFACE SOIL SAMPLE LOCATION
DISCLAIMER:
WETLANDS DELINEATION BOUNDARIES WERE DEVELOPED USING NJDEP GEOGRAPHIC INFORMATION SYSTEM DIGITAL DATA, IN CONJUCTION WITH B & R ENVIRONMENTAL'S WORK, BUT THIS SECONDARY PRODUCT HAS NOT BEEN VERIFIED BY NJDEP AND IS NOT STATE AUTHORIZED.
A COMPLETE WETLAND LEGEND, PREPARED BY NJDEP, IS INCLUDED IN IN TABLE 1-1 OF THE RI REPORT. HYDROPUNCH DATA (SAMPLE IDENTIFIED BY THE LETTERS HP) HAS NOT BEEN VALIDATED USING THE EPA DATA VALIDATION PROCESS.
0 120 240
SCALE IN FEET
CAD: K:\CADD\5803\5803CM02.DGN 09/23/96 MJJ
REVISIONS
DESCRIPTION
DATE
APPROVED
A/E
DESIGN
DRAWN
REVIEW
CHIEF ARCH./ENGR.
PROJECT MANAGER
FIRE PROTECTION
QUALITY CONTROL
BRANCH MANAGER
DESIGN DIRECTOR
Brown & Root Environmental
ACTIVITY - SATISFACTORY TO
FOR EFD FOR COMMENT
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION
PHILADELPHIA, PENNSYLVANIA
COLTS NECK, NEW JERSEY
NWS EARLE
SITE 4, 22, 23, 24, & 25
SITE RELATIONSHIP MAP
SHEET TITLE
CODE ID. NO. 80091
SIZE D
SCALE:
EFD NO.
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SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
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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 remedial action objectives (RAOs) that are protective of human health and the environment with regard to the contaminants and media of concern, exposure pathways, and the preliminary remediation goals (PRGs), 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 applicable or relevant and appropriate requirements (ARARs) and other guidance to be considered (TBCs) in the development of RAOs for the NWS Earle OU-1, OU-2, and OU-3 Sites. Section 2.2 briefly presents the overall approach used to develop RAOs. Section 2.3 summarizes the overall approach used in development of preliminary remediation goals (PRGs). Section 2.4 identifies the general response actions that may be implemented at NWS Earle. The site-specific development of RAOs, PRGs, general response actions, and screening of remedial technologies and process options for Sites 4, 5, 19 and 26 is presented in Sections 2.6, 2.7, 2.8 and 2.9 respectively.

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 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 cleanup 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 cleanup 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 close 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 Sites 4, 5, 19, and 26 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 cleanup 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 cleanup 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 cleanup 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 cleanup levels that are protective of human health and the environment.

TABLE 2-1
POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs
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 the NWS Earle Sites. MCLs can be used to derive potential soil cleanup 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 record keeping 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 (AWQC)	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. AWQC 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
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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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 which 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 cleanup 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 the NWS Earle Sites 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 cleanup 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 FEDERAL 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
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.	Both Sites 4 and 5 landfills are 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 ground water quality through establishing groundwater protection and clean up standards, and setting numerical criteria limits for discharges to ground water. The Ground Water Criteria (GWQC) (N.J.A.C. 7:9-6.7) are the maximum allowable for pollutant concentrations in ground water that are protective of human health. This regulation also prohibits the discharges to groundwater that subsequently discharges to surface water, which do not comply the Surface Water Quality Standards (SWQS).	Because contaminated groundwater is present underneath the NWS Earle Sites in excess of GWQS, these regulations will be considered in determining groundwater action levels.
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, establish water quality based criteria, and effluent discharge limitations. The Surface Water Criteria (SWQC) (N.J.A.C. 7:9B-14) are the maximum allowable for pollutant concentrations in surface water for the designated use.	For alternatives where surface water may be affected by the sites, 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 the portion of the aquifer underlying the NWS Earle Sites. MCLs can be used to derive potential soil cleanup 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 cleanup criteria for soil concentrations for residential direct contact, non-residential direct contact, and impact to ground water (through leaching).	These criteria will be considered in the development of soil cleanup goals.

While there are no specific promulgated soil cleanup standards, 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 cleanup 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.

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 (if on-base treatment of contaminated materials is enacted within a wetland).

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

TABLE 2-3
POTENTIAL FEDERAL LOCATION-SPECIFIC ARARs AND TBCs
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 the NWS Earle Sites. 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 the floodplain 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 of 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), endangered or threatened species present at the NWS Earle Sites.
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 to 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 U.S. Fish and Wildlife Service, the State DEP, and EPA would be consulted.

TABLE 2-3
POTENTIAL FEDERAL LOCATION-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
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 the NWS Earle Site.
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 the NWS Earle Site.

TABLE 2-4
POTENTIAL STATE LOCATION-SPECIFIC ARARs AND TBCs
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 fresh water wetland areas including: removing or dredging wetland soils, disturbing the water level or water table, driving piles, placing of 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 the NWS Earle Sites.
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 flood plains 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 the NWS Earle Sites.
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, ground water, air, and environmentally sensitive areas.	If remedial alternatives employs an on-site or on-base treatment of contaminated soils, sediments, or materials, then remediation activities will be consistent with these requirements.

indicate how a selected alternative must be achieved. Summaries of the potential action-specific 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 record keeping [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, closure and post-closure 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 Sites 4 and 5 are military municipal landfills, 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

TABLE 2-5
POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
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, record keeping, 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 and implemented site remediation. Copies of the plans will be kept on-site.
RCRA - Manifesting Recordkeeping, and Reporting (40 CFR 265 Subpart E)	Potentially Applicable	Specifies the record keeping 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
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
RCRA - Closure and Post-Closure (40 CFR 258, Subpart F)	Potentially Applicable	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 municipal landfill, then these requirements will be complied with during and following site remediation.
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 in-situ or 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
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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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 would be considered in formulating remedial alternatives for Sites 4 and 5.
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 would be considered in formulating remedial alternatives for Sites 4 and 5.

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

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
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, record keeping, 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 Applicable	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 final cover, groundwater monitoring, and maintaining and operating a gas collection system.	If an alternative includes closure of a municipal landfill, then these requirements will be complied with during site remediation.
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 in consistent with this regulation.

TABLE 2-6
POTENTIAL STATE ACTION-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 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 in 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 measures to comply with these requirements.

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 GWQS).

RAO development for Sites 4, 5, 19 and 26 is presented in Sections 2.6, 2.7, 2.8, and 2.9, respectively.

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. For each site, 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 Sections 2.6, 2.7, 2.8, and 2.9, respectively.

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 cleanup 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 GWQS 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 a Hazard Index (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 any of the sites for residential purposes.

2.3.3 Ecological Risk Basis

Ecological risk screening indicated the presence of cadmium, chromium, and lead at concentrations above their respective ecotox threshold in Site 19 sediment. However, the preferred remedy for Site 19 includes removal and off-site treatment and/or disposal of the contaminated ditch sediments. Therefore, no contaminants of concern are addressed and no PRGs are developed under this FS based on ecological risk .

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 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 upper tolerance limit (UTL) values were calculated and are presented in Tables 31-7 and 31-8 of the RI. Representative background groundwater concentration values for formations underlying NWS Earle are presented in Tables 31-4, 31-5, and 31-6 of the RI Report. 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 sites include:

- 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:

- 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 Sites 4, 5, 19, and 26 are presented in Sections 2.6, 2.7, 2.8, and 2.9 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 for each site.

2.6 SITE 4 TECHNOLOGY SCREENING

The selection of viable remedial technologies and process options for assemblage into remedial alternatives for Site 4 is presented in this section.

2.6.1 Site 4 Remedial Action Objectives

The results of the RI, previous investigations, and the human health and ecological risk assessments for Site 4 were evaluated to determine the remedial action objectives that may be needed to protect human health and the environment.

Human Health Protection Considerations

Because Site 4 is an inactive military landfill with no known deposition of military-specific wastes (e.g., chemical warfare agents), the presumptive remedy guidance for CERCLA municipal landfills was applied to the site. Landfill materials and soils likely contain a variety of chemicals based on the chemicals that were detected in downgradient groundwater and the adjacent wetlands and on information obtained under previous investigations regarding materials that were disposed in the landfill. Therefore, exposure to contaminated landfill soils and materials may pose excess health risks to humans and remedial action would be warranted to protect human health.

Risk assessment results indicated that, under the future residential land use scenario, exposure to contaminated groundwater through ingestion, dermal contact, and inhalation poses potential risks that would exceed EPA's target risk range of 1 E-06 to 1 E-04 carcinogenic risk, and the HI for target organs would exceed 1.0. Therefore, remedial actions may be needed to mitigate potential human health risks through exposure to contaminated groundwater.

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 4 being considered for future residential land use.

Ecological Receptors Risk Considerations

The Site 4 ecological risk assessment (ERA) identified the presence of wetlands adjacent to the landfill and indicated that runoff and groundwater discharge could convey landfill contaminants into the wetlands. However, review of the RI findings indicates the metals present did not exceed

any benchmark toxicity values and only nitrobenzene exceeded a screening value. The ERA concluded that, because of the low contaminant concentrations present in the wetland surface water and sediment adjacent to the landfill, Site 4 does not pose significant potential risks to ecological receptors. Therefore, active remedial actions for the wetlands sediments and surface water may not be warranted to protect ecological receptors.

Environmental Media Protection Considerations

The RI determined that the Site 4 landfill was a continuing source of metals and VOCs that degraded the groundwater quality and that groundwater adjacent to the landfill contained contaminants in concentrations in excess of the state GWQS (see Table 2-7). Review of the RI data revealed that although iron and manganese levels exceeded the GWQS, most metal analytes of concern were present at levels that were comparable to or slightly higher than the GWQS. RI data indicated VOCs in excess of GWQS at 2 of the 4 wells (04GW02 and 04GW05) downgradient of the landfill. The VOCs were detected at concentrations that were comparable to or slightly greater than the regulatory standards. The extent of groundwater contamination is limited, and only a few chemicals exceeded the state ARARs.

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. 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 (1,2-DCE, TCE, and VC) and metals (barium, iron, and manganese) 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 4 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 400 feet downgradient of Site 4, would be well below either the state GWQS or the background levels (Table 1, Appendix A). Another iteration of the computer model estimated that 55 feet downgradient of the site was the maximum distance where metals in groundwater would exceed either GWQS or background levels (Table 2,

TABLE 2-7
SITE 4 GROUNDWATER CONTAMINANTS OF CONCERN
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Exceeds NJ GWQS	Exceeds SDWA MCLs	Poses Human Health Risk
Barium	--	--	X (2)
Iron	X	(1)	X (2)
Manganese	X	(1)	--
1,2-dichloroethene	X	--	X (2)
Trichloroethene	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 Ground Water 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

-- Not a COC; does not exceed GWQS, SWDA MCLs, or pose potential human health risks
(1) No SDWA MCL for this analyte.
(2) COC contributes to HI > 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.

Appendix A). These results indicate that metals are unlikely to migrate very far from Site 4, and their concentrations would be below either GWQS or background levels within a relatively short distance of Site 4. The lack of lateral dispersion can probably be attributed to the metals' soil-water partitioning coefficients (Kd) values, which indicate a preference for adsorption to the soils, thus retarding the metals downgradient migration.

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, and use the new data to refine the model estimates through input of site-specific soil-water partitioning coefficients that would be developed as part of the remedial action. If the revised model or observation of actual site conditions indicate 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.

The RI concluded that surface runoff from the landfill and groundwater discharge likely conveyed contaminants into the nearby wetlands sediments and surface water. Several metals and organics were detected in surface water at levels exceeding the state SWQCs. If source control measures are implemented to reduce landfill erosion and groundwater contamination, then contaminant migration to the wetlands is likely to diminish in the long term. Therefore, if the presumptive remedy is applied at Site 4, then no active remediation of the wetland sediments and adjacent surface water may be necessary.

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.

RAOs Selection

For the reasons provided above, the following remedial action objectives have been selected for Site 4:

Protection of Human Health RAOs

- Prevent potential human exposure to contaminated landfill soils and materials.
- Prevent potential human exposure to VOCs and metals in groundwater.

Protection of the Environment RAO

- Minimize migration of landfill contaminants to groundwater and the adjacent wetlands (surface water and sediments) and restore the aquifer to the applicable standard.

2.6.2 Site 4 Preliminary Remediation Goals

Data from the RI, the human health risk assessment, and ARARs were reviewed to identify contaminants of concern (COCs) for Site 4. A summary and the basis for selecting the COCs are provided in Table 2-7 .

Because Site 4 is an inactive military municipal landfill, the presumptive remedy for CERCLA municipal landfill will be applied. RI sampling of soils and landfill materials was limited to visual inspection and field instruments testing.

The organics and metal contaminants in groundwater that would contribute to excess human health carcinogenic risk (greater than 1 E-04 total) or on HI greater than 1.0 were selected as human health risk-based COCs, which are presented in Table 2-8.

Because several organic and metal contaminants in groundwater underlying and adjacent to the site exceed the state GWQS, 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.

A set of proposed groundwater PRGs for Site 4 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

TABLE 2-8
SITE 4 GROUNDWATER PRELIMANARY REMEDIATION GOALS (μg/L)
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	ARARS NJ GWQS	SDWA MCLs	PRG(3) Based on Risk = 1E-6 [carcinogen]	PRG(3) Based on HI = 0.1 [non-carcinogen]	Maximum Background Conc.	Maximum Detected Site Conc.
Barium	--	--	--	104	518	961
Iron	300	(1)	--	452	7690	20900
Manganese	50	(1)	--	--	65	306
1,2-Dichloroethene	10	100/70 (2)	--	13.3	BDL	25
Trichloroethene	1	5	3.65	--	BDL	55
Vinyl Chloride	5	2	0.028	--	BDL	3

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) 100 mg/L for trans-1,2 DCE and 70 mg/L for cis-1,2 DCE.
(3) PRG numerical values for carcinogens and non-carcinogens are based on exposure scenarios and factors applied in the NWS Earle human health risk assessment.

TABLE 2-9
SITE 4 PROPOSED GROUNDWATER PRGs
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Proposed PRG	Basis of Selection
Barium	518	Background
Iron	7690	Background
Manganese	65	Background
1,2-dichloroethene	100/10	NJ GWQS
Trichloroethene	1	NJ GWQS
Vinyl Chloride	2	NJ GWQS

Notes:

- all units in µg/L
- New Jersey State Ground Water Quality Standards (GWQS) [N.J.A.C. 7:9-6] are ARARs.

volume of contaminated groundwater that may need to be evaluated for potential remedial action, and may also be used in establishing Classification Exception Areas (CEAs) as defined under the N.J.A.C. 7:9-6.

2.6.3 Site 4 General Response Actions

General response actions were selected based on the RAOs for Site 4 and the consideration that the site is an inactive military municipal landfill, thus incorporating the application of a presumptive remedy. Treatment of contaminated landfill soils and materials is considered technically impracticable. The general response actions for Site 4 that address potential human exposures to contaminated landfill soils and materials and 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)

2.6.4 Identification, Screening, and Evaluation of Technologies and Process Options for Site 4

Table 2-10 presents a summary of potential remedial technologies and process options that apply to the Site 4 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, VOCs), 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.

Site conditions that were considered include fill materials consisting of heterogeneous construction debris possibly mixed with minor quantities of military waste materials, the location of the landfill

TABLE 2-10
SITE 4 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Environmental Media	Remedial Action Objectives (from site characterization)	General Response actions (for all RAOs)	Remedial Technology Types (for general response actions)	Process Options
Soils and Landfill Materials	**Protection of Human Health** Prevent human exposure to contaminated landfill soils and 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 D Landfill - Municipal landfill

TABLE 2-10
SITE 4 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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Environmental Media	Remedial Action Objectives (from site characterization)	General Response Action (for all remedial action objectives)	Remedial Technology Types (for general response actions)	Process Options
Groundwater	Protection of Human Health	No Action	No Action	- Not applicable
	Prevent human exposure to VOC and metal contaminants in groundwater	Limited Action	Limited Action Technologies - Institutional Controls - Long-Term Monitoring	- Deed restrictions - Classification Exception Area designation - Groundwater monitoring

adjacent to a wetlands area, relatively sparse top cover of the landfilled materials, leaching of soil contaminants into underlying groundwater, discharge of groundwater into adjacent wetlands 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 presented in Tables 2-13 and 2-14, respectively.

2.6.5 Summary of Site 4 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.

2.7 SITE 5 TECHNOLOGY SCREENING

The selection of viable remedial technologies and process options for assemblage into remedial alternatives for Site 5 is presented in this section. The identification and evaluation of remedial technologies and process options for Site 5 are similar to these performed for Site 4 because both are inactive military municipal landfills. Because Site 5's surficial features differ from those of Site 4, there are differences in the selection of remedial technologies.

TABLE 2-11
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 4 SOILS/LANDFILL MATERIALS
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 bylaws and board of health regulations, used to limit property use and activities such as well installation.	Not viable, local ordinances may not be applicable 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 run-off.	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 4 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (cont.)	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 site to prevent direct contact, to minimize erosion, and to minimize leaching of contaminants from landfill into groundwater. Additional layers would be required to protect the barrier.	Potentially viable to prevent direct contact and to minimize erosion and infiltration. Retained.
		Composite (double) Barrier	Multi-media cap with two low permeability layers (clay &/or synthetic membranes) constructed over site to prevent direct contact and minimize significant 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 minimize 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 4. 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 4 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal and Disposal (cont.)	Disposal Off Base	RCRA Landfill	Transport and disposal of excavated materials to a RCRA permitted landfill.	Technically impractical 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 landfill on-site.	Technically impractical 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 impractical 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 4 CONTAMINATED GROUNDWATER
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 some 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 4 SOILS/LANDFILL MATERIALS
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 dependant 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 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 continued contaminated groundwater. No contaminant reduction.	Readily implementable, numerous companies with personnel and equipment to perform sampling.	Capital: Low O & M: Low	Retained.

TABLE 2-13
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 4 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
Containment	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.
		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.
		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 4 since groundwater contamination is low and is unused.	Implementable by standard construction, would require specialized equipment and materials to install double barrier cap. More care to install than soil cover or single barrier.	Capital: Moderate O & M: Low	Eliminated.

TABLE 2-13
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 4 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSIONS
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.
	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 Site	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 4 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NWS 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 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.

2.7.1 Site 5 Remedial Action Objectives

The results of the RI, previous investigations, and the human health and ecological risk assessments for Site 5 were evaluated to determine the remedial action objectives that may be needed to protect human health and the environment.

Human Health Protection Considerations

Because Site 5 is an inactive military landfill with no known deposition of military specific wastes (e.g., chemical warfare agents) the presumptive remedy guidance for CERCLA municipal landfills was applied to the site. Landfill materials and soils likely contain a variety of chemicals, based on the chemicals detected in downgradient groundwater and information obtained under previous investigations regarding materials that were disposed in the landfill. However, the majority of the landfill is currently covered by a layer of loose sand and is heavily treed. There is no evidence of exposed landfill materials. In these areas of the landfill, there does not appear to be any potential direct contact threats posed by the covered landfill materials.

The skeet and shooting range comprise an open area that overlies a portion of the Site 5 landfill. The skeet and shooting area surface soils are periodically groomed by base personnel who use sweeping machines to collect spent shells and clay pigeons. There is a concern that the underlying landfill materials may be exposed through the periodic groundskeeping activities needed to support the continued use of the skeet and shooting range. It is the Navy's intention to continue the use of the skeet and shooting range after the implementation of a remedial action.

Potential exposure to contaminated landfill soils and materials may result through the continued use of the skeet and shooting range, if contaminated landfill soils and materials are exposed. A remedial action may be warranted to protect human health by preventing exposures to landfill soils and materials in this area.

Risk assessment results indicated that, under the future residential land use scenario, exposure to contaminated groundwater through ingestion, dermal contact, and inhalation posed potential risks that would exceed EPA's target risk range of 1 E-06 to 1 E-04 carcinogenic risk for an adult receptor, and the HI for target organs would exceed 1.0 for a child receptor. Therefore, remedial actions may be needed to mitigate potential human health risks through exposure to contaminated groundwater.

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 5 being considered for future residential land use.

Ecological Receptors Risk Considerations

The RI identified the presence of wetlands adjacent to the Site 5 landfill but concluded that surface runoff and groundwater discharge from the landfill were unlikely to convey landfill contaminants into those wetlands. The surface topography of the landfill is relatively flat and precipitation that falls in the landfill area generally perches and infiltrates into the soils. Precipitation does not appear to runoff into the adjacent wetlands. Based on measured hydraulic heads, the groundwater underlying the Site 5 landfill flows away from the wetland area and would be unlikely to discharge contaminants to the wetland sediments and soils. The ERA concluded that, because migration of landfill contaminants to the adjacent wetlands is limited and the landfill appears to be adequately covered to limit terrestrial organism exposures, Site 5 poses very low potential risks. Therefore, active remedial actions may not be warranted to protect ecological receptors.

Environmental Media Protection Considerations

The RI determined that the Site 5 landfill was a continuing source of metals and VOCs that degraded the groundwater quality and that groundwater adjacent to the landfill contained contaminants concentrations in excess of the state GWQS (see Table 2-15).

Review of the RI data revealed that aluminum, cadmium, cobalt, iron, manganese, nickel, and thallium levels exceeded the state GWQS and the background concentration range. RI data indicated VOCs presence in excess of GWQS at three of the four wells (05MW05, 05MW06, and 05MW07) located downgradient of the landfill. The VOCs were detected at concentrations that were comparable to or slightly greater than the regulatory standards. The extent of groundwater contamination is limited, and only a few chemicals exceeded the state ARARs.

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. 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 (benzene, chloroform, TCE, and VC) and metals (aluminum, cadmium, iron, manganese, nickel, and thallium) contamination would be

TABLE 2-15
SITE 5 GROUNDWATER CONTAMINANTS OF CONCERN
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Exceeds NJ GWQS	Exceeds SDWA MCLs	Poses Human Health Risk
Aluminum	X	(1)	--
Arsenic	--	--	X (2)
Cadmium	X	X	--
Iron	X	(1)	X (3)
Manganese	X	(1)	--
Nickel	X	X	--
Thallium	--	X	--
Benzene	X	X	--
Chloroform	X	X	--
Trichloroethene	X	X	--
Vinyl chloride	--	--	X (2)

Notes:

- X indicates the basis for selection of the compound or element as a COC.
- The New Jersey State Ground Water Quality Standards (GWQS) are ARARs.
- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels regulate organic and inorganic constituents in public drinking water supplies
- Human health COC selected if it one of the primary contributors to total estimated carcinogenic risk > 1E-04 or to HQ > 1.0

-- Not a COC; does not exceed GWQS, SWDA MCLs, or pose potential human health risks
(1) No SDWA MCL for this analyte
(2) COC contributes to excess carcinogenic risks for the future residential adult through RME ingestion, dermal and inhalation exposures
(3) COC contributes to HI > 1.0 for future residential child under RME and CT exposures

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 5 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 also indicated that metals concentration at the nearest discharge point, a stream located approximately 3500 feet downgradient of Site 5, would be well below either the state GWQS or the background levels (Table 1, Appendix A). Another iteration of the computer model estimated that 13 feet downgradient of the site was the maximum distance where metals in groundwater would exceed either GWQS or background levels (Table 2, Appendix A). These results indicate that metals are unlikely to migrate very far from Site 5, and their concentrations would be below either GWQS or background levels within a relatively short distance of Site 5. The lack of lateral dispersion can probably be attributed to the metals' soil-water partitioning coefficients (Kd) values, which indicate a preference for adsorption to the soils, thus retarding the metals downgradient migration.

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, and use the new data to refine the model estimates through input of site-specific soil-water partitioning coefficients that would be developed as part of the remedial action. If the revised model or observation of site actual site conditions indicate 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 migration of landfill contaminants to the underlying groundwater.

RAOs Selection

For the reasons provided above, the following remedial action objectives have been selected for Site 5:

Protection of Human Health RAO

- Prevent potential human exposure to contaminated landfill soils and materials underlying the skeet and shooting range.

Protection of the Environment RAO

- Minimize migration of landfill contaminants to groundwater and restore the aquifer to the applicable standard.

2.7.2 Site 5 Preliminary Remediation Goals

Data from the RI, the human health risk assessment and ARARs were reviewed to identify COCs for Site 5. The summary and basis for selecting the COCs are presented in Table 2-15.

Because Site 5 is an inactive military landfill, the presumptive remedy for CERCLA municipal landfills will be applied. RI sampling of soils and landfill materials was primarily limited to visual inspection and field instrument testing from test pits at site.

The organics and metal contaminants in groundwater that would contribute to excess human health carcinogenic risk (greater than 1 E-04 total) or HIs greater than 1.0 were selected as human health risk-based COCs and are presented in Table 2-16.

Because several organic and metal contaminants in groundwater underlying and adjacent to the site exceed the state GWQS, these contaminants were selected as COCs and the GWQS were selected as the ARAR-based PRGs. Table 2-16 lists the metal contaminants whose concentration range exceeded those of the maximum detected background groundwater concentrations.

A set of proposed groundwater PRGs for Site 5 is presented on Table 2-17, along with the basis for selection. These proposed PRGs may be used to assist in the delineation of the volume of

TABLE 2-16
SITE 5 GROUNDWATER PRELIMINARY REMEDIATION GOALS (µg/L)
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	ARARS NJ GWQS	SDWA MCLs	PRG[3] Based on Risk = 1E-6 [carcinogen]	PRG[3] Based on HI = 0.1 [non-carcinogen]	Maximum Background Conc.	Maximum Detected Site Concentration
Aluminum	200	(1)	--	--	7870	42000
Arsenic	--	--	0.045	--	5.8	5.3
Cadmium	4	5	--	--	1.9	7.5
Iron	300	(1)	--	452	7690	59200
Manganese	50	(1)	--	--	65	302
Nickel	100	100 (4)	--	--	25.5	102
Thallium	10	2	--	--	5.1	5.6
Benzene	1	5	--	--	BDL	3
Chloroform	6	100 (2)	--	--	BDL	22
Trichloroethene	1	5	--	--	BDL	4
Vinyl Chloride	--	--	0.028	--	BDL	2

Notes:
- NJ GWQS 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.
- Arsenic was eliminated since maximum detected site concentration was less than the CRDL.

(1) No SDWA MCL for this analyte.
(2) As total trihalomethanes.
(3) PRG numerical values for carcinogens and non-carcinogens are based on exposure scenarios and factors applied in the NWS Earle human health risk assessment.
(4) The MCL for nickel was remanded by EPA in 1995

TABLE 2-17
SITE 5 PROPOSED GROUNDWATER PRGs
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Proposed PRG	Basis of Selection
Aluminum	7870	Background
Arsenic	5.8	Background
Cadmium	4	NJ GWQS
Iron	7960	Background
Manganese	65	Background
Nickel	100	NJ GWQS
Benzene	1	NJ GWQS
Chloroform	6	NJ GWQS
Trichloroethene	1	NJ GWQS
Vinyl chloride	2	NJ GWQS

Notes:

- all units in µg/L
- The New Jersey State Ground Water Quality Standards (GWQS) are ARARs.

contaminated groundwater that may need to be evaluated for potential remedial action, and may also be used in establishing Classification Exception Areas (CEAs) as defined under the N.J.A.C. 7:9-6.

2.7.3 Site 5 General Response Actions

General response actions were selected based on the RAOs for Site 5 and the consideration that the site is an inactive military landfill, thus incorporating the application of a presumptive remedy. Treatment of contaminated landfill soils and materials is considered technically impracticable. The general response actions for Site 5 that address potential human exposures to contaminated landfill soils and materials and potential contaminant migration into groundwater 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)

Table 2-18 presents a summary of the Site 5 RAOs and corresponding general response actions.

2.7.4 Identification and Screening of Technologies and Process Options for Site 5

Table 2-18 presents a summary of potential remedial technologies and process options that apply to the Site 5 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, VOCs), current site conditions, and planned continued land use of the skeet and shooting range. During the screening step, process options and entire technology types were eliminated from further consideration on the basis of technical implementability.

TABLE 2-18
SITE 5 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Environmental Media	Remedial Action Objectives (from site characterization)	General Response actions (for all RAOs)	Remedial Technology Types (for general response actions)	Process Options
Soils and Landfill Materials	**Protection of Human Health** Prevent human exposure to contaminated landfill soils and 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 base	- Consolidation (into existing landfill) - New landfill
			Disposal Off base	- RCRA D Landfill - Municipal landfill

TABLE 2-18
SITE 5 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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Environmental Media	Remedial Action Objectives (from site characterization)	General Response Action (for all remedial action objectives)	Remedial Technology Types (for general response actions)	Process Options
Groundwater	Protection of Human Health	No Action	No Action	- Not applicable
	Prevent human exposure to VOC and metal contaminants in groundwater.	Limited Action	Limited Action Technologies - Institutional Controls - Long-Term Monitoring	- Deed restrictions - Classification Exception Area designation - Groundwater monitoring

Site conditions considered include fill materials consisting of heterogeneous construction debris possibly mixed with minor quantities of military waste materials, a cover of sandy soils over the landfilled materials and leaching of soil contaminants into underlying groundwater. The preliminary screening of soils and landfill material remedial technologies is presented and summarized in Table 2-19, and the screening of groundwater response remedial technologies is summarized in Table 2-20. Detailed evaluations of the remedial technologies and process options for contaminated soils/landfill materials and groundwater are presented in Tables 2-21 and 2-22, respectively.

2.7.5 Site 5 Summary of Selected Remedial Technologies and Process Options

Tables 2-21 and 2-22 identify the remedial technologies that were retained after the detailed evaluation process. The technologies and process options that are not likely to be implementable or effective, or that would result in higher implementation costs were eliminated from further consideration. Site-specific considerations were also factors in the elimination of candidate technologies and process options.

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.

2.8 SITE 19 TECHNOLOGY SCREENING

The selection of viable remedial technologies and process options for assemblage into remedial alternatives for Site 19 is presented in this section.

2.8.1 Site 19 Remedial Action Objectives

The results of the RI, previous investigations, and the human health and ecological risk assessments for Site 19 were evaluated to determine the remedial action objectives that may be needed to protect human health and the environment.

TABLE 2-19
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
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 bylaws 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 run-off.	Grading of current cover material of varied thickness, may not be effective. Grading would be potentially viable if additional cover materials added. Retained.

TABLE 2-19
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (cont.)	Surface Controls (cont.)	Revegetation	Seeding and maintaining site surface to establish vegetation to minimize erosion and to promote evapotranspiration of precipitation thus reducing infiltration.	Potentially viable. Retained.
	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. Limited effectiveness for reducing infiltration. Retained.
		Single Barrier	Cap constructed with one low permeability layer (clay or synthetic membrane) over site to prevent direct contact, to minimize erosion, and to minimize leaching of contaminants from landfill into groundwater. Additional layers would be required to protect the barrier.	Potentially viable to prevent direct contact and to minimize erosion and infiltration. Retained.
		Composite (double) Barrier	Multi-media cap with two low permeability layers (clay &/or synthetic membranes) constructed over site to prevent direct contact and minimize significant 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 minimize 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 4. 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 2-19
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal and Disposal (cont.)	Disposal Off Base	RCRA Landfill	Transport and disposal of excavated materials to a RCRA permitted landfill.	Technically impractical 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 Base	New RCRA-Type Landfill	Disposal of bulk untreated landfill materials in a specially constructed on base landfill.	Technically impractical 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 impractical to excavate and relocate landfill. Eliminated. Retained for consolidating small quantities of contaminated materials into existing on-base landfill.

TABLE 2-20
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 5 CONTAMINATED GROUNDWATER
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 some 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 2-21
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
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 dependant 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 and is implementable.	Capital: Low O & M: Low	Retained.
	Access Restrictions	Fencing	Would limit access to potentially contaminated soils, and would limit useability of skeet and shooting range. 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 continued contaminated groundwater. No contaminant reduction.	Readily implementable, numerous companies with personnel and equipment to perform sampling.	Capital: Low O & M: Low	Retained.

TABLE 2-21
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
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.
		Revegetation	Would be effective in reducing precipitation infiltration through promotion of evapotranspiration and reduction of surface erosion.	Implementable, numerous companies with personnel and equipment to seeding and periodic maintenance.	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 2-21
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
Containment (cont.)	Cap (cont.)	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 5 since groundwater contamination is low and unused.	Implementable by standard construction, would require specialized equipment and materials to install double barrier cap. More care to install than soil cover or single barrier.	Capital: Moderate O & M: Low	Eliminated.
Removal and Disposal	Excavation	Mechanical Excavation	Effective method for removing highly contaminated soils and hot spot materials, if encountered during remediation.	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 2-21
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 SOILS/LANDFILL MATERIALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
Removal and Disposal (cont.)	Disposal Off Base	RCRA Landfill	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 2-22
EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 5 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NWS 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 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.

Human Health Protection Considerations

Site 19 currently consists of a paved area, where equipment operators are trained to use fork lifts; the former settling pond for the ordnance maintenance area; and a barricade. Current use of this site by base personnel is limited to the paved areas of Site 19.

The Site 19 HHRA, which was calculated based on the assumption that areas of heavy metals contamination (the process discharge settling basin and the drainage ditch) would be removed as a part of any selected remedial alternative, indicated that exposure to contaminated site soils (from the former settling pond) resulted in estimated RME lifetime carcinogenic risks within the acceptable risk range. RME noncarcinogenic HIs were less than 1.0. Therefore, no further remedial actions are warranted to protect a potential future industrial worker from contaminated soils exposures. For potential exposure to contaminated groundwater, the RME risk results indicate carcinogenic risks within the acceptable risk range (10 E-04 to 10 E-6) but noncarcinogenic HIs greater than 1.0 for several target organs. Thallium and arsenic (for skin, only) posed the majority of noncarcinogenic risks. Further remedial actions may be warranted to protect a potential future industrial worker from groundwater exposure.

The Site 19 HHRA indicated that exposure to contaminated subsurface soils under the RME future residential scenario resulted in adult carcinogenic risks within the acceptable risk range and child noncarcinogenic HIs below 1.0. Because the former settling pond subsurface soils do not appear to pose health risks to a future residential receptor, further remedial actions for these soils are not warranted to protect human health.

Potential exposures to contaminated groundwater resulted in estimated RME adult ingestion carcinogenic risks of 3.3 E-04 (slightly exceeding the acceptable risk range) attributable solely to arsenic. The RME child noncarcinogenic HIs exceeded 1.0 for the groundwater ingestion (27); thallium and arsenic were the principal contributors of risk. For the child receptor exposure scenarios, only the ingestion of groundwater posed noncarcinogenic HIs greater than 1.0. Thallium (all target organs), arsenic (skin only), and cadmium and chromium VI (kidney) were the principal contributors of noncarcinogenic risks. Further remedial actions may be warranted to protect human health from potential exposures to contaminated groundwater that result in unacceptable risks.

Exposure risks for future residential children to lead in soils, dust, and water were characterized using the IEUBK Lead Model (v0.99). The results indicated 15.5 percent of the children exposed

to similar site conditions could have blood-lead levels greater than 10 µg/dL; these results exceed the EPA protective guideline of five percent of the maximum proportion of individuals. Therefore, remedial action may be needed to protect human health from exposures to lead in environmental media at Site 19.

Exposure to contaminated sediments and surface water were evaluated for the future recreational receptor. The risk results indicated estimated carcinogenic risks below the acceptable risk range and noncarcinogenic HIs below 1.0. Therefore, no further actions are warranted to protect human health from contaminated sediments and surface water at Site 19.

A variety of metals pose potential risks to potential future adult and child receptors. While the HHRA included a future residential scenario, there are no current plans for base realignment at NWS Earle and future use of the Site 19 area for residential purposes is unknown. It is not known what changes in the future may occur that may result in different land uses. The underlying groundwater is not used as a potable water supply. Should base realignment occur in the future, resulting in different land use for Site 19, then an Environmental Baseline Survey may be warranted and measures to protect human health from exposures to contaminated soils (due to lead presence) and groundwater would be evaluated.

Ecological Receptors Risk Considerations

The RI identified the presence of wetlands adjacent to the former paint chip and sludge disposal area for Site 19 and concluded that precipitation runoff was the principal mechanism for conveying contaminants from the settling pond (topographic depression) to the wetlands via the drainage ditch. The RI also hypothesized that precipitation infiltration would mobilize soil contaminants into groundwater, which may eventually discharge to the surface water in the wetlands.

The ERA, which was calculated based on the assumption that areas of heavy metals contamination (the process discharge settling basin and the drainage ditch) would be removed as a part of any selected remedial alternative, identified aluminum, barium, beryllium, chromium, lead, vanadium, and zinc as contaminants of potential concern; these metals are present at concentrations in excess of the background range. However, the ERA concluded that most of the metals detected, based on their respective HQs, posed low potential risks for ecological receptors. The HQs for chromium, lead, and zinc were sufficiently high to indicate moderate potential risks. The RI concluded that removal of sediments in the drainage ditch and process settling basin would eliminate the source and prevent future overland contaminant migration.

Remedial action may be warranted to protect the wetlands sediments and surface water and ecological receptors.

Environmental Media Protection Considerations

Soils - A variety of metals were detected in the soil samples collected from the depression and the drainage ditch. Antimony, cadmium, chromium VI, lead, and zinc were found to exceed the New Jersey Non-Residential Soil Clean-Up Criteria (a TBC) at one location 19SB03. These metal concentrations also exceeded the background metals range. Although lead was detected at all soil sampling locations, only the 19SB03 results exceeded the state soil clean-up criteria (TBC). The RI identified the presence of low concentrations of PCE in the soil samples obtained from the topographic depression. No VOCs were detected in the underlying groundwater, which suggests that the source areas do not contain high levels of PCE.

The RI concluded that the hexavalent chromium detected in subsurface soils has the potential to migrate into and contaminate the underlying groundwater; however, groundwater chromium concentrations do not exceed the state GWQS but do exceed the background range. Other metals were detected in both the subsurface soils and in groundwater, including antimony, cadmium, and lead, that exceeded both the New Jersey Non-Residential soil clean-up criteria (a TBC) and the GWQS. Aluminum and iron (detected in all Site 19 wells) and arsenic, manganese, and thallium (detected in individual well locations) were present at concentrations exceeding the GWQS. These metals were all present in the subsurface soils.

These results indicate that the subsurface soils are probably continuing sources of metal contaminants to groundwater. Because precipitation infiltration causes leaching of contaminants to groundwater in excess of the GWQS, a remedial response action may be needed to address the continuing groundwater contamination by the Site 19 soils in the topographic depression and the drainageway.

Groundwater - Aluminum and iron exceeded the GWQS in all Site 19 well samples; only aluminum in the 19GW05 sample exceeded the background range. Antimony, arsenic, cadmium, lead, and thallium were also detected in the 19GW07 sample at concentrations that exceeded the GWQS and the background metals range. Manganese was detected in 19GW05 and 19GW06 samples at levels that exceeded the GWQS and the 19GW05 sample concentration also exceeded the background range. During the RI, no organic compounds were detected in any of

the groundwater samples. Although PCE was detected in the soil samples, the data suggest that the source areas do not contain levels of PCE at sufficient concentrations to degrade groundwater quality.

The RI concluded that Site 19 soils are contributing to groundwater contamination. If limited source removal and 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. Source removal and 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 metals (aluminum, arsenic, cadmium, iron, lead, manganese, and thallium) contamination would be attenuated through a combination of degradation and attenuation processes. Physical processes may include: advection, convection, dispersion, adsorption, and absorption. Chemical processes may include: partitioning, oxidation/reduction, hydrolysis, and acid/base reactions.

The computer model estimated that Site 19 groundwater metal concentrations would gradually diminish over a long period of time (see Appendix A), assuming source removal and control measures would be implemented. The model also indicated that metals concentration at the nearest discharge point, a stream located 500 feet downgradient of Site 19, would be well below either the state GWQS or the background levels (Table 1, Appendix A). Another iteration of the computer model estimated that 191 feet downgradient of the site was the maximum distance where metals in groundwater exceeded either GWQS or background levels (Table 2, Appendix A). These results indicate that metals are unlikely to migrate very far from Site 19, and their concentrations would be below either GWQS or background levels within a relatively short distance of Site 19. The lack of lateral dispersion can probably be attributed to the metals' soil-water partitioning coefficients (Kd) values, which indicate a preference for adsorption to the soils, thus retarding the metals downgradient migration.

Based on the available information, the low anticipated risk levels, the limited extent of observed groundwater contamination, likely implementation of source removal and 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, and use the new data to refine the model estimates through input of site-specific soil-water partitioning coefficients that would be developed as part of the remedial action.

If the revised model or observation of actual future site conditions indicate 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.

Sediments - The one Site 19 sediment sample collected at the confluence of the drainage ditch and the wetland stream contained arsenic, chromium, and lead concentrations that exceeded screening toxicity values and their respective background concentration ranges. A number of metals detected in the subsurface soils (generally near surface) from the topographic depression were also detected in the one sediment sample, which suggests that the Site 19 soils were and may still be contributors of metal contamination to sediments in the drainageway. Examination of current drainage conditions indicates that flow from the topographic depression to the wetlands was not likely to occur since most of the precipitation would probably infiltrate into underlying groundwater. However, flooding of the wetlands during precipitation events could raise the surface water level and convey contaminated sediments from the drainageway into the wetlands.

Although eight PAHs and three pesticides were detected in the sediment sample at concentrations that exceeded benchmark toxicity values, these organic contaminants were not detected in either the subsurface soils or groundwater at Site 19. These results indicate that the Site 19 soils in the topographic depression are not continuing sources of organic compound contamination to sediments.

In summary, a remedial action of the Site 19 soils and drainageway sediments because of metal contaminants is warranted to protect the adjoining wetland.

Surface Water - Copper and mercury were detected in the one surface water sample at concentrations that exceeded the fresh water chronic aquatic AWQC (TBC). Copper was also present at 19SW01 at slightly higher than background levels. The organic compounds detected at 19SW01 did not exceed any screening values.

Because surface runoff and groundwater discharge have the potential to cause contaminant migration to surface water in the adjacent wetlands in excess of the SWQC, a remedial response action may be needed to address this aspect of site contamination.

The RI indicated that surface water originating at Site 19 discharges to Mingamahone Brook, which discharges upstream of a potable water intake. Contaminants originating at Site 19 could migrate to water bodies used for drinking water.

If source removal and control measures are implemented at Site 19, then a reduction in surface water contaminant concentrations affiliated with the soils can be expected in the long term. No active surface water response actions would be needed at this time other than the implementation for source control actions.

RAOs Selection

Based on the reasons provided above, the following remedial action objectives have been selected for Site 19:

Protection of Human Health RAO:

- Prevent potential human exposures to contaminated soils and groundwater.

Protection of the Environment RAO

- Minimize migration of soils and drainageway contaminants to groundwater and the adjacent wetlands and restore the aquifer to applicable standards.

2.8.2 Site 19 Preliminary Remediation Goals (PRGs)

The summary and basis for selecting the soils COCs are presented in Table 2-23. Soil COCs were selected if they exceeded the State Non-Residential or Residential Soil Cleanup Criteria [a TBC] and exceeded the background concentration, or if they posed risks to human health. Soil PRGs are presented in Table 2-24, and are based on State non-promulgated soil cleanup criteria, risk-based estimates, detection limits, and the maximum background metal concentrations. Proposed Site 19 soil PRGs are in Table 2-25, along with the basis for their selection. The proposed soil PRGs would be used to estimate the volume of contaminated materials to be addressed and possibly guide the remedial action.

The summary and basis for selecting groundwater COCs, based on exceedance ARARs (e.g., GWQS) and risks to human health, are presented in Table 2-26. The organics and metal

TABLE 2-23
SITE 19 SOIL CONTAMINANTS OF CONCERN
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Exceeds NJ Soil Cleanup Criteria	Poses Human Health Risk
Antimony	X	--
Cadmium	X	--
Chromium VI	X	--
Lead	X	X
Zinc	X	--

Notes:

- X indicates the basis for selection of the compound or element as a COC.
- The New Jersey State Non-residential and Residential Soil Cleanup Criteria are To-Be-Considered (TBC) guidance levels.
- Lead selected as COC based on estimated blood-lead levels exceeding 10 µg/L in 15.5 percent of children, if they were to be exposed to lead levels similar to those at Site 19.
- -- Not a COC under this parameter.

TABLE 2-24
SITE 19 SOIL PRELIMINARY REMEDIATION GOALS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	NJ Non-Residential Soil Cleanup Criteria	NJ Non-Residential Soil Cleanup Criteria	Human Health Risk	Maximum Background Concentration	Maximium Detected Site Concentration
Antimony	340	14	--	ND	32.15
Cadmium	100	1	--	0.57	5.9
Chromium VI	10	--	--	59.5	528
Lead	600	100	400 (1)	39.4	1345
Zinc	1500	1500	--	50.7	7760

Notes:

- All units in mg/kg
- NJ Non-residential and Residential Direct Contact Soil Cleanup Criteria are To-Be-Considered numerical guidance values.
- Protection of human health lead value based on EPA lead guidance level.
- (1) Lead level is based on OSWER Directive No. 9355.4-12, Revised Interim Soil Lead Guidance Level for CERCLA Sites and RCRA Corrective Action Facilities, July 1994, suggested value
- -- Not a COC under this parameter

TABLE 2-25
SITE 19 PROPOSED SOIL PRGs
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Proposed PRGs	Basis of Selection
Antimony	340	NJ Non-residential Criteria
Cadmium	100	NJ Non-residential Criteria
Chromium VI	59.5	Background
Lead	600	NJ Non-residential Criteria
Zinc	1500	NJ Non-residential Criteria

Notes:

- Under current and projected use of Site 19 for continued base activities, a residential land use is unlikley. Therefore, the New Jersey State Non-residential Soil Cleanup Criteria are proposed as soils PRGs.

TABLE 2-26
SITE 19 GROUNDWATER CONTAMINANTS OF CONCERN
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Exceeds NJ GWQS	Exceeds SDWA MCLs	Poses Human Health Risk
Aluminum	X	(1)	--
Arsenic	X	--	X (2,3)
Cadmium	X	--	X (3)
Chromium VI	--	--	X (3)
Iron	X	(1)	--
Lead	X	X	X
Manganese	X	(1)	--
Thallium	X	X	X (3)

Notes:

- X indicates the basis for selection of the compound or element as a COC.
- The New Jersey State Ground Water Quality Standards (GWQS) are ARARs.
- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels regulate organic and inorganic constituents in public drinking water supplies; included for comparison purposes, only.
- -- Not a COC; does not exceed GWQS, SWDA MCLs, or pose potential human health risks
- (1) No SDWA MCL for this analyte
- (2) COC contributes to excess carcinogenic risks for the future residential adult through RME ingestion, dermal and inhalation exposures
- (3) COC contributes to HI > 1.0 for future adult resident future under CT exposures, or for residential child under RME and CT exposures

contaminants in groundwater that would contribute to excess human health risk were selected as human health risk-based COCs. PRGs for groundwater contaminants used the State GWQS numerical values, risk-based groundwater concentrations that do not result in carcinogenic risks exceeding 1 E-06 or HI greater than 1.0, analytical detection limits, and maximum detected background concentrations. Tables 2-27 presents a set of candidate groundwater PRGs. A set of proposed Site 19 PRGs for groundwater are presented in Table 2-28, along with the basis for their selection. These proposed groundwater PRGs can be used to delineate the volume of contaminated groundwater that may need to be evaluated for potential remedial action, and may be used in establishing Classification Exception Areas as defined under the N.J.A.C. 7:9-6.

2.8.3 Site 19 General Response Actions

General response actions were selected based on the RAOs for Site 19, the types and extent of contaminants present in the soils and groundwater, and the potential migration of contaminants into the adjacent wetlands through surface runoff and groundwater discharge. The general response actions for Site 19 that address potential human exposures to contaminated soils and groundwater and potential contaminant migration into groundwater and the wetlands include

- No action
- Institutional controls (limited action)
- Containment
- Excavation and treatment
- 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)

Table 2-29 presents a summary of the Site 19 RAOs and corresponding general response actions.

TABLE 2-27
SITE 19 GROUNDWATER PRELIMINARY REMEDIATION GOALS (µg/L)
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	NJ GWQS	SDWA MCLs	PRG[3] Based on Risk = 1 -06 [carcinogen]	PRG[3] Based on HI = 0.1 [non-carcinogen]	Maximum Background Concentration	Maximium Detected Site Conc.
Aluminum	200	(1)	--	--	7870	9610
Arsenic	8	50	0.045	0.468	5.8	27.4
Cadmium	4	5	--	0.767	1.9	7.5
Chromium VI	100	100	--	7.13	BDL	43.1
Iron	300	(1)	--	--	7690	4880
Lead	10	15 (2)	(4)	(4)	3	17.2
Manganese	50	(1)	--	--	65	185
Thallium	10	2	--	0.12	5.1	28.9

Notes:

- New Jersey state groundwater quality standards (GWQS) 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 SDWA MCL for this analyte.
(2) Action level
(3) PRG numerical values for carcinogens and non-carcinogens are based on exposure scenarios and factors applied in the NWS Earle human health risk assessment.
(4) No risk-based PRG derived; lead is both a carcinogen and a toxicant.

TABLE 2-28
SITE 19 PROPOSED GROUNDWATER PRGs
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Proposed PRGs	Basis of Selection
Aluminum	7870	Background
Arsenic	8	NJ GWQS
Cadmium	4	NJ GWQS
Lead	10	NJ GWQS
Manganese	65	Background
Thallium	10	NJ GWQS

Notes:

- All units in µg/L
- The New Jersey State Ground Water Quality Standards (GWQS) are ARARs.

TABLE 2-29
SITE 19 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

Environmental Medium	Remedial Action Objective (from site characterization)	General Response Action (for all RAOs)	Remedial Technology Type (for general response actions)	Process Options
Soils and Sediments	Protection of Human Health Prevent human exposure to contaminated soils.	No Action	No Action	Not Applicable
		Limited Action	Institutional Controls	- Land use restrictions - Local ordinances
			Access Restrictions	- Fencing
			Monitoring	- Monitoring of groundwater (to assess contaminant status)
	Protection of the Environment Minimize contaminant migration into groundwater and adjacent wetlands.	Containment	Surface Controls	- Grading - Revegetation
			Containment Technologies: - Horizontal barriers - Vertical barriers	- Soil cover, single barrier, composite (double) barrier - Slurry wall, grout injection, sheet piling

TABLE 2-29
SITE 19 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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Environmental Medium	Remedial Action Objective (from site characterization)	General Response Action (for all RAOs)	Remedial Technology Type (for general response actions)	Process Options
Soils and Sediments (continued)	(See previous page)	Removal and Disposal	Excavation	- Mechanical excavation
			Disposal Off Base	- RCRA C or D landfill (depending on constituents)
			Disposal On Base	- Consolidation (into existing landfill) - New landfill
		Excavation, Treatment, and Disposal	Excavation	- Mechanical excavation - Discrete removal
			Treatment Technologies:	
			- Thermal treatment	- Incineration, pyrolysis, low-temperature thermal desorption, vitrification
			- Physical/chemical treatment	- Soil washing, solvent extraction, dechlorination, fixation
			- Immobilization	- Sorption, micro-encapsulation, clay pelletizing/sintering
			- Biological treatment	- Aerobic biodegradation, anaerobic biodegradation

TABLE 2-29
SITE 19 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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Environmental Medium	Remedial Action Objective (from site characterization)	General Response Action (for all RAOs)	Remedial Technology Type (for general response actions)	Process Options
Soils and Sediments (cont.)	(See page 1)	Excavation, Treatment, and Disposal (cont.)	Disposal Technologies: - Landfill - Land disposal	- Off-base landfill, on-base landfill - Beneficial re-use, consolidation
		In-Situ Treatment	In-Situ Treatment Technologies: - Thermal treatment - Physical/chemical treatment - Immobilization - Biological treatment	- In-situ vitrification - Soil vapor extraction, soil flushing - In-situ fixation - In-situ biodegradation
Groundwater	Protection of Human Health Prevent human exposure to contaminated groundwater.	No Action	No Action	- Not applicable
		Limited Action	Institutional Controls	- Deed restrictions - Classification Exception Area designation
			Long-Term Monitoring	- Groundwater monitoring

2.8.4 Site 19 Identification and Screening of Technologies and Process Options

Table 2-29 presents a summary potential remedial technologies and process options that apply to the Site 19 RAOs and general response actions. Screening of the remedial technologies considered their overall applicability to the media of concern (soil, sediment, and groundwater), primary contaminants (metals), current site conditions, and planned continued use of the area for training purposes. During the screening step, process options and entire technology types were eliminated from further consideration on the basis of technical implementability.

Site conditions considered include contaminated soils and paint chips and sludges, VOCs in soils, contaminated sediments in the drainageway, erosion of contaminated soils and subsequent discharge to the wetlands, and leaching of soil contaminants into underlying groundwater.

The preliminary screening of soil and sediment remedial technologies is presented and summarized in Table 2-30, and the screening of groundwater response remedial technologies is summarized in Table 2-31. Detailed evaluations of the remedial technologies and process options for contaminated soils/sediment and groundwater are presented in Tables 2-32 and 2-33, respectively.

2.8.5 Summary of Site 19 Selected Remedial Technologies and Process Options

Tables 2-32 and 2-33 identify the remedial technologies that were retained after the detailed evaluation process. The technologies and process options that are not likely to be implementable or effective or that result in higher implementation costs were eliminated.

For the contaminated soils and sediment options, fencing was eliminated since it would not be effective in protecting from exposures to mobile soils (e.g., airborne lead dusts). The composite cap was eliminated since it did not offer substantially greater protectiveness than the single barrier cap. In-situ solidification was eliminated because it may not be as effective as the ex-situ version and adequate mixing of treatment reagents and contaminated soils may not be as complete or effective.

The soils and sediment remediation technology types and process options remaining after detailed evaluation include:

- No Action

TABLE 2-30
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
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 bylaws and board of health regulations, used to limit property use and activities such as well installation.	Eliminated. Typically difficult to implement. Local ordinances may not apply to military bases.
	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 Site.	Potentially viable. Retained.
Containment	Surface Controls	Grading	Reshaping of topography to manage precipitation infiltration and surface run-off.	Grading of materials in topographic depression would not be effective in minimizing metal contaminant leaching. Eliminated.
		Revegetation	Seeding and maintaining site surface to establish vegetation to minimize erosion and to promote evapotranspiration of precipitation thus reducing infiltration.	Revegetation of topographic depression and drainage way would not mitigate metal contaminant leaching. Eliminated.
	Horizontal Barriers (Capping)	Soil (permeable) cover	Soil with a vegetative cover to prevent direct contact and minimize erosion and surface migration of contaminated soils.	Potentially viable. Some effectiveness in reducing infiltration. Retained.

TABLE 2-30
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (cont.)	Horizontal Barriers (Capping) (cont.)	Single Barrier	Cap constructed with one low permeability layer (clay or synthetic membrane) over site to prevent direct contact, to minimize erosion, and to minimize leaching of contaminants from landfill into groundwater. Additional layers would be required to protect the barrier.	Potentially viable to prevent direct contact and to minimize erosion and infiltration. Retained.
		Composite (double) Barrier	Multi-media cap with two low permeability layers (clay &/or synthetic membranes) constructed over site to prevent direct contact and minimize significant 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 minimize erosion and infiltration. Retained.
	Vertical Barriers	Slurry Walls	Trench filled with clay or cement slurry to form low permeability wall to restrict horizontal migration of contaminants.	Eliminated. Would not be implementable since slurry wall needs to be keyed into low permeability horizontal barrier or geologic unit, which is absent at this site.
		Grout Injection	Use of pressure-injected cement grout to form impermeable or semi-permeable barrier to restrict horizontal migration of contaminants.	Eliminated. Would not be implementable since wall needs to be keyed into low permeability horizontal barrier or geologic unit, which is absent at this site.
		Sheet piles	Steel sheet piles used to form barrier to restrict horizontal migration of contaminants.	Eliminated. Would not be implementable since wall needs to be keyed into low permeability horizontal barrier or geologic unit, which is absent at this site.

TABLE 2-30
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal and Disposal	Excavation	Mechanical Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers, excavators and front-end loaders.	Implementable. Retained.
	Disposal Off Site	RCRA C or D Landfill	Transport and disposal of excavated materials to a RCRA permitted landfill.	Implementable for volume of soil at Site 19. Retained.
	Disposal On Site	New RCRA-Type Landfill	Disposal of untreated hot spot materials in a specially constructed landfill on the base.	Technically impractical to construct and maintain landfill for relatively small volume of soils. Eliminated.
		Consolidation (into existing landfill)	Relocation of untreated materials into an on base landfill that would be closed.	Potentially viable. Retained.
Excavation, Treatment, and Disposal	Excavation	Mechanical Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers, excavators and front-end loaders.	Potentially applicable. Retained.
	Immobilization	Solidification	Mixing of excavated contaminated materials with treatment reagents to physically and/or chemically bind and decrease the mobility of contaminants. Common treatment reagents include cement, pozzolanic materials, thermoplastics, polymers, and asphalt.	Potentially applicable. Retained.
		Clay Pelletizing/ Sintering	Encapsulation of wastes by mixing with clay, followed by sintering.	Eliminated. Not applicable to contaminants present. Typically used for volatile metals remediation.

TABLE 2-30
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Excavation, Treatment, and Disposal (cont.)	Thermal Treatment	Vitrification	Melting of wastes to entrain inorganics in a stable vitreous residual.	Eliminated. Technically impractical for volume of soils involved.
		Incineration	Destruction of organics by oxidation at high temperatures under controlled conditions in a combustion chamber.	Eliminated. Not implementable for metal contaminated soils.
		Pyrolysis	Chemical decomposition of wastes by heating the material in absence of oxygen.	Eliminated. Not implementable for metal contaminated soils.
		Thermal Desorption	Ambient air, heat, and mechanical agitation are used to volatilize organic contaminants from soil into gas stream for further treatment.	Eliminated. Not implementable for metal contaminated soils.
	Physical Treatment	Soil Washing	Water-based process in which soils are separated into coarse and fine fractions to reduce the volume of materials requiring intensive treatment or disposal.	Potentially applicable.
	Chemical Treatment	Solvent Extraction	Desorption of contaminants from soil particles through washing with a solvent solution.	Eliminated. Not technically practical for metal contaminated soils.
		Dechlorination	Chemical reaction displaces chlorine atom in chlorinated organic compound to convert toxic compounds into less toxic, more water soluble compounds.	Eliminated. Not implementable for metal contaminated soils. VOCs in soils are not COCs.
	Biological Treatment	Aerobic Biodegradation	Degradation of organics to carbon dioxide and water in the presence of oxygen. Treatment can be conducted under easily controlled conditions in an enclosed reactor or using standard irrigation and soil mixing techniques in an above-ground cell.	Eliminated. Not implementable for metal contaminated soils. While applicable to site VOCs, these are not soil COCs.

TABLE 2-30
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Excavation, Treatment, and Disposal (cont.)	Biological Treatment (cont.)	Anaerobic Biodegradation	Degradation of organics to methane and carbon dioxide in the absence of oxygen.	Eliminated. Not applicable to site metals, and not feasible for most site organics which are not COCs. Limited application to certain complex organics.
In-Situ Treatment	Physical Treatment	In-Situ Solidification	Deep soil mixing equipment is used to apply treatment reagents to contaminated soils. Contaminants are physically and/or chemically immobilized in a cement-like mass.	Potentially implementable. Retained.
		Soil Vapor Extraction	Induced vacuum in a network of extraction wells in the unsaturated soil zone desorbs volatile organics from soil particles and removes contaminated vapor from soil pore space. Process may be enhanced using heated air, steam, or radiant heat or air sparging.	Eliminated. Not applicable for metals in soils. Would be implementable for site VOCs, but these are not COCs.
	Biological Treatment	In-Situ Biodegradation	Enhancement of natural biodegradation of organic contaminants by addition of nutrients and control of the environment.	Eliminated. Metals would not be addressed. Would be implementable for site VOCs, but these are not COCs.
	Chemical Treatment	Soil Flushing	In-situ process which employs a water-based extraction fluid and an injection/extraction well system to flush contaminants from soils.	Eliminated. Metals would not be addressed. May be implementable for site VOCs, but these are not COCs.
	Thermal Treatment	In-Situ Vitrification	An electrical network is used to melt contaminated soils in-place. Metals are immobilized within a vitreous mass, organics are destroyed by pyrolysis.	Eliminated. Not appropriate use in locations with shallow water tables.

TABLE 2-31
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 19 CONTAMINATED GROUNDWATER
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.
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. Retained.
	Long-Term Monitoring	Groundwater Monitoring	Periodic sampling and analysis of media to assess groundwater contaminant status and potential migration downgradient.	Potentially applicable. Retained.

TABLE 2-32
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
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 dependant on continued future enforcement to prevent use of underlying groundwater or prohibit residential development. No contaminant reduction.	Can be added to property deed and is implementable.	Capital: Low O & M: Low	Retained.
	Access Restrictions	Fencing	Would limit access topographic depression, but no contamination reduction. Dusts laden with metals can still be dispersed to environment. Would be effective in mitigating direct contact threats to humans and ecological receptors.	Readily implementable. Numerous companies available to perform construction.	Capital: Low O & M: Low	Retained.
	Monitoring	Groundwater Monitoring	Would allow assessment of contaminant status and leaching/migration in groundwater. Would enable action to be taken to reduce continued contaminated groundwater. No contaminant reduction.	Readily implementable, numerous companies with personnel and equipment to perform sampling and evaluation of results.	Capital: Low O & M: Low	Retained.

TABLE 2-32
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSION
Containment	Cap	Soil (permeable) Cover	Would prevent direct exposure to contaminated soils. Would reduce precipitation infiltration and contaminant leaching to groundwater, and would eliminate erosion of soils in depression and drainage way 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 eliminate erosion of soils into adjacent wetlands. 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.
		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 5 since groundwater contamination is low and unused.	Implementable by standard construction, would require specialized equipment and materials to install double barrier cap. More care to install than soil cover or single barrier.	Capital: Moderate O & M: Low	Eliminated.
Removal and Disposal	Excavation	Mechanical Excavation	Effective method for removing highly contaminated soils.	Equipment and resources are readily available from various contractors.	Capital: Low O & M: None	Retained.

TABLE 2-32
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSIONS
	Disposal Off Site	RCRA Landfill	Effectively addresses contaminated soils and eliminates future releases to the environment. Can probably handle volume of Site 19 soil. Depending on soil constituents, RCRA facility may require treatment of soils 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.
Removal and Disposal (cont.)	Disposal On Site	Consolidation	Allows small volumes of materials from discrete locations to be consolidated and addressed with the majority of landfill materials.	Implementable. Two NWS Earle landfills (Site 4 and 5) would be able to accept the small volume of soils that needs to be disposed, prior to closure.	Capital: Low O & M: None	Retained.
Excavation, Treatment, and Disposal	Excavation	Mechanical Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers, excavators and front-end loaders.	Implementable. Equipment and resources are readily available from various contractors.	Capital: Low O & M: None	Retained.
	Immobilization	Solidification and Fixation	Mixing of excavated contaminated soils and paint chips with treatment reagents (cement) would be effective in physically and/or chemically binding and decrease soil contaminant mobility.	Implementable. A number of vendors are available to perform this treatment process.	Capital: Moderate O&M: None	Retained.

TABLE 2-32
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 SOILS and SEDIMENTS
FEASIBILITY STUDY
NAVAL WEAPON STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	CONCLUSIONS
In-Situ Treatment	Physical Treatment	In-Situ Solidification	Deep mixing with reagents could effectively immobilize metals in contaminated soils. However, this treatment process may be less effective than the ex-situ solidification, which can be better controlled to achieve desired results.	Vendors with equipment and personnel are available to perform in-situ treatment. Treatability study needed to assess process effectiveness.	Capital: Moderate O&M: None	Eliminated.

TABLE 2-33
EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 19 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NWS 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 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.

- Institutional Controls
  - Deed restrictions

- Monitoring

- Capping
  - Soil Cover
  - Single Barrier

- Excavation
  - Mechanical Excavation

- Disposal Off site
  - RCRA D landfill

- Disposal On site
  - Consolidation

- Immobilization
  - Solidification and Fixation

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

- No Action

- Institutional Controls
  - Deed Restrictions

- Monitoring

2.9 SITE 26 TECHNOLOGY SCREENING

The selection of viable remedial technologies and process options for assemblage into remedial alternatives for Site 26 is presented in this section.

2.9.1 Site 26 Remedial Action Objectives

The results of the RI, previous investigations, and the human health and ecological risk assessments for Site 26 were evaluated to determine what remedial actions may be needed to protect human health and the environment, and to develop the site-specific RAOs.

Human Health Protection Considerations

The Site 26 HHRA results (RI Table 25-19) indicated that exposure to contaminated subsurface soils by a future industrial worker resulted in estimated RME lifetime carcinogenic risks (3.2 E-05) within the acceptable risk range (1 E-04 to 1 E-06), and RME noncarcinogenic HIs were less then 1.0. Therefore, no further remedial actions are warranted to protect a potential future industrial worker from contaminated soils exposures at Site 26.

For potential exposure to contaminated groundwater by the future industrial worker, the RME risk results indicate that total carcinogenic risks are within the acceptable risk range, and noncarcinogenic HIs of greater than 1.0 for several target organs. A review of RI Table 25-14 indicate that TCE and 1,2-DCE are the primary contributors of carcinogenic and non-carcinogenic risks. Therefore further remedial actions may be warranted at Site 26 to protect a potential future industrial worker from potential exposures to contaminants, if groundwater is used as a potable water supply.

The Site 26 HHRA results (RI Table 25-19) indicated that exposure to contaminated subsurface soils by a future resident resulted in estimated RME lifetime carcinogenic risks of 1.26 E-04, which slightly exceeds the acceptable risk range (10 E-04 to 10 E-06). The RME noncarcinogenic HIs for the future child resident were less then 1.0. Review of RI Table 25-11 indicates that the primary contributors of risks are arsenic and beryllium. The representative concentrations used in the risk assessment for arsenic and beryllium were 3.1 and 0.2 mg/kg, which are below the maximum detected background concentrations. The risks attributable to Site 26 soil arsenic and beryllium are not of concern for the future resident since the background concentrations are higher than the site-specific ones, there is no information suggesting that beryllium and barium

were disposed in the area, and sampling has not shown any evidence of a source area. Therefore, no further remedial actions are warranted to protect a future resident from contaminated soils exposures at Site 26.

Potential exposures to contaminated groundwater resulted in estimated RME adult total carcinogenic risks of 1.8 E-04 (slightly exceeding the acceptable risk range) attributable primarily to TCE and 1,1-DCE. For the RME child receptor exposure scenarios (RI Table 25-18), both ingestion of and dermal contact with the contaminated Site 26 groundwater posed non-carcinogenic HIs greater than 1.0 for several target organs including the cardiovascular system, the liver, and the central nervous system. TCE and 1,2-DCE, individually or in combination, were the principal contributors of non-carcinogenic risks. Therefore further remedial actions may be warranted at Site 26 to protect potential future residents from potential exposures to contaminants, if groundwater is used as a potable water supply.

The lead concentrations detected in Site 26 soils and groundwater were below EPA guidelines and are not expected to pose significant blood-lead levels based on the IEUBK Lead Model (v0.99).

Several chlorinated VOCs in groundwater pose potential risks to future industrial worker and resident adult and child receptors. While the HHRA included a future residential scenario, there are no current plans for base realignment at NWS Earle and future use of the Site 26 area for residential purposes is not currently planned. It is unknown what changes in the future may occur that may result in different land uses. As discussed previously in Section 1.3.4, the underlying groundwater is not used as a potable water supply. Should base realignment occur in the future that may result in different land use for Site 26, then an Environmental Baseline Survey would be conducted and measures to protect human health from exposures to contaminated groundwater may be warranted.

Ecological Receptors Risk Considerations

The RI concluded that soil contaminants at Site 26 were relatively low and did not constitute any significant threat to ecological receptors, the Site 26 area was relatively small, was mostly developed or covered by turfgrass, and did not offer a suitable ecological habitat for terrestrial organisms. The RI results indicated that there are no wetlands, sensitive habitats, or threatened or endangered species present in the vicinity of Site 26. Therefore, no further remedial actions are needed to protect ecological receptors at this Site.

Environmental Media Protection Considerations

Soils - The majority of the Site 26 soils do not appear to be continuing sources of groundwater contamination. Soils immediately adjacent to the process leach tank are likely contaminated by VOCs because of intimate contact with spent solvents as they were leached from the tank into the water table. The soil analytical results outside the immediate tank area indicate that virtually all detected VOCs and metals were present at levels below both the State Soil Residential and Non-Residential Direct Contact Cleanup Criteria (TBCs), and the Soil Impact to Groundwater Cleanup Criteria (TBC). While cadmium was present at all soil sampling locations, only the 26SB03-06 sample [1.2 mg/kg] slightly exceeded the Residential Direct Contact Cleanup Criteria of 1 mg/kg but is well below the Non-Residential Direct Contact Cleanup Criteria of 100 mg/kg. Based on the available analytical information, estimated risks, and comparison with State's non-promulgated soil cleanup criteria, no remediation of soils are except for the area immediately adjacent to the leach tank. It is anticipated that source control would be employed to address the process leach tank and associated contaminated soils.

Groundwater - Groundwater samples obtained from Site 26 contained a number of metals at concentrations generally comparable to the background levels. Aluminum, cadmium, iron, and manganese were detected at concentrations that exceeded the state GWQS. The cadmium concentration at only one groundwater sampling location [26MW04] exceeded the background range. The 26MW04 groundwater cadmium concentration of 4.4 μg/L only slightly exceeds the New Jersey GWQS of 4 μg/L.

The RI identified the presence of TCE and several degradation products at two monitoring well locations. Based on the high TCE concentration and corresponding 1,2-DCE levels detected at 26MW-01, the RI concluded that this location is near where the TCE was released and that the release occurred a number of years ago. 26MW-01 is located near the process leach tank. The VOCs TCE; 1,1,-DCE; and 1,2-DCE detected at 26MW-01 exceeded the state GWQS [ARAR]. VOCs detected at the other location, 26MW06, were present at or below the GWQS. No TCE or related compounds were found in background samples.

Based on the results of the October 1996 direct push groundwater sampling and field analyses, a VOC plume [exceeding the GWQS] has been identified extending approximately 400 feet in a southwesterly direction from the process leach tank. The interpreted VOC plume configuration is

consistent with the migration of contaminants laterally with the direction of groundwater flow. Figures 1-21 (a,b,c), Figures 1-22 (a,b,c), and Figures 1-23 show the interpreted groundwater TCE plume. However, an underlying aquitard (a clay layer varying between 10 to 15 feet thickness at approximately 25 feet below ground surface) appears to be limiting the vertical migration of these VOCs. Review of available data indicates that the plume appears to be migrating with groundwater towards the southwest. It is not known if the semi-permeable clay layer tends toward the ground surface, resulting in plume flow discharging to a surface water body, or if the clay lens tapers out to extinction or dips to greater depths. However, watershed samples taken in surface waters downgradient of Site 26 do not show any indication of TCE or DCE. Migration of contaminated groundwater appears to be unimpeded in the lateral direction.

Review of the RI data and comparison with the State GWQS and background concentrations and the single detection of slightly higher than GWQS cadmium concentration at 26MW04 indicate that no further remedial actions are warranted to address metals in groundwater at Site 26.

The RI data, in conjunction with the recent groundwater sampling data, indicate the presence of a VOC plume at concentrations that exceed the GWQS. It is likely that the suspected source of TCE and other VOCs, process leach tank and affiliated contaminated soils, are contributing to groundwater contamination at Site 26. Based on available information and anticipated risks, groundwater response actions need to be considered in this FS.

RAOs Selection

Based on the reasons provided, the following remedial action objectives have been selected:

Protection of Human Health RAO:

- Prevent potential human exposures to contaminated groundwater.

Protection of the Environment RAO:

- Mitigate migration of VOC contaminants in groundwater and restore the aquifer to applicable standards.

2.9.2 Site 26 Preliminary Remediation Goals (PRGs)

Data from the RI and the October 1996 sampling event, the human health risk assessment, and the ARARs were reviewed to identify the Site 26 contaminants of concern (COCs) which would be used to identify and select the appropriate PRGs. No COCs for soils were identified since site-related contaminants are not present at concentrations that pose human health risks. If excavation is necessary as a component of remedial action for the suspected source (process leach tank and associated soils), then the State Soil Impact to Groundwater Cleanup Criteria, or some other agreed-to standard, for VOCs could be used to determine the extent of soils removal.

The summary and basis for selecting groundwater COCs, based on exceedance of regulatory requirements (GWQS and SDWA MCLs) and risks to human health, are presented in Table 2-34. The organics and metal contaminants in groundwater that would contribute to excess human health carcinogenic risk (greater than 1 E-04 total) or HI greater than 1.0) were selected as human health risk-based COCs. PRGs for groundwater contaminants used the State GWQS numerical values, risk-based groundwater concentrations that do not result in carcinogenic risks exceeding 1 E-06 or HI greater than 0.1, and maximum detected background concentrations. Tables 2-35 presents a set of candidate groundwater PRGs. A set of proposed Site 26 PRGs for groundwater are presented in Table 2-36, along with the basis for their selection. These proposed groundwater PRGs can be used to delineate the volume of contaminated groundwater that may need to be evaluated for potential remedial action, and may be used in establishing Classification Exception Areas (CEAs) as defined under the N.J.A.C. 7:9-6.

2.9.3 Site 26 General Response Actions

General response actions were selected based on the RAOs for Site 26, the types and extent of contaminants present, leaching of contaminants from the suspected source (process leach tank and adjacent soils), and mitigation of contaminated groundwater.

The general response actions for Site 26 that address the suspected VOC source and continued contaminant leaching into groundwater include:

- No Action
- Removal and Disposal

TABLE 2-34
SITE 26 GROUNDWATER CONTAMINANTS OF CONCERN
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Exceeds NJ GWQS	Exceeds SDWA MCLs	Poses Human Health Risk
Trichloroethene	X	X	X (2)
1,1-Dichloroethene	X	–	X (2)
1,2-Dichloroethene	X	X	X (3)
Benzene	X (1)	X	–
Carbon tetrachloride	X (1)	X	–
Tetrachloroethene	X (1)	X	–
Cadmium	X	–	–

Notes:

- X indicates the basis for selection of the compound or element as a COC.
- The New Jersey State Ground Water Quality Standards (GWQS) are ARARs.
- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels regulate organic and inorganic constituents in public drinking water supplies; included as a TBC for comparison purposes only.
- – Not a COC; does not exceed GWQS, SWDA MCLs, or pose potential human health risks.
- (1) COC exceeds GWQS, based on direct push sampling and analysis data.
- (2) COC contributes to excess carcinogenic risks for the future residential adult through RME ingestion, dermal and inhalation exposures.
- (3) COC contributes to HI > 1.0 for future industrial worker, adult resident future under RME exposures, or for residential child under RME exposures.

TABLE 2-35
SITE 26 GROUNDWATER PRELIMINARY REMEDIATION GOALS (µg/L)
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	ARARS NJ GWQS	SDWA MCLs	PRG(2) Based on Risk = 1E06 [carcinogen]	PRG(2) Based on HI = 0.1 [non-carcinogen]	Maximum Background Concentration	Maximum Detected Site Conc.
Trichloroethene	1	5	3.65	8.45	BDL	4800 (1)
1,1-Dichloroethene	1	7	0.11	--	BDL	5 (1)
1,2-Dichloroethene (cis/trans)	10/100	70/100	--	13.3	BDL	2000
Benzene	0.2	5	--	--	BDL	11 (1)
Carbon tetrachloride	0.4	5	--	--	BDL	2 (1)
Tetrachloroethene	1	5	--	--	BDL	5 (1)
Cadmium	4	5	--	--	1.9	4.4

Notes:

- New Jersey State Ground Water Quality Standards (GWQS) are ARARs.
- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels regulate organic and inorganic constituents in public drinking water supplies, and are presented here only for comparison purposes.
- -- not a COC under this parameter.
- BDL Below detection limit.

(1) Based on direct push sampling with field GC analysis.
(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.

TABLE 2-36
SITE 26 PROPOSED GROUNDWATER PRGs
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

Contaminant of Concern	Proposed PRGs	Basis of Selection
Trichloroethene	1	NJ GWQS
1,1-Dichloroethene	10	NJ GWQS
1,2-Dichloroethene (cis/trans)	10/100	NJ GWQS
Benzene	1	NJ GWQS
Carbon tetrachloride	2	NJ GWQS
Tetrachloroethene	1	NJ GWQS
Cadmium	4	NJ GWQS

Notes:

- The New Jersey State Ground Water Quality Standards (GWQS) are ARARs.

General response actions that address potential human exposure to groundwater and continued migration of contaminated groundwater include:

- No Action
- Institutional controls (limited action)
- Containment
- Collection, Treatment, and Discharge
- In-Situ Treatment

Table 2-37 presents a summary of the Site 26 RAOs and corresponding general response actions.

2.9.4 Site 26 Identification and Screening of Technologies and Process Options

Table 2-37 presents a summary of potential remedial technologies and process options that apply to the Site 26 RAOs and general response actions. Screening of the remedial technologies considered their overall applicability to the media of concern, primary contaminants (VOCs), known Site conditions, and planned use of the Site. During the screening step, process option and entire technology types were eliminated from further consideration on the basis of technical implementability.

Site conditions considered include: presence of the suspected source, a process leach tank and associated soils, a VOC plume in groundwater extending away from the process leach tank, and the continued migration of groundwater contaminants.

The preliminary screening of groundwater response technologies is presented in Table 2-38. Detailed evaluations of the remedial technologies and process options for contaminated groundwater are presented in Table 2-39.

2.9.5 Summary of Site 26 Selected Remedial Technologies and Process Options

Table 2-39 identifies the remedial technologies that were retained after the detailed evaluation process. The technologies and process options that are not likely to be implementable, effective, or would result in higher implementation costs were eliminated from further consideration. Site

TABLE 2-37
SITE 26 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

Environmental Media	Remedial Action Objectives (from site characterization)	General Response actions (for all RAOs)	Remedial Technology Types (for general response actions)	Process Options
Groundwater	**Protection of Human Health** Prevent human exposure to contaminated groundwater.	No Action	No Action	- Not applicable
		Natural Attenuation	Natural Attenuation	- Biological processes - Chemical processes - Physical processes
	Protection of the Environment Mitigate migration of contaminant VOCs in groundwater.	Limited Action	Institutional Controls	- Deed restrictions - Classification Exception Area designation
			Long-Term Monitoring	- Groundwater monitoring
		Containment	Physical Containment - Vertical barriers - Horizontal barriers	- slurry wall, grout injection, sheet piling - horizontal subsurface barrier

TABLE 2-37
SITE 26 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY
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Environmental Media	Remedial Action Objectives (from site characterization)	General Response Action (for all RAOs)	Remedial Technology Types (for general response actions)	Process Options
Groundwater (cont.)	(see previous page)	Collection, Treatment, and Discharge	Collection Technologies: - Extraction - Enhanced Removal	- extraction wells, collection trench - Blasting/Hydrofracturing
			Treatment Technologies: - Physical - Chemical - Biological	- equalization, dewatering, sedimentation, oil-water separation, filtration, reverse osmosis, air stripping, carbon adsorption, extraction, distillation, evaporation, electrodialysis - ion exchange, electrolytic recovery, enhanced oxidation, chemical oxidation, reduction, neutralization, precipitation, coagulation-flocculation, dechlorination - aerobic or anaerobic biodegradation - air sparging, reactive wall, biodegradation, chemical oxidation
Groundwater (Cont.)			Discharge Technologies: - Beneficial re-use - Surface discharge - Subsurface discharge	- on-site use, off-site use - direct surface discharge, discharge to POTW, spray irrigation - reinjection

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 26 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NAVAL WEAPONS 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.
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. Retained.
	Long-Term Monitoring	Groundwater Monitoring	Periodic sampling and analysis of media to assess groundwater contaminant status and potential migration downgradient.	Potentially applicable. Retained.
Containment	Vertical Barriers	Slurry wall	Use of bentonite mixture to form low-permeability barrier to prevent contaminated groundwater movement. Ability to restrict chlorinated VOCs migration may be limited. Could be used to change direction of groundwater flow.	If used to form complete containment barrier, would need to be keyed into horizontal impermeable layer. Potentially applicable. Retained.
		Grout injection	Cement grout is injected to form a curtain wall that would restrict contaminated groundwater flow. Ability to restrict chlorinated VOCs migration may be limited. Could be used to change direction of groundwater flow.	If used to form complete containment barrier, would need to be keyed into horizontal impermeable layer. Potentially applicable. Retained.

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (cont.)	Vertical Barriers	Sheet piles	Sheet piles are driven vertically into the subsurface and linked to each other to form a continuous physical vertical barrier to groundwater flow. Could be used to change direction of groundwater flow.	If used to form complete containment barrier, would need to be keyed into horizontal impermeable layer. Potentially applicable. Retained.
	Horizontal barriers	Grout injection	Cement grout is jetted in a circular pattern to form a horizontal barrier to contaminated groundwater flow. Ability to restrict chlorinated VOCs migration may be limited.	Would not restrict lateral contaminated groundwater migration. Eliminated.
Collection	Extraction	Extraction Wells	Discrete pumping wells to collect contaminated water or divert clean water. Could also be used to provide hydraulic containment of contaminated groundwater flow, if well network designed to capture plume.	Potentially applicable. Retained.
		Collection Trench	A permeable trench used to intercept and collect clean or contaminated groundwater.	Potentially applicable. Retained.
	Enhanced Removal	Blasting/ Hydrofracturing	Blasting or hydrofracturing of bedrock or low-permeability overburden materials to promote access to groundwater in bedrock fractures.	Aquifer is sufficiently permeable so as not to require enhanced removal. Eliminated.
Treatment	Physical	Equalization	Dampening of flow and/or contaminant concentration variation in a large vessel to promote constant discharge rate and water quality.	Potentially applicable. Retained.
		Dewatering	Mechanical removal of free water from treatment residuals using equipment such as a filter press or vacuum filter.	Potentially applicable. Retained.

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 26 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Treatment (cont.)	Physical (cont.)	Sedimentation	Gravity settling of suspended solids from water in a vessel.	Potentially applicable. Retained.
		Oil/Water Separation	Mechanical separation of oils or other non-aqueous phase liquids from water by gravity and differences in liquid densities.	Potentially applicable, if NAPLs encountered. Retained.
		Filtration	Separation of material from water via entrapment in a bed or membrane separation.	Potentially applicable. Retained.
		Reverse Osmosis	Use of high pressure and membranes to separate dissolved materials, including organics and inorganics, from water.	Membranes would be subject to degradation by chlorinated organic compounds. Eliminated.
		Air Stripping	Transfer of volatile organic compounds from the aqueous phase to the vapor phase through contact of contaminated water with air or steam in a countercurrent process.	Potentially applicable. Retained.
		Carbon Adsorption	Adsorption of aqueous phase contaminants onto activated carbon. Suitable as either a primary treatment or polishing step.	Potentially applicable. Retained.
		Distillation	Vaporization of a liquid followed by condensation of the vapors by cooling.	Not effective on wastes containing dilute mixtures of many different contaminants. Eliminated.
		Evaporation	Change from the liquid to the gaseous state at a temperature below the boiling point.	Not effective on wastes containing dilute mixtures of many different contaminants. Eliminated.

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 26 CONTAMINATED GROUNDWATER
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Treatment (cont.)	Chemical (cont.)	Ion exchange	Process in which toxic ions are removed from the aqueous phase by being exchanged with relatively harmless ions held by electrostatic forces to a specifically formulated resin.	Potentially applicable. Retained.
		Enhanced Oxidation	Use of strong oxidizers to chemically oxidize organic materials. Typically hydrogen peroxide and/or ozone with UV radiation can be used to treat aqueous stream. Oxidation may also be accomplished using high temperatures, pressures, and air.	Potentially applicable. Retained.
		Chemical Oxidation	Use of oxidizing agents such as hydrogen peroxide, ozone, chlorine, or potassium permanganate to chemically increase the oxidation state of materials in order to reduce their toxicity or solubility.	Potentially applicable. Retained.
		Reduction	Use of strong reducers such as ferrous iron, sulfur dioxide, or sulfite to chemically reduce the oxidation state of materials in order to reduce their toxicity or solubility.	Contaminants present are not amenable to reduction. Not applicable for organics, primarily used for reduction of hexavalent chromium, mercury, and lead. Eliminated.
		Neutralization	Use of acids or bases to counteract excessive pHs or adjust pH to the optimum for a given treatment process.	Potentially applicable. Retained.
		Precipitation	Use of reagents to convert dissolved contaminants into insoluble materials that can be physically removed from the waste stream.	Potentially applicable. Retained.

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 26 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Treatment (cont.)	Chemical (cont.)	Flocculation	Use of chemicals to neutralize surface charges and promote attraction of colloidal particles to facilitate settling.	Potentially applicable. Retained.
		Dechlorination	Use of chemicals to remove chlorine from chlorinated compounds.	Typically utilized for high concentration wastewater streams. Not effective on waste streams containing a dilute mixture of many different contaminants. Eliminated.
	Biological	Aerobic	Suspended growth or fixed film process employing aeration and biomass recycle to decompose organic contaminants. Or biomass may be stimulated in a reactor to degrade aromatic hydrocarbon compounds.	Potentially effective for petroleum hydrocarbons, but not very effective for treating heavily chlorinated organics. May be used to treat decomposition components of chlorinated organics. Retained.
		Anaerobic	Suspended growth or fixed film process employing anaerobic bacteria to decompose chlorinated organic contaminants in an oxygen-free environment.	Potentially effective for treating chlorinated organics. Retained.
	In-situ Treatment	Air Sparging	Injection of air into groundwater to foster physical stripping of VOCs from the aqueous phase into the gas phase. The VOCs would rise through the vadose zone and soil column to be captured by a soil vapor extraction system.	The Site 26 soils from the ground surface to nearly top of the water table are relatively free of VOCs. Air sparging may result in low level contamination of these soils. Retained.
		Permeable Reaction Wall	A trench is excavated in the path of a contaminant plume and filled with chelators, sorbents, microbes, or other materials to degrade or retain contaminants as ground water passes through the wall.	This process option is an innovative technology in the developmental stage. Several full size systems have been constructed in 1996, but results are currently unknown. Retained.

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 26 CONTAMINATED GROUNDWATER
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NEW JERSEY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Treatment (cont.)	In-situ Treatment (cont.)	Biodegradation	Naturally occurring organisms are stimulated or adapted to metabolize hydrocarbons as a food source. Oxygen and nutrients are sometimes added to promote organic compound degradation. Co-metabolism of chlorinated hydrocarbons can be stimulated through the addition of methane in the presence of methanotrophs.	In developmental stage. Potentially applicable. Retained.
		Chemical Oxidation	Hydrogen peroxide, ozone, and other oxidizers may be injected into the groundwater plume to degrade the chlorinated organic contaminants, which may subsequently be further degraded by soil microbes.	In developmental stage. Potentially applicable. Retained.
Discharge	Beneficial Reuse	On-Site reuse	Treated recovered water may be used as process water or for watering lawns, shrubbery, etc.	Potentially applicable. Retained.
	Surface Discharge	Direct Discharge	Discharge of treated water to local stream or river, approximately 1000 feet away.	Potentially applicable. Retained.
		Indirect Discharge (POTW)	Discharge of treated water to a publicly owned treatment works.	Not feasible since on-base POTW not able to receive this type of aqueous stream. Eliminated.
		Off-Site Treatment Facility	Transport of untreated groundwater to permitted off site facility for treatment and disposal.	Not easily implementable to transport quantities of contaminated groundwater to off-base POTW. Also may be difficult to find POTW that would accept groundwater. Eliminated.

TABLE 2-38
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FOR SITE 26 CONTAMINATED GROUNDWATER
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Discharge (cont.)	Surface Discharge (cont.)	Spray Irrigation	Use of spray irrigation on open land to aerate treated groundwater and foster evapotranspiration.	Potentially applicable. Retained.
	Subsurface Discharge	Underground Injection or Infiltration	Use of reinjection or infiltration galleries to discharge treated groundwater back into the aquifer.	Potentially applicable. Retained.

TABLE 2-39
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ

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 migration and assessing effectiveness of remedial action.	Readily implementable; numerous companies are available with resources to perform monitoring.	Capital: Low O&M: Low	Retained.
Containment	Vertical Barriers	Slurry Wall	Would prevent or limit groundwater flow, but may have some be difficulty in retarding chlorinated solvent migration. Groundwater levels not anticipated to be a problem.	Readily implementable. Would need to key into low permeability horizontal layer. Could be used to channel groundwater flow direction. Would need to excavate trench, disposal of VOC-contaminated spoils pose problems.	Capital: Low O&M: Low	Eliminated.

TABLE 2-39
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
Containment (cont.)	Vertical Barriers (cont.)	Grout Injection	Would prevent or limit groundwater flow, but may have some be difficulty in retarding chlorinated solvent migration. Groundwater levels not anticipated to be a problem.	Readily implementable. Would need to key into low permeability horizontal layer. Could be used to channel groundwater flow direction.	Capital: Low O&M: Low	Retained.
		Sheet Piles	Would prevent or limit groundwater flow. Effective permeability may be higher than other vertical barriers.	Readily implementable using standard construction techniques. Could be used to channel groundwater flow direction.	Capital: Low O&M: Low	Retained.
Collection	Extraction	Extraction Wells	Effective method for containing contaminant migration and extracting groundwater for treatment. May be limited by site geologic or hydrogeologic conditions.	Readily implementable using readily available equipment and resources.	Capital: Low O&M: Low	Retained.
		Collection Trench	Effective method for containing contaminant migration and extracting groundwater for treatment. Most applicable for low permeability or heterogeneous soils.	Installation in contaminated areas would generate a quantity of contaminated soils that would need to be stored on site or disposed off site.	Capital: Medium O&M: Low	Retained.

TABLE 2-39

DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
Treatment	Physical	Equalization	Effective process for dampening flow and contaminant surges. Does not directly remediate contaminants, but necessary process to ensure proper operation of treatment system.	Readily implementable using commercially available equipment.	Capital: Low O&M: Low	Retained.
		Dewatering	Effective process for removing free water from treatment residues (sludges). Would improve sludge handling characteristics and lower disposal costs.	Readily implementable using commercially available equipment.	Capital: Medium O&M: Medium	Retained.
		Sedimentation	Effective for removal of settleable solids, such as those formed by precipitation and flocculation processes.	Readily implementable using commercially available equipment.	Capital: Low O&M: Low	Retained.
		Oil/Water Separation	Effective for separating oils and non-aqueous phase liquids, if recovered from extraction wells or trench.	Readily available through a number of vendors.	Capital: Low O&M: Low	Retained.
		Filtration	Effective process for removal of particulate metals and suspended solids from groundwater	Readily implementable using commercially available equipment and resources.	Capital: Low O&M: Low	Retained.

TABLE 2-39

DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
Treatment (cont.)	Physical (cont.)	Air Stripping	Effective for removal of most Site VOCs from groundwater, capable of meeting remediation goals for most VOCs. Off-gas controls would be required.	Readily implementable using commercially available equipment and resources.	Capital: Low O&M: Low	Retained.
		Carbon Adsorption	Effective for nearly complete removal of most VOCs from Site groundwater, but may require frequent replacement. Can be used as polishing step.	Readily implementable using commercially available equipment and resources.	Capital:Medium O&M: Low/ Medium	Retained.
	Chemical	Ion Exchange	May effectively remove dissolved metals from Site groundwater. However, concentrations of VOCs in groundwater may degrade resin and reduce its ion exchange capacity.	Readily implementable using commercially available equipment and resources.	Capital: Low O&M: Medium/High	Retained.
		Enhanced Oxidation	Effective for destruction of Site VOCs. Capable of meeting remediation goals; however, long retention time may be required to destroy chlorinated alkanes.	Implementable. Equipment and resources are commercially available from a few vendors.	Capital: Medium/ High O&M: Medium/ High	Retained.
		Chemical Oxidation	Effective process for degrading VOCs in extracted groundwater.	Readily implementable using commercially available equipment and resources.	Capital: Low O&M: Low	Retained.

TABLE 2-39
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER
FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
Treatment (cont.)	Chemical (cont.)	Neutralization	Effective means of balancing or changing the pH of a solution to ensure optimum treatment efficiency or to meet discharge requirements.	Readily implementable using commercially available equipment and resources.	Capital: Low O&M: Low	Retained.
		Flocculation/ Precipitation	Effective for removal of dissolved, particulate metals and suspended solids from site groundwater. Sludge produced may require treatment prior to disposal.	Readily implementable using commercially available equipment and resources.	Capital: Medium O&M: Medium	Retained.
	Biological	Aerobic	Would be effective for aromatic hydrocarbons such as BTEX. Could be employed in a reactor to degrade VOCs.	Implementable, but could lose VOCs to ambient air during treatment. Would require methane and oxygen and methanotrophs to degrade chlorinated hydrocarbons.	Capital:Medium O&M: Medium	Other process options would be more effective. Eliminated.
		Anaerobic	Would be effective in addressing chlorinated hydrocarbons under anaerobic conditions.	Implementable, but could lose VOCs to ambient air during treatment.	Capital:Medium O&M: Medium	Other process options would be more effective. Eliminated.

TABLE 2-39
DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
Treatment (cont.)	In-situ treatment	Biodegradation	Microbes may potentially be able to reduce VOC levels to GWQS, if proper conditions available for microbial activity including reaction time. Would result in less residuals handling.	This process option is relatively new, innovative, and better demonstrated for petroleum hydrocarbons (BTEX). Chlorinated compounds pose biodegradability difficulties. Several firms are available to provide service.	Capital:Medium O&M: Low	Retained, as an innovative technology.
		Permeable Reaction Wall	This process has been tested at the bench and pilot scale, and 6 full-size units have been constructed. Would be capable of treating most site organics. A number of site-specific factors (such as pH, volume of treatment medium required, or biological activity) could affect effectiveness of the wall.	The process is readily implemented using standard construction techniques to construct the trench, and filling with the proper reaction medium (adsorbents, catalysts). Currently, several firms appear to provide this process commercially.	Capital:Medium O&M: Low	Retained, as an innovative technology.
		Chemical Oxidation	Chlorinated VOCs may be oxidized by strong oxidizers if the chemicals can be delivered to the contaminants. Would result in less residuals handling.	This innovative method has been attempted at the bench and pilot scales, and is not well demonstrated. However, stratigraphy and low groundwater flow rate may be conducive to process.	Capital: Medium O&M: Low	Retained, as an innovative technology.

TABLE 2-39

DETAILED EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS FOR SITE 26 GROUNDWATER FEASIBILITY STUDY
NAVAL WEAPONS STATION EARLE, COLTS NECK, NJ
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	RETAIN/ ELIMINATE
Treatment (cont.)	In-situ treatment (cont.)	Air Sparging/Soil Vapor Extraction	This process has been proven effective in treating soil and groundwater where extensive VOC contamination is present.	This process is readily implementable and is proven. Numerous firms could provide this process.	Capital:Medium O&M: Medium	Retained.
Discharge	Surface Discharge	Direct Discharge	Direct discharge to stream or creek is a viable option for discharge of treated groundwater.	Implementable. The discharge would be required to meet appropriate discharge limitations to protect water quality of the river.	Capital: Low O&M: Low	Retained.
		Spray Irrigation	Would be effective for disposal of treated groundwater, if sufficient open land is available.	Implementable using available standard equipment and installation techniques.	Capital: Low O&M: Low	Retained.
	Subsurface Discharge	Infiltration	Treated water could be reintroduced into aquifer downgradient of extraction zone. Geologic materials are capable of receiving infiltrated water. Would be effective.	Moderate implementability due to regulatory considerations.	Capital: Low O&M: Low	Retained.

specific considerations were also factors in the elimination of candidate technologies and process options.

For the suspected TCE source, the process leach tank and associated soils, process options include:

- No Action
- Removal and Disposal

For contaminated groundwater, the following technology types and process options were retained:

- No Action
- Limited Action
  - Deed restrictions
  - Long-term monitoring
- Containment
  - Grout injection
  - Sheet piles
- Extraction
  - Extraction wells
  - Collection trench
- Physical Treatment
  - Equalization
  - Dewatering
  - Sedimentation
  - Oil/water separation
  - Filtration
  - Air stripping
  - Carbon adsorption

- Chemical Treatment
  - Ion exchange
  - Enhanced oxidation
  - Chemical oxidation
  - Neutralization
  - Flocculation
  - Precipitation

- In-situ Treatment
  - Permeable reaction wall
  - Biodegradation
  - Chemical oxidation
  - Air-Sparging

- Discharge
  - Direct discharge
  - Spray irrigation
  - Infiltration

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 4 - DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section will discuss the rationale for development of remedial action alternatives for Site 4, describe the assembled alternatives, and present the screening of alternatives. Detailed evaluations and costing of the retained alternatives are presented in Section 4.0

3.1.1 Site 4 - Rationale for Development of Alternatives

Factors considered in formulating the remedial alternatives to achieve the RAOs for Site 4 are discussed below:

Statutory and Guidance Considerations - 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 were developed in compliance with statutory requirements of the NCP and in consideration of applicable EPA directives and guidance, including

- 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.

- Presumptive Remedy for CERCLA Municipal Landfill Sites, OSWER Directive No. 9355.0-49FS, September 1993.

- Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance), OSWER Directive No. 9355.0-62FS, April 1996.

- Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, OSWER Directive No. 9355.3-11, EPA/540/P-91/001, February 1991.

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 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 4 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.

Protection of Human Health Considerations - The RAOs for protection of human health specify preventing human exposure to the contaminated landfill materials and preventing potential exposure to contaminants in site groundwater. The alternatives were formulated to meet these objectives.

Protection of the Environment Considerations - The RAO for protection of the environment specifies minimizing contaminant migration to groundwater and the adjacent wetlands (surface water and sediments) and restoration of the aquifer to the applicable standard. The alternatives for Site 4 contain measures to meet these objectives.

3.1.2 Site 4 - Remedial Alternatives Descriptions

This section presents detailed descriptions of the source control alternatives. As previously presented, no active groundwater response actions are anticipated based on the evaluation of current site contaminant conditions. Contaminated groundwater will not be used for potable purposes through establishment of institutional controls (deed restrictions and Classification Area Exception waiver), and there are no plans to convert Site 4 to residential use. In the long term, natural degradation and attenuation factors would diminish groundwater contaminant levels (for alternatives employing active source control) to below regulatory of background levels. Long-term groundwater monitoring is included in each Site 4 remedial alternative to assess contaminant status, to determine whether humans and environment may be at risk from contaminated groundwater associated with the site, and to assess whether additional source control or groundwater response actions are warranted to reduce human health risks or to protect the environment. The key components of Alternatives 1 through 3 are identified on Table 3-1.

3.1.2.1 Site 4 - 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 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.

Although extensive investigation of landfill contents has not been conducted, the RI concluded that landfill materials appear to be a continuing source of contaminants to site groundwater and surface water. Under the no-action alternative, no measures would be implemented to prevent potential human or animal exposure to landfill materials or site groundwater or to mitigate contaminant migration to 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 main protective feature is a sandy soil cover that reduces the potential for human and animal contact with landfill materials. The cover is moderately vegetated with grasses and scrub pines, that serve to reduce infiltration of precipitation into landfill materials and limit surface runoff and erosion. The cover is present over the majority of the landfill; however, erosion of the cover and exposed debris are evident on the eastern side of the landfill. Where present and in good condition, the vegetation may

TABLE 3-1
SITE 4 - REMEDIAL ALTERNATIVES COMPONENTS
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	KEY COMPONENTS OF ALTERNATIVE
1	No Action	• Annual groundwater, surface water, and sediment monitoring • Five-year reviews
2	Limited Action	• Fencing • Institutional Controls (deed restrictions, CEA*) • Annual 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 (deed restrictions, CEA*) • Natural attenuation of groundwater contaminants • Long-term operation and maintenance • Annual 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.

reduce precipitation infiltration and surface runoff, but as indicated by RI sampling results, contaminant migration into groundwater and surface water is not prevented by the cover.

Because no actions would be conducted under Alternative 1 to maintain or cover the landfill, the landfill surface would continue to erode, potentially exposing more contaminated materials, increasing infiltration and attendant contaminant leaching and migration; and allowing surficial materials to be transported through precipitation and wind erosion. Under the no-action alternative, contaminants would continue to migrate.

Long-Term Monitoring - Under Alternative 1, the groundwater, surface water, and wetland sediment would be sampled periodically (beginning semi-annually) to monitor the migration of contaminants from the landfill and the potential impacts to downgradient areas. The data collected would be evaluated during the 5-year review period.

For the purpose of costing, it is assumed that groundwater samples will be collected from the six existing monitoring wells and the sample will be analyzed for site-specific contaminants (metals and VOCs). Surface water and sediment would be collected from three locations within the adjacent wetlands. 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 evaluation of analytical and hydrogeologic data, assessing whether contaminant migration has increased, and determining whether human or ecological receptors or natural resources are at risk.

3.1.2.2 Site 4 - Alternative 2: Limited Action (Institutional Controls, Access Restrictions, and Long-Term Monitoring)

Alternative 2 was developed as an option that relies on access restrictions and institutional controls to limit exposures to hazardous substances. This alternative does not employ treatment or containment to address site contamination.

Restrictions would be attached to the property title and/or the Base Master Plan (access restrictions) to limit future uses of the site that may result in disturbance of the existing soil cover or direct contact with contaminated media. A fence would be erected around the landfill to limit access to the site, to restrict human contact with contaminated landfill materials and to protect the integrity of the existing cover. Long-

term, periodic (beginning as semi-annual) 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 2 are identified on Table 3-1 and described below.

Existing Features - Existing site features offer limited protection of human health and the environment. The main protective feature is a sandy soil cover that reduces the potential for human and animal contact with landfill materials. The cover is moderately vegetated with grasses and scrub pines, which serve to reduce infiltration of precipitation into landfill materials and limit surface runoff and erosion. The cover is present over the majority of the landfill; however, erosion of the cover and exposed debris are evident on the eastern side of the landfill. Where present and in good condition, the vegetation may reduce precipitation infiltration and surface runoff, but as indicated by RI sampling results, contaminant migration into groundwater and surface water is not prevented by the cover.

Because no actions would be conducted to maintain or further cover the landfill, the landfill surface would continue to erode, potentially exposing more contaminated materials, increasing infiltration and attendant contaminant leaching and migration, and allowing surficial materials to be transported through precipitation and wind erosion. Contaminants will continue to migrate.

Institutional Controls - Under Alternative 2, access restrictions would be enacted to limit future use of the landfill property. Restrictions would be placed on future activities that could result in increased human exposure to contaminated landfill materials or increased erosion and contaminant migration. Restricted activities would include excavation, vehicular traffic (off-road vehicles and dirt bikes), and use of untreated groundwater for drinking water.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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.

Fencing - The entire landfill area would be fenced to limit human access to contaminated soils and landfill materials. An estimated 1,700 linear feet of 6-foot-high chain-link fence would be required to encircle the landfill area. The fencing would also limit animal intrusion into the landfill area thus reducing exposure of biota to contaminated materials. However, fencing would not restrict access to birds or small, burrowing animals that may be at the greatest risk from exposure to contaminants within the landfill. One gate would provide access. The fencing would be inspected and repaired annually.

Long-Term Monitoring - Under Alternative 2, the groundwater, surface water, and wetland sediment would be sampled annually to monitor the migration of contaminants from the landfill and the potential impacts to downgradient areas. 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 (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants (metals and VOCs). Surface water and sediment would be collected from three locations within the adjacent wetlands. 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 ecological receptors or natural resources are at risk.

3.1.2.3 Site 4 - 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 attenuate naturally through biological and chemical degradation (VOCs only), adsorption (metals and VOCs), and precipitation (metals). Contaminant concentrations in groundwater will 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. 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 (beginning as semi-annual) 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. Test pitting, sampling, and chemical analyses would be required to more fully delineate the extent of the landfill materials. 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. However, settling concerns are likely to be minimal because the landfill has been inactive and subject to waste degradation and settling since the 1960s.

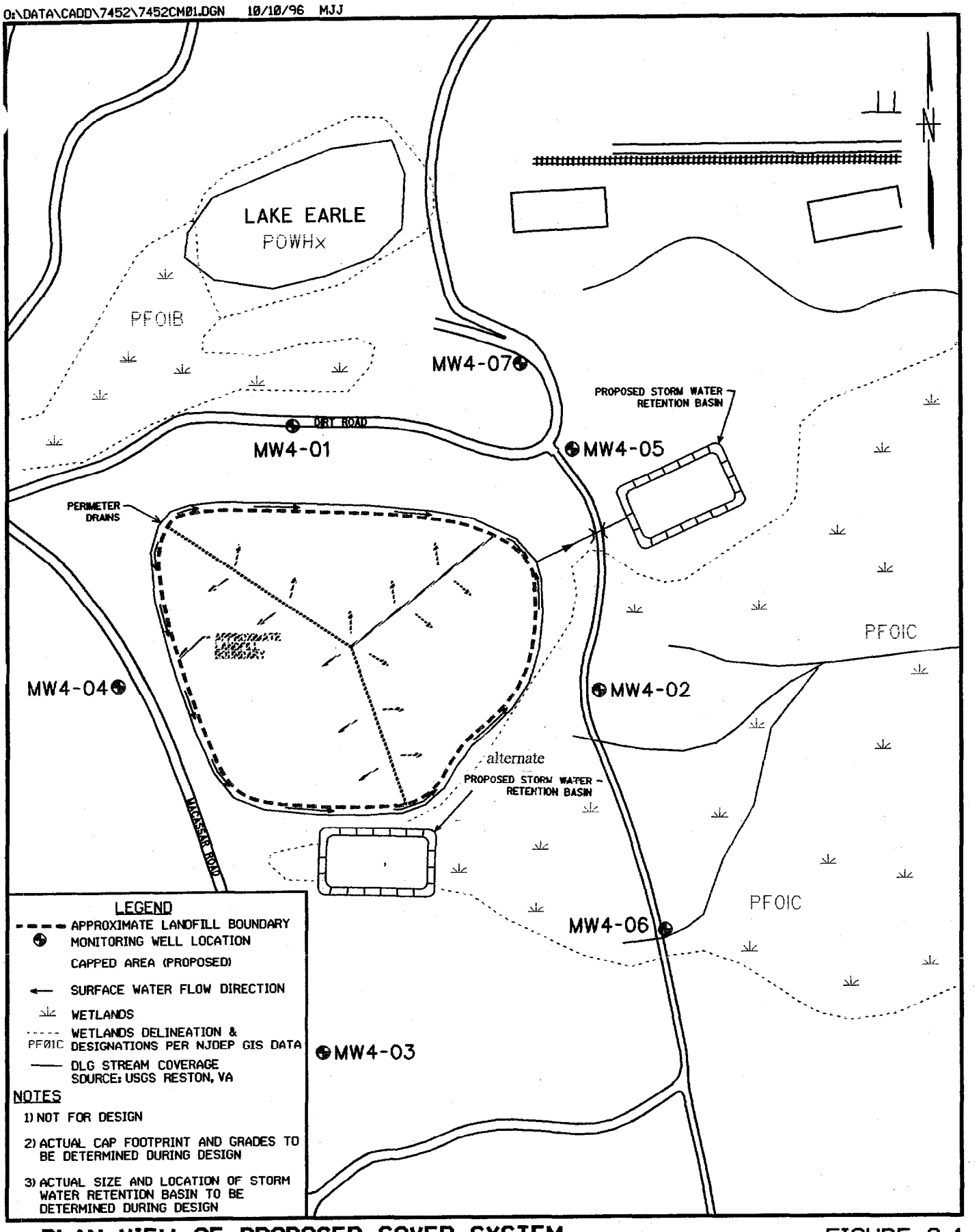
Site Preparation - The site has not been used for many years and is moderately vegetated with grasses and pine trees. Clearing and grubbing of the vegetative growth would be necessary to prepare the site for capping. Silt fences or staked hay bales would be required to minimize erosion effects while 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. Site utilities may need to be established prior to the start of remediation.

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 organics and 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 layer) and generally meet RCRA Criteria for Municipal Solid Waste Landfills (40 CFR 258).

For the purpose of this focused FS, a single-barrier cover system was selected as the representative capping option. Figure 3-1 presents a plan view of conceptual design of the cover. A cross section of a conceptual cover system is presented on Figure 3-2. Descriptions of the individual cover layers are summarized as follows, from bottom to top:

O:\DATA\CADD\7452\7452CM01.DGN 10/10/96 MJJ



PLAN VIEW OF PROPOSED COVER SYSTEM

SITE 4 - ALTERNATIVE 3 FS - NWS EARLE

FIGURE 3-1

0 200 400

SCALE IN FEET

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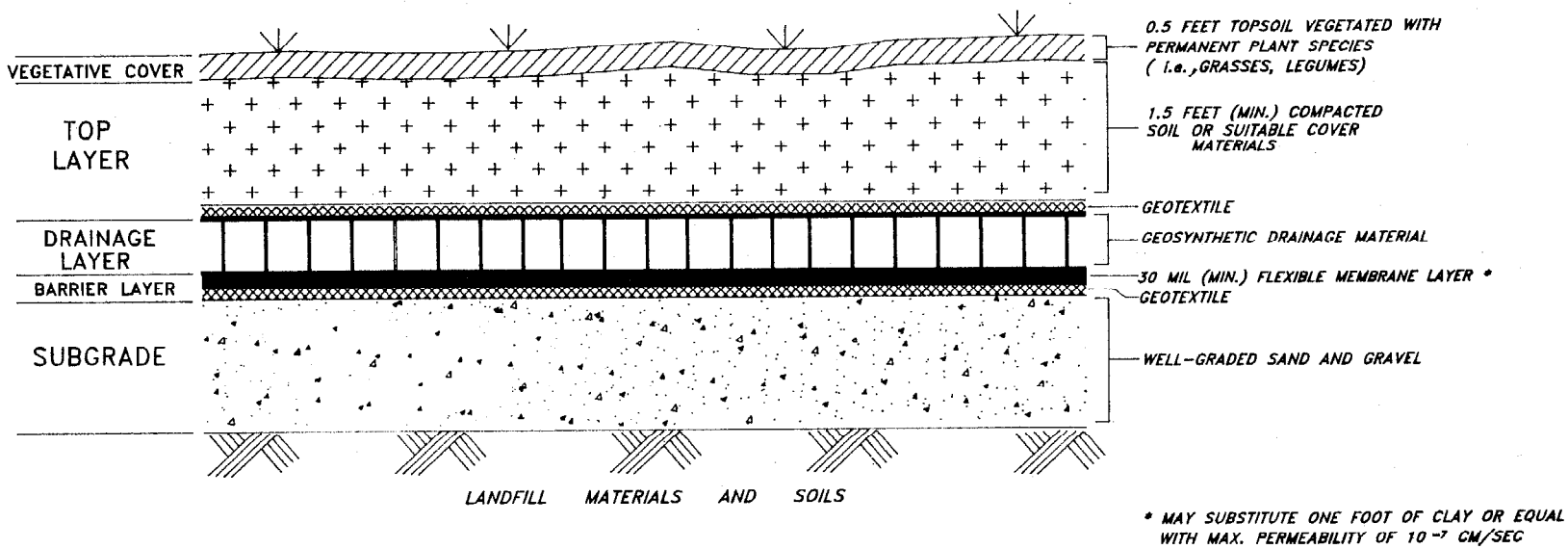

CROSS-SECTIONAL VIEW

NOTE:

1. NOT TO SCALE.
2. NOT FOR DESIGN.

CONCEPTUAL COVER SYSTEM DESIGN
SITE 4 – ALTERNATIVE 3
FEASIBILITY STUDY REPORT
NWS EARLE, COLTS NECK, NEW JERSEY

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FIGURE 3-2

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.

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 and covered with permeable cover materials since the 1960s, 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 sensitive 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 is 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 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. A minimum of 2 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 and soil loss. Trees, woody shrubs, and other deep rooted plants that might penetrate the low-permeability layer would be prevented from growing on the cover.

The final surface slope of cover system in the plateau area should have a slope of between three percent (3V:100H) and 15 percent (15V: 100H) to ensure slope stability, control erosion, and allow compaction, seeding, and revegetation of the cover materials. The final slope would also 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 encompass all landfill materials.

If other NWS Earle wastes are to be consolidated at Site 4, consolidation would occur prior to cover placement.

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 4 feet high chain-link, 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 (off-road vehicles and dirt bikes), and use of untreated groundwater for drinking water.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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, 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, the groundwater, surface water, and wetland sediment would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from the landfill and assess the potential impacts to downgradient areas. The collected data would be evaluated during the 5-year review period. The frequency of monitoring and the number of analytical parameters

may be decreased if the 5-year review determines that significant contaminant leaching reduction or improvement of groundwater quality has been attained.

For the purpose of costing, it is assumed that groundwater samples will be collected from six existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants. Surface water and sediment would be collected from three locations within the adjacent wetlands. 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 4 - 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 4. The screening is presented in Table 3-2. Alternative 2 - Limited Action was eliminated because it offered limited additional benefit, when compared to Alternative 1, for the additional cost.

3.2 SITE 5 - DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section presents the rationale for development of remedial action alternatives for Site 5, describes the assembled alternatives, and presents the screening of alternatives. Detailed evaluations and costing of the retained alternatives are presented in Section 4.0

3.2.1 Site 5 - Rationale for Development of Alternatives

Factors considered during formulation of the remedial alternatives to achieve the RAOs for Site 5 are discussed below:

Statutory and Guidance Considerations - 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 were developed in compliance with statutory requirements of the NCP and in consideration of applicable EPA directives and guidance, including

TABLE 3-2
SITE 4 - SCREENING OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
1	No Action: (long term monitoring, five 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.
2	Limited Action (Institutional controls, access restrictions, long-term monitoring, five-year reviews)	Provides little 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 minimal additional protectiveness for additional cost. Eliminated.
3	Capping, Institutional Controls, and Long-Term Monitoring	Protects human health and the environment. Capping contaminated landfill materials prevents direct contact exposure and minimizes contaminant migration to the environment. Groundwater use would be restricted. Groundwater contaminants will naturally attenuate 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.

- 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.

- Presumptive Remedy for CERCLA Municipal Landfill Sites, OSWER Directive No. 9355.0-49FS, September 1993.

- Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance), OSWER Directive No. 9355.0-62FS, April 1996.

- Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, OSWER Directive No. 9355.3-11, EPA/540/P-91/001, February 1991.

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 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 5 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.

Protection of Human Health Considerations - The RAOs for protection of human health specify preventing human exposure to the contaminated landfill materials and preventing potential exposure to contaminants in site groundwater. Remedial alternatives were formulated to meet these objectives.

Protection of the Environment Considerations - The RAO for protection of the environment specifies minimizing contaminant migration to groundwater and restore the aquifer to the applicable standard. These objectives were considered in the formulation of alternatives.

3.2.2 Site 5 - Remedial Alternatives Descriptions

This section presents detailed descriptions of the source control alternatives. As previously presented, no active groundwater response actions are anticipated based on the evaluation of current site contaminant conditions. Contaminated groundwater will not be used for potable purposes through establishment of institutional controls (deed restrictions and Classification Area Exception waiver), and there are no plans to convert Site 5 to residential use. In the long term, natural degradation and attenuation factors would diminish groundwater contaminant levels (for alternatives employing active source control) to below regulatory of background levels. Long-term groundwater monitoring is included in each Site 5 remedial alternative to assess contaminant status, to determine whether humans and environment may be at risk from contaminated groundwater associated with the site, and to assess whether additional source control or groundwater response actions are warranted to reduce human health risks or to protect the environment. The key components of Alternatives 1 through 3 are identified on Table 3-3.

3.2.2.1 Site 5 - 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 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.

Although extensive investigation of landfill contents has not been conducted, the RI concluded that landfill materials appear to be a continuing source of contaminants to site groundwater. Under the no-action alternative, no measures would be implemented to prevent potential human or animal exposure to landfill

TABLE 3-3
SITE 5 - REMEDIAL ALTERNATIVES COMPONENTS
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	KEY COMPONENTS OF ALTERNATIVE
1	No Action	• Annual groundwater monitoring • Five-year reviews
2	Limited Action	• Institutional Controls (access restrictions, CEA*) • Annual groundwater monitoring • Quarterly inspection of existing cover in skeet/shooting range • Five-year reviews
3	Capping, Institutional Controls, and Long- Term Monitoring	• Pre-design investigations • Site preparation • Site grading • Single barrier cover system • Institutional controls (access restrictions, CEA*) • Natural attenuation of groundwater contaminants • Long-term operation and maintenance • Annual groundwater 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.

materials or site groundwater or to mitigate contaminant migration to the environment. Key components of Alternative 1 are identified on Table 3-3 and described below.

Existing Features - Currently, site features offer limited protection of human health and the environment. The primary protective features are the sandy soil cover over the entire landfill that reduces the potential for human and animal contact with landfill materials and the vegetative cover that reduces infiltration of precipitation into landfill materials and limits surface runoff and erosion of the cover. Two different types of vegetative cover are present in discrete areas of the landfill: the western portion of the 13-acre landfill is moderately vegetated with scrub pines and grasses, and the eastern portion of the landfill surface is sparsely covered with only low weeds and grasses. The grasses and scrub pines on the western side of the landfill are expected to be moderately effective for limiting infiltration, surface runoff, and erosion. The sparse cover on the eastern side of the landfill is likely less effective at controlling infiltration, runoff, and erosion, because the vegetation and cover materials are thin in some areas. As indicated by RI sampling results, the vegetative cover is not completely effective at preventing contaminant migration into groundwater.

Because no actions would be conducted under Alternative 1 to maintain or cover the landfill, the landfill surface could possibly erode in the future, potentially exposing contaminated materials, increasing infiltration and attendant contaminant leaching and migration, and allowing surficial materials to be transported through precipitation and wind erosion. Under the no-action alternative, contaminants would continue to migrate.

Long-Term Monitoring - Under Alternative 1, the groundwater would be sampled periodically (beginning semi-annually) to monitor the migration of contaminants from the landfill and the potential impacts to downgradient areas. 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 eight existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance") and analyzed for site-specific contaminants (metals and VOCs). 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 evaluation of analytical and hydrogeologic data, assessing whether contaminant migration has increased, and determining whether human or ecological receptors or natural resources are at risk.

3.2.2.2 Site 5 - Alternative 2: Limited Action (Institutional Controls, Access Restrictions, and Long-Term Monitoring)

Alternative 2 was developed as an option that relies on access restrictions and institutional controls to limit exposures to hazardous substances. This alternative does not employ treatment or containment to address site contamination.

Access restrictions would be attached to the property title and/or the Base Master Plan to limit future uses of the site that may result in disturbance of the existing soil cover or direct contact with contaminated media. A fence would be erected around the landfill to limit access to the site, to restrict human contact with contaminated landfill materials and to protect the integrity of the existing cover. Because the current and intended future use of the eastern portion of the landfill is as a skeet and shooting range, access to the site would be limited to authorized persons but would not be prohibited.

Long-term, periodic (beginning as semi-annual) 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 2 are identified on Table 3-3 and described below.

Existing Features - Existing site features offer limited protection of human health and the environment. The primary protective features are the sandy soil cover over the entire landfill that reduces the potential for human and animal contact with landfill materials and the vegetative cover that reduces infiltration of precipitation into landfill materials and limits surface runoff and erosion of the cover. Two different types of vegetative cover are present in discrete areas of the landfill: the western portion of the 13-acre landfill is moderately vegetated with scrub pines and grasses, and the eastern portion of the landfill is sparsely covered with only low weeds and grasses. The grasses and scrub pines on the western side of the landfill are expected to be moderately effective for limiting infiltration, surface runoff, and erosion. The sparse cover on the eastern side of the landfill is probably less effective at these functions because the vegetation and cover materials are thin in some areas. As indicated by RI sampling results, the vegetative cover is not completely effective at preventing contaminant migration into groundwater.

Because no actions would be conducted under Alternative 2 to maintain or further cover the landfill, the landfill surface could possibly erode in the future, potentially exposing contaminated materials, increasing infiltration and attendant contaminant leaching and migration, and allowing surficial materials to be transported through precipitation and wind erosion. Contaminants would continue to migrate.

Institutional Controls - Under Alternative 2, access restrictions would be enacted to restrict future use of the landfill property. Restrictions would be placed on future activities that could result in human exposure to contaminated landfill materials or erosion and subsequent contaminant migration. Restricted activities would include excavation, vehicular traffic (off-road vehicles and dirt bikes), and use of untreated groundwater for drinking water.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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.

Fencing - The entire landfill area would be fenced to limit human access to contaminated soils and landfill materials. An estimated 1,800 linear feet of 6-foot-high chain-link fence would be required to encircle the landfill area. The fencing would also limit animal intrusion into the landfill area, thus reducing exposure of biota to contaminated materials. However, fencing would not restrict access to birds or small, burrowing animals that may be at the greatest risk from exposure to contaminants within the landfill. One gate would provide access to the site. The fencing would need to be inspected and repaired annually.

Long-Term Monitoring - Under Alternative 2, groundwater would be sampled periodically (beginning semi-annually) to monitor the migration of contaminants from the landfill and the potential impacts to downgradient areas. For the purpose of costing, it is assumed that groundwater samples would be collected from six of the existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants (metals and VOCs). 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. The collected data would be evaluated during the 5-year review period.

Because the current and intended future use of the eastern portion of the landfill is as a skeet shooting range, Alternative 2 would include quarterly inspection of the existing soil cover in this area to assess its integrity and evaluate whether recreational use of the site should continue.

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 ecological receptors or natural resources are at risk.

3.2.2.3 Site 5 - 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. Active treatment would not be employed to address site contamination. Over time, the contaminants in groundwater would likely attenuate naturally through biological and chemical degradation (VOCs only), adsorption (metals and VOCs), and precipitation (metals only). 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 constructed over former active landfill areas of the landfill to prevent potential human and animal contact with contaminant materials, limit contaminant leaching to groundwater, and minimize contaminant migration via surface runoff and erosion. Access restrictions would be enacted to limit future uses of the site that may result in disturbance of the soil cover or direct contact with contaminated media.

Long-term, periodic (beginning as semi-annual) 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 3-3 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 enhanced cover system design. Test pitting, sampling, and chemical analyses would be required to more fully delineate the extent of the landfill materials. 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. However, settling concerns are likely to be minimal because the landfill has been inactive and subject to waste degradation and settling since 1978.

Site Preparation - Clearing and grubbing of the vegetative growth would be necessary to prepare the portion of the site to be further capped. 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. Site utilities may need to be established prior to the start of site remediation.

Site Grading - Grading of the landfill area to be further capped would be required following removal of site vegetation and consolidation of materials removed from the wooded portion of the landfill. 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 over the former active portion of the landfill to prevent human and animal exposures to landfill material contaminants, to reduce infiltration and resulting organics and metals leaching into groundwater, and to prevent migration of contaminants by wind and surface runoff. The cover design would conform with RCRA Criteria for Municipal Solid Waste Landfills (40 CFR 258).

For the purpose of this focused FS, a single-barrier cover system was selected as the representative capping option. The cover system would be installed over former active portions of the Site 5 landfill. Figure 3-3 presents a plan view of conceptual design of the cover. A cross section of a conceptual cover system is presented on Figure 3-4. 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.

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 and covered with permeable cover materials since the 1970s, 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.

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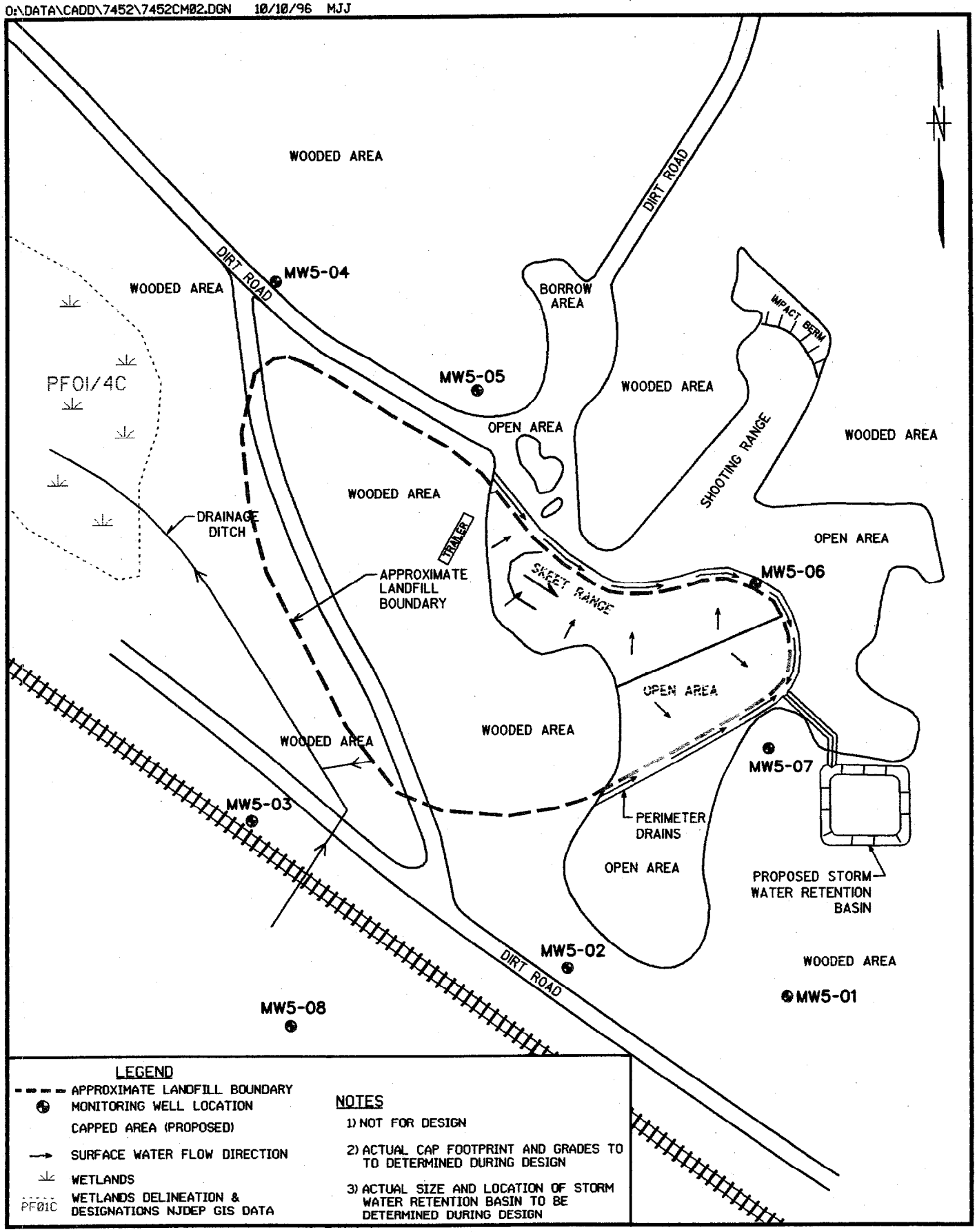

PLAN VIEW OF PROPOSED COVER SYSTEM

SITE 5 - ALTERNATIVE 3 FS - NWS EARLE

FIGURE 3-3

0 150 300

SCALE IN FEET

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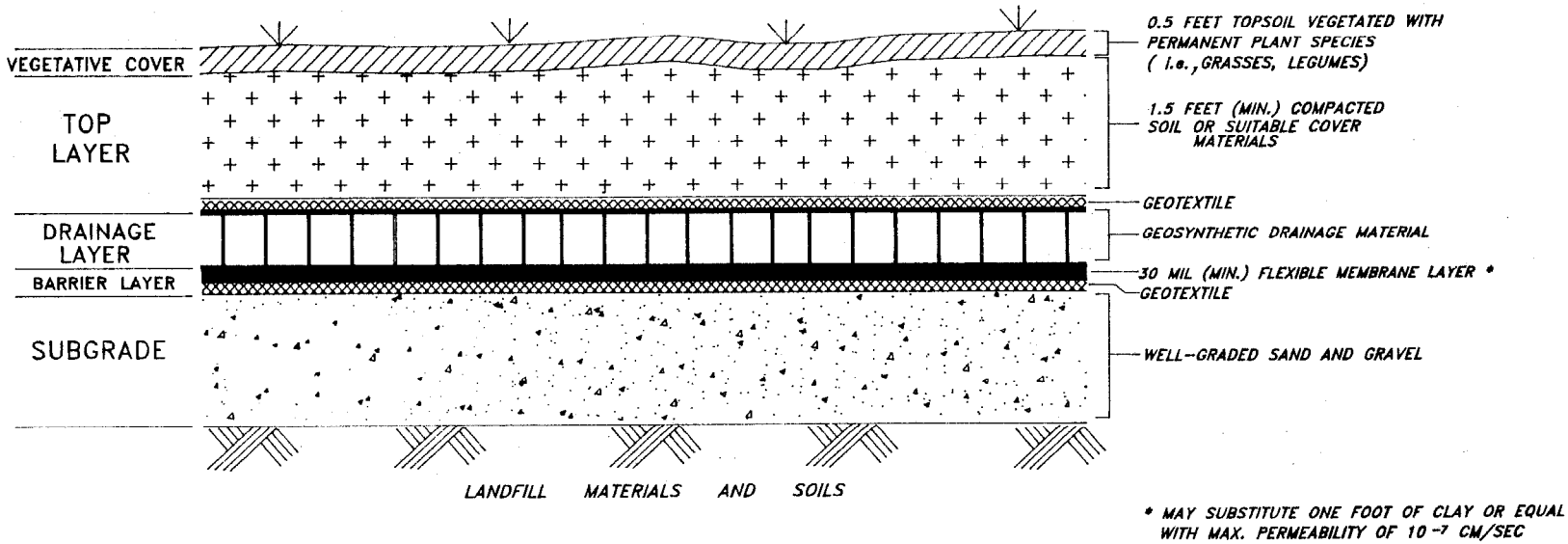

CROSS-SECTIONAL VIEW

NOTE:

1. NOT TO SCALE.
2. NOT FOR DESIGN.

CONCEPTUAL COVER SYSTEM DESIGN
SITE 5 – ALTERNATIVE 3
FEASIBILITY STUDY REPORT
NWS EARLE, COLTS NECK, NEW JERSEY

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FIGURE 3-4

For this FS, a geomembrane barrier will be selected as the representative barrier layer. Geomembranes can be installed more efficiently than a compacted clay layer and are less sensitive 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 focused FS, it is 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 the drainage layer would ultimately be discharged via drains to the wetlands east 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. A minimum of 2 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 and soil loss. Trees, woody shrubs, and other deep rooted plants that might penetrate the low-permeability layer would be prevented from growing on the cover.

The final surface slope of cover system in the plateau area should have a slope of between 3 percent (3V:100H) and 15 percent (15V: 100H) to ensure slope stability, control erosion, and allow compaction, seeding, and revegetation of the cover materials. The final slope would also 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 remedial design.

If wastes are to be consolidated at Site 5, consolidation would occur prior to cover placement.

Institutional Controls - After construction of the enhanced cover, access restrictions would be used to 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 (off-road vehicles and dirt bikes), and use of untreated groundwater for drinking water.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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, maintenance, and repairs of the fencing, runoff and drainage systems, gas vent system, and the cover system will be required.

Long-term Monitoring - Under Alternative 3, the groundwater would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from the landfill and assess the potential impacts to downgradient areas. The collected data would be evaluated during the 5-year review period. The frequency of monitoring and the number of analytical parameters would be decreased if the 5-year review determines that significant contaminant leaching reduction or improvement of groundwater quality has been attained.

For the purpose of costing, it is assumed that groundwater samples would be collected from six of the existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants. 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.

3.2.3 Site 5 - Alternatives Screening

In this section, alternatives are evaluated generally with regard to effectiveness, implementability, and cost to determine the most plausible array of remedial alternatives for Site 5. The screening is presented in Table 3-4. Alternative 2 - Limited Action was eliminated because it offered limited additional benefit, when compared to Alternative 1, for the additional cost.

TABLE 3-4
SITE 5 - SCREENING OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
1	No Action: (long term monitoring, five year reviews)	Provides no additional protection of human health or the environment. Does not reduce potential for human exposure to contaminants in the landfill or groundwater. 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.
2	Limited Action (Institutional controls, access restrictions, long-term monitoring, five-year reviews)	Provides little 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 minimal additional protectiveness for additional cost. Eliminated.
3	Capping, Institutional Controls, and Long-Term Monitoring	Protects human health and the environment . Capping contaminated landfill materials beneath the skeet and shooting range reduces potential for direct contact exposure and reduces contaminant migration to the environment. Groundwater use would be restricted. Groundwater contaminants will naturally attenuate over time. No reduction of toxicity or volume of contaminants.	Readily implementable. No technical or administrative difficulties. Personnel and materials necessary to implement this alternative are widely available.	Capital: moderate O&M: moderate	Retained.

3.3 SITE 19 - DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section presents the rationale for development of remedial action alternatives for Site 19, describes the assembled alternatives, and presents the screening of alternatives. Detailed evaluations and costing of the retained alternatives are presented in Section 4.0

3.3.1 Site 19 - Rationale for Development of Alternatives

Factors considered in formulating the remedial alternatives to address the RAOs for Site 19 are discussed below:

Statutory and Guidance Considerations - 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 were developed 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, 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 alternatives that favor treatment technologies to address principal threats and alternatives that employ engineering controls to address relatively low long-term threats; and suggests development of a range of alternatives, including one or more engineering control alternatives (such as containment), one or more innovative treatment alternatives, and the baseline no action alternative.

Protection of Human Health Considerations - The RAOs for protection of human health specify preventing human exposure to contaminated soils and 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 minimizing contaminant migration to groundwater and the adjacent wetlands and restoration of the aquifer to applicable standards. These objectives have been addressed in the formulation of remedial alternatives.

3.3.2 Site 19 - Remedial Alternatives Descriptions

This section presents detailed descriptions of the source control alternatives. As previously presented, no active groundwater response actions are anticipated based on the evaluation of current site contaminant conditions. Contaminated groundwater will not be used for potable purposes through establishment of institutional controls (deed restrictions and Classification Area Exception waiver), and there are no plans to convert Site 19 to residential use. In the long term, natural degradation and attenuation factors would diminish groundwater contaminant levels (for alternatives employing active source control) to below regulatory of background levels. Long-term groundwater monitoring is included in each Site 19 remedial alternative to assess contaminant status, to determine whether humans and environment may be at risk from contaminated groundwater associated with the site, and to assess whether additional source control or groundwater response actions are warranted to reduce human health risks or to protect the environment. The key components of Alternatives 1 through 5 are identified on Table 3-5.

3.3.2.1 Site 19 - 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 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 mitigate contaminant migration to the environment. Key components of Alternative 1 are identified on Table 3-5 and described below.

Existing Features - Currently, site features offer limited protection of human health and the environment. Much of the site is currently covered with gravel or pavement; however, the contaminant source area (the topographic depression where paint chips and sludge were disposed) is not covered, allowing infiltration and leaching of contaminants from soils into groundwater. Additionally, the overflow pipe that connects the topographic depression with the drainage ditch is intact; under extreme storm conditions, the pipe may allow surface water flow from the topographic depression to discharge to the wetlands.

Because no actions would be conducted under Alternative 1 to remove or cover contaminated soils in the topographic depression or the drainage ditch, migration of contaminants to groundwater and surface water would continue and ecological receptors could be adversely affected by site contaminants.

Long-term Monitoring - Under Alternative 1, groundwater, surface water, and sediments would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from Site 19 and the potential impacts to the adjacent wetlands. 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 (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA), and surface water and sediment would be collected from three locations within the adjacent wetlands. All samples would be analyzed for site-specific contaminants (metals and organics). 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 evaluation of analytical and hydrogeologic data, assessing whether contaminant migration has increased, and determining whether human or biological receptors or natural resources are at risk.

3.3.2.2 Site 19 - Alternative 2: Limited Action (Institutional Controls, Access Restrictions, and Long-Term Monitoring)

Alternative 2 was developed as an option that relies on access restrictions and institutional controls to limit exposures to hazardous substances. This alternative does not employ treatment or containment to address site contamination.

Access restrictions would be attached to the property title and/or the Base Master Plan to limit future uses of the site that may result in increased migration of contaminants or direct contact with contaminated media. A fence would be erected around the contaminant source area soils to prevent access and intrusive activities that could result in further contaminant migration to groundwater and the adjacent wetlands. Long-term, periodic monitoring would be conducted to assess contaminant status and potential threats to human health and the environment. Since wastes are left in place, site conditions and risks would be reviewed every five years. Key components of Alternative 2 are identified on Table 3-5 and described below.

TABLE 3-5
SITE 19 - REMEDIAL ALTERNATIVES COMPONENTS
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	KEY COMPONENTS OF ALTERNATIVE
1	No Action	• Annual groundwater, surface water, and sediment monitoring • Five-year reviews
2	Limited Action	• Fencing • Institutional Controls (access restrictions, CEA*) • Annual groundwater, surface water, and sediment monitoring • Five-year reviews
3	Soils Consolidation, Capping, Natural Attenuation, and Long-Term Monitoring	• Pre-design investigations • Site preparation • Excavation of drainage ditch soils/consolidation in the topographic depression • Single barrier cover system • Institutional controls (access restrictions, CEA*) • Natural attenuation of groundwater contaminants • Long-term operation and maintenance • Annual groundwater monitoring • Five-year reviews
4	Excavation, On-Site Solidification, On-Site Disposal, Natural Attenuation, and Long-Term Monitoring	• Site preparation • Excavation/consolidation • On-site solidification • On-site disposal • Institutional controls (access restrictions, CEA*) • Natural attenuation of groundwater contaminants • Annual groundwater monitoring • Five-year reviews
5	Excavation and Disposal	• Excavation • A. Off-Base Disposal (RCRA landfill) • B. On-Base Disposal (Site 4 or 5 landfill) • Institutional controls (access restrictions, CEA*) • Natural attenuation of groundwater contaminants • Annual groundwater 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.

Existing Features - Currently, site features offer limited protection of human health and the environment. Much of the site is currently covered with gravel or pavement; however, the contaminant source area (the topographic depression where paint chips and sludge were disposed) is not covered, allowing infiltration and leaching of contaminants from soils into groundwater. Additionally, the overflow pipe that connects the topographic depression with the drainage ditch is intact; under extreme storm conditions, the pipe may allow surface water flow from the topographic depression to discharge to the wetlands.

Because no actions would be conducted under Alternative 2 to remove or cover contaminated soils in the topographic depression or the drainage ditch, migration of contaminants to groundwater and surface water would continue unabated and ecological receptors may be adversely affected by site contaminants.

Institutional Controls - Under Alternative 2, access restrictions would be enacted to restrict the future use of the site. Restrictions would be placed on future activities such as excavation that could result in increased human exposure to contaminated subsurface materials or increased erosion and subsequent contaminant migration. Future use of untreated site groundwater for drinking water would be prohibited to prevent ingestion, inhalation, and dermal exposure to site contaminants.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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.

Fencing - The topographic depression would be fenced to limit human access to source area contaminants. An estimated 190 linear feet of 6-foot-high, chain-link fence would be required to encircle the area; one gate would be provided to allow authorized access to the area. The fencing would be inspected and repaired annually.

Long-term Monitoring - Under Alternative 2, groundwater, surface water, and sediments would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from the site and the potential impacts to the adjacent wetlands. 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 (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA), and surface water and sediment would be collected

from three locations within the adjacent wetlands. All samples would be analyzed for site-specific contaminants (metals and organics). 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 at risk.

3.3.2.3 Site 19 - Alternative 3: Soils Consolidation, Capping, and Long-Term Monitoring

Alternative 3 relies on containment and institutional controls to limit exposure to hazardous substances and minimize migration of contaminants to groundwater and the adjacent wetlands. Active treatment is not employed to address site contamination. Contaminants in site groundwater would naturally attenuate over time through dispersion as leaching of contaminants from source soils is reduced.

Contaminated sediments from the drainage ditch would be excavated and consolidated into the topographic depression and the depression would be capped to prevent erosion and minimize migration of contaminants. Access restrictions would be attached to the property title to limit future uses of the site that may result in damage to the cover and increased migration of contaminants. Access restrictions would also prohibit the use of untreated groundwater for drinking water.

Long-term, periodic (beginning as semi-annual) 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 3-5 and described below.

Pre-Design Investigations and Activities - Pre-design investigations would be conducted to collect topographic and chemical data needed for the remedial design. A topographic survey of the site would be performed to collect accurate elevation, location, and contour data for use in the cover system design. Soil and sediment sampling and analyses may be necessary to more fully delineate the extent of contaminated materials requiring consolidation under the cap.

Site Preparation - Demolition and removal of the barricade and limited removal of the existing pavement cover would be required to prepare the topographic depression area for capping. The below-ground overflow pipe that connects the topographic depression to the drainage ditch would be permanently sealed at both ends to prevent contaminant migration through the pipe. Site utilities may need to be established prior to the start of site remediation.

Excavation/Consolidation - Contaminated soil and sediment from the drainage ditch would be excavated and placed into the topographic depression. Excavation/consolidation would remove a source of wetland contaminants, minimize ecological exposure to contaminated soils, and facilitate containment of drainage ditch sediment.

Cover System Placement - Following consolidation of contaminated sediments from the drainage ditch, a low-permeability cover system would be installed over the topographic depression area to prevent direct contact with contaminated soils, minimize infiltration and contaminant leaching into groundwater, and prevent surface migration of contaminants into the adjacent wetlands. The cover design would conform with RCRA Criteria for Municipal Solid Waste Landfills (40 CFR 258).

For the purpose of this focused FS, a single-barrier cover system was selected as the representative capping option. Figure 3-5 presents a plan view of conceptual design of the cover. A cross section of a conceptual cover system is presented on Figure 3-6. 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. The subgrade may be a well-graded sand and gravel.

Barrier Layer - This layer would be designed to minimize precipitation infiltration into the consolidated sediments. 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 equivalent would be used.

For this FS, a geomembrane barrier will be selected as the representative barrier layer. Geomembranes can be installed more efficiently than a compacted clay layer and are less sensitive to extreme weather conditions. The geomembrane may be a flexible membrane liner (FML) composed of low-density synthetics for tolerating subsidence-induced strains.

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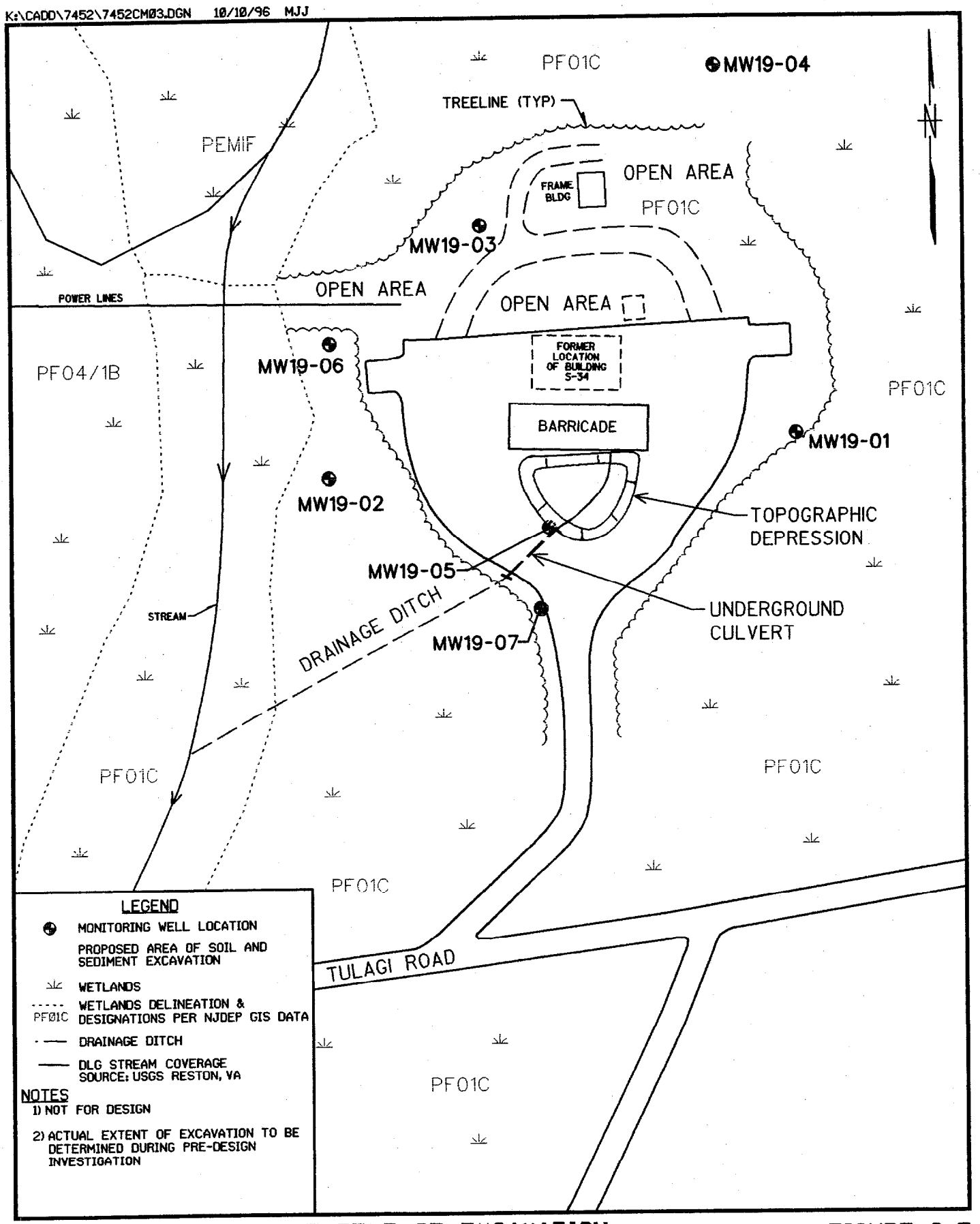

PROPOSED AERIAL EXTENT OF EXCAVATION

SITE 19 - ALTERNATIVES 4 & 5 FS - NWS EARLE

FIGURE 3-5

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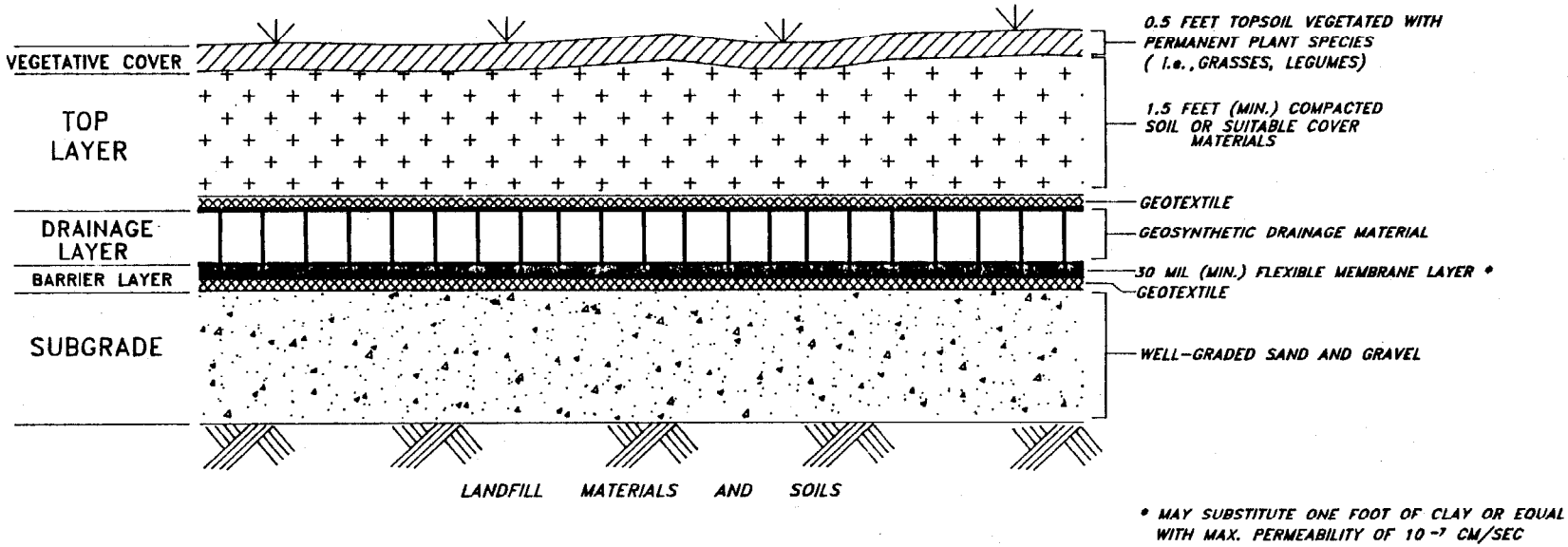
SCALE IN FEET

Brown & Root Environmental



CROSS-SECTIONAL VIEW

NOTE:

1. NOT TO SCALE.
2. NOT FOR DESIGN.

CONCEPTUAL COVER SYSTEM DESIGN

SITE 19

FEASIBILITY STUDY REPORT

NWS EARLE, COLTS NECK, NEW JERSEY

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FIGURE 3-6

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 focused FS, it is 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 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. A minimum of 2 feet of uniform, compacted soil, covered with pavement or a vegetative cover, would be placed over the drainage layer.

The final surface slope of cover system in the plateau area should have a slope of between 3 percent (3V:100H) and 15 percent (15V: 100H) to ensure slope stability and control erosion. The final slope would also promote precipitation runoff while inhibiting erosion or infiltration. The final slopes and materials to be used in the cover system would be determined during the remedial design.

Institutional Controls - After the cover has been constructed, access restrictions would be used to limit the future activities that could result in intrusion into and possible damage of the cover and accidental exposure to the contaminated soil and sediment. Restricted activities would include excavation and use of untreated groundwater for drinking water

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (CEA) pursuant to N.J.A.C 7:9-6 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 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 maintenance of the cover system would be required.

Long-term Monitoring - Under Alternative 3, the groundwater would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from the site and assess the potential impacts to downgradient areas. The data collected would be evaluated during the 5-year review period. The frequency of monitoring and the number of analytical parameters may be decreased if the 5-year

review determines that significant contaminant leaching reduction or improvement of groundwater quality has been attained.

For the purpose of costing, it is assumed that groundwater samples would be collected from six existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants. 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.

3.3.2.4 Site 19 Alternative 4 - Excavation, On-Site Solidification, On-Site Disposal, and Long-Term Monitoring

Alternative 4 employs soil treatment to limit exposure to hazardous substances and minimize migration of contaminants to groundwater and the adjacent wetlands. Contaminants in site groundwater would naturally attenuate over time through dispersion after leaching of contaminants from site soils and sediments is abated.

Under this alternative, the contaminated sediments and soils from the drainage ditch and the topographic depression would be excavated and solidified using cement or cement-asphalt mixtures. Treated soils would be placed in the topographic depression and the depression would be closed with an asphalt cover, forming a contained, treated-soil cell. Access restrictions would be enacted to limit future uses of the site that may result in intrusion into the treated-soil cell. Access restrictions would also prohibit the use of untreated groundwater for drinking water.

Long-term, periodic (beginning as semi-annual) monitoring of groundwater would be conducted to assess contaminant status and potential threats to human health and the environment. Since wastes would be left on site, site conditions and risks would be reviewed every five years. Key components of Alternative 4 are identified on Table 3-5 and described below.

Site Preparation - Demolition and removal of the barricade and limited removal of the existing pavement cover would be required to access the contaminated soils in the topographic depression and prepare the

area for treated waste placement/capping. The below-ground overflow pipe that connects the topographic depression to the drainage ditch would be permanently sealed at both ends to prevent contaminant migration through the pipe. Site utilities may need to be established prior to the start of site remediation.

Excavation/Consolidation - Contaminated soil and sediment from the topographic depression and the drainage ditch would be excavated and transported to a temporary staging area for the on-site solidification facility.

On-Site Solidification - Excavated soils would be treated by solidification to immobilize metals in a stable cement matrix. Treatment would be conducted on site using a modular, transportable treatment unit. Treated soils would be cured prior to being redeposited on site in the topographic depression. Treatability studies would be required to determine the optimum reagent mixture and treatment conditions to minimize metals leaching and to ensure long-term stability of the treated matrix.

On-Site Disposal - Treated, cured soils would be redeposited on site in the topographic depression. The depression would then be backfilled with clean subgrade materials to the level of the surrounding pavement. The cell would be covered with a layer of pavement to minimize leaching and disturbance of the treated soils.

Institutional Controls - Access restrictions would be enacted to restrict the future use of the site that could result in disturbance of the treated soils. Future use of untreated site groundwater for drinking water would be prohibited to prevent ingestion, inhalation, and dermal exposure to site contaminants.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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.

Natural Attenuation - Because Alternative 4 will reduce contaminant mobility in site soils and sediments and reduce further contaminant migration into site groundwater, over time groundwater contamination would naturally attenuate by chemical, physical, and biological (organics only) mechanisms.

Long-term Monitoring - Under Alternative 4, the groundwater would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from the site and assess the potential impacts to downgradient areas. The collected data would be evaluated during the 5-year review period.

The frequency of monitoring and the number of analytical parameters may be decreased if the 5-year review determines that significant contaminant leaching reduction or improvement of groundwater quality has been attained.

For the purpose of costing, it is assumed that groundwater samples would be collected from six existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants. 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 ecological receptors or groundwater resources are at risk.

3.3.2.5 Site 19 - Alternative 5: Excavation and Disposal

This alternative would constitute a clean closure of this site. All contaminated soils and sediments in excess of selected clean-up goals would be excavated and sent off of Site 19 for disposal. Site 19 soils would no longer pose threats to groundwater or the adjacent wetlands. Once the source of contamination is removed, contaminants in site groundwater would naturally attenuate over time through dispersion.

Long-term monitoring of groundwater and the 5-year review of site conditions would be necessary to verify the natural attention of the groundwater. Key components of Alternative 5 are identified on Table 3-5 and described below.

Excavation - Contaminated soil and sediment from the topographic depression and the drainage ditch would be excavated using common construction equipment, such as bulldozers or loaders. If necessary, soils would be dewatered by natural drainage within the overall excavation area. The below-ground overflow pipe that connects the topographic depression to the drainage ditch would be removed to prevent contaminant migration through the pipe.

Off-Site Disposal - Two off-site disposal options are under consideration:

A. Off-Base Disposal: Under this option, excavated soils would be transported off base to an appropriate hazardous or industrial-waste-type landfill. TCLP testing of soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the soils would be conducted to immobilize metals prior to disposal.

B. Disposal in On-Base Landfill: If capping is the selected remedial alternative for Site 4, the excavated soils from Site 19 could be consolidated on the Site 4 landfill prior to capping. Although this option would not result in the soils leaving the base, it would allow clean closure of Site 19 without significantly altering the remedial action at Site 4.

Institutional Controls - Access restrictions would be enacted to restrict the future use of untreated site groundwater for drinking water to prevent ingestion, inhalation, and dermal exposure to site contaminants. Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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 - Because contaminated groundwater is not actively remediated under Alternative 5, the groundwater would be sampled periodically (beginning as semi-annually) to monitor the migration of contaminants from the site and assess the potential impacts to downgradient areas. The collected data would be evaluated during the 5-year review period. The frequency of monitoring and the number of analytical parameters may be decreased if the 5-year review determines that improvement of groundwater quality has been attained.

For the purpose of costing, it is assumed that groundwater samples would be collected from six existing monitoring wells (additional wells will be required if existing wells are not adequate to establish a "line of compliance" for the CEA) and analyzed for site-specific contaminants. 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 groundwater contaminants remain at concentrations exceeding state groundwater quality standards, 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 human or biological receptors or groundwater resources are at risk.

3.3.3 Site 19 - Alternatives Screening

In this section, alternatives are evaluated generally with regard to effectiveness, implementability, and cost to further focus the FS on the most plausible array of remedial alternatives for Site 19. The screening is presented in Table 3-6. Based on the screening, Alternatives 2 - Limited Action and Alternative 3 - Soils consolidation and capping were eliminated.

3.4 SITE 26 - DEVELOPMENT AND SCREENING OF ALTERNATIVES

Section 3.4.1 presents the rationale for development of remedial action alternatives for Site 26, Section 3.4.2 describes and the assembled alternatives, Section 3.4.3 presents the screening of alternatives. Detailed evaluations and costing of the retained alternatives are presented in Section 4.0.

3.4.1 Site 26 - Rationale for Development of Alternatives

Factors considered in formulating the remedial alternatives to address the RAOs for Site 26 are discussed below:

Protection of Human Health Considerations - The RAO for protection of human health specifies preventing human exposure to contaminated groundwater. This objective has 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 26 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.

TABLE 3-6
SITE 19 - SCREENING OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
1	No Action: (long term monitoring, five year reviews)	Provides no additional protection of human health or the environment. Does not reduce potential for human exposure to contaminants in soils, sediment, or groundwater. 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.
2	Limited Action (Institutional controls, access restrictions, long-term monitoring, five-year reviews)	Provides little 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 minimal additional protectiveness for additional cost. Eliminated.
3	Soils Consolidation, Capping, Institutional Controls, and Long-Term Monitoring	Protects human health and the environment by containing contaminated soils and sediments within the topographic depression, preventing direct contact and reducing contaminant migration to the environment. Groundwater use would be restricted. No reduction of toxicity or volume of contaminants. Groundwater contaminants will naturally attenuate over time.	Readily implementable. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are widely available.	Capital: moderate O&M: moderate	Provides the same degree of protection as Alt. 5, but because it doesn't result in clean closure of Site 19, it requires long-term operation , maintenance, and monitoring. Also likely to be more expensive than Alt. 5. Eliminated.

TABLE 3-6
SITE 19 - SCREENING OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
4	Excavation, On-Site Solidification, On-Site Disposal, Natural Attenuation, and Long-Term Monitoring	Protects human health and the environment by immobilizing soil contaminants, preventing direct contact, and minimizing contaminant migration to the environment. Groundwater use would be restricted. Groundwater contaminants will naturally attenuate over time.	Readily implementable. Specialized treatment equipment is required, but is available from several vendors. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are widely available.	Capital: moderate O&M: moderate	Retained as representative treatment alternative.
5 A	Excavation and Off-Base Disposal	Protects human health and the environment by excavating contaminated soils and sediments and transporting them off-base for disposal in a RCRA landfill. Groundwater use would be restricted. Groundwater contaminants will naturally attenuate over time. No reduction of toxicity or volume of contaminants.	Readily implementable. Adequate landfill capacity exists for disposal of the small volume of contaminated materials from Site 19.	Capital: low O&M: low	Alternative would result in clean closure of Site 19 and would expedite its reuse. Retained.
5 B	Excavation and On-Base Disposal	Protects human health and the environment by excavating contaminated soils and sediments and transporting them off-site for consolidation in an existing on-base landfill that is being capped under a separate remedial action. Groundwater use would be restricted. Groundwater contaminants will naturally attenuate over time. No reduction of toxicity or volume of contaminants.	Readily implementable if capping is the selected alternative at the Site 4 landfill. The small volume of contaminated materials from Site 19 would be used to assist in achieving the proper grades for the final cap. The small volume of soils from Site 19 would not be expected to significantly alter the cost or design of the proposed landfill cap.	Capital: low O&M: low	Alternative would result in clean closure of Site 19 and would expedite its reuse. Retained.

3.4.2 Site 26 - Remedial Alternatives Descriptions

This section presents detailed descriptions of the remedial alternatives for Site 26. The key components of Alternatives 1 through 5 are identified on Table 3-7.

3.4.2.1 Site 26 - 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 remove or contain the suspected contaminant source (the process leach tank and associated soils), 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 3-7 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 26 is not used as a potable water supply. As a result, there is currently no pathway for human exposure to VOC-contaminated groundwater. However, potable water supply wells are situated elsewhere on the base (within approximately one mile crossgradient of the site) and site groundwater could conceivably be used as a potable water supply in the future, posing a potential excess human health risk.

Discharge of contaminants to the process leach tank has ceased; however, residual contamination in the tank and associated soils is a potential continuing source of contamination to site groundwater. Under Alternative 1, no actions would be taken to mitigate contaminant migration to -- or in -- groundwater.

Long-term Monitoring - Under Alternative 1, groundwater would be sampled semi-annually to monitor the migration of contaminants from Site 26 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 will be collected from approximately three existing and four new monitoring wells. One of the four new monitoring wells will be located near the highest concentration of TCE in the plume, and the remaining three would be located downgradient of the

TABLE 3-7
SITE 26 - REMEDIAL ALTERNATIVES COMPONENTS
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	KEY COMPONENTS OF ALTERNATIVE
1	No Action	• Long-term groundwater monitoring • Five-year reviews
2	Source Removal, Institutional Controls, and long-term Monitoring.	• Excavation and disposal of process leach tank and associated VOC-contaminated soils A. Off-Base Disposal (RCA landfill) of process leach tank and associated contaminated soils B. On-Base Disposal (Site 4 or 5 landfill) of process leach tank and associated contaminated soils • Institutional Controls (deed restrictions, cease) • Long-term groundwater monitoring • Five-year reviews
3	Reactive Wall: Source Removal, In-Situ Permeable Reactive Wall Groundwater Treatment: Institutional Controls, and long-term Monitoring	• Treatability studies • Pre-design investigations • Excavation and disposal of process leach tank and associated VOC-contaminated soils A. Off-Base Disposal (RCRA landfill) of process leach tank and associated contaminated soils B. On-Base Disposal (Site 4 or 5 landfill) of process leach tank and associated contaminated soils • In-situ treatment of groundwater by permeable reactive wall treatment • Institutional controls (deed restrictions, CEA*) • Long-term groundwater monitoring • Five-year reviews
4	Pump-and-Treat: Source Removal, Extraction and Treatment of Groundwater, Institutional Controls, and Long-Term Monitoring	• Pre-design investigations • Excavation and disposal of process leach tank and associated VOC-contaminated soils A. Off-Base Disposal (RCRA landfill) of process leach tank and associated VOC-contaminated soils B. On-Base Disposal (Site 4 or 5 landfill) of process leach tank and associated contaminated soils • Extraction of contaminated groundwater • Treatment of VOC-contaminated groundwater (e.g., by air stripping and activated carbon polishing) • Institutional controls (deed restrictions, CEA*) • Long-term groundwater monitoring • Five-year reviews

	ALTERNATIVE	KEY COMPONENTS OF ALTERNATIVE
5	Air Sparging/Soil Vapor Extraction: Source Removal, Air Sparging/Soil Vapor Extraction, Institutional Controls, and Long-Term Monitoring	• Treatability Studies • Pre-Design Investigations • Excavation and disposal of process leach tank and associated VOC-contaminated soils A. Off-Base Disposal (RCRA Landfill) of process leach tank and associated VOC-contaminated soils B. On-Base Disposal (Site 4 on 5 landfill) of process leach tank and associated contaminated soils • Air Sparging/Soil Vapor Extraction • Treatment of extracted vapor-phase contaminants • Institutional controls (deed restrictions, CEA*) • Long-Term groundwater monitoring • Five-year reviews (if necessary)
6	Engineered Bioremediation: Source Removal, In-situ Enhanced Bioremediation, Institutional Controls, and Long-Term Monitoring	• Treatability Studies • Pre-Design Investigation • Excavation and disposal of process leach tank and associated VOC-contaminated soils A. Off-Base Disposal (RCRA landfill) of process leach tank and associated VOC-contaminated soils B. On-Base Disposal (Site 4 or 5 landfill) of process leach tank and associated contaminated soils • Engineered bioremediation of contaminants in-site • Institutions controls (deed restrictions, CEA*) • Long-Term groundwater monitoring • Five-year reviews (if necessary)

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.

currently delineated plume. All samples will be analyzed for site-specific contaminants (VOCs). The sampling results will 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 five years, as required by CERCLA. The reviews would consist of evaluation of analytical and hydrogeologic data, assessing whether contaminant migration has increased, and determining whether human or biological receptors or natural resources are at risk.

3.4.2.2 Site 26 - Alternative 2: Source Removal, Institutional Controls, and Long-Term Monitoring

Alternative 2 was developed as an option that relies on source removal and institutional controls to limit exposures to hazardous substances. This alternative does not employ engineered treatment or containment to address groundwater contamination; however, the contaminant source (the process leach tank and associated soils) is removed, and groundwater is assumed to naturally attenuate.

Institutional controls would be enacted to prohibit use of impacted groundwater. Long-term, periodic (beginning as semi-annual) monitoring would be conducted to assess the ongoing effectiveness of natural attenuation and potential threats to human health and the environment. Site conditions and risks would be reviewed every five years since contaminants are left in place. Key components of Alternative 2 are identified on Table 3-7 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 26 is not used as a potable water supply. As a result, there is currently no pathway for human exposure to VOC-contaminated groundwater. However, potable water supply wells are situated elsewhere on the base (within approximately one mile crossgradient of the site) 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, removal of the contaminant source would facilitate natural attenuation of groundwater contaminants by dispersion, dilution, and degradation. This process is estimated to require approximately 45 years to reduce all groundwater concentrations to below the GWQS assuming removal of the process leach tank and associated soils. (see Appendix A for modeling results).

Source Removal - The process leach tank and any associated VOC-contaminated soils in the vicinity of the tank would be removed and disposed of away from Site 26 (off-site) to eliminate the source of contaminants to groundwater. The tank is believed to be constructed of concrete block and has approximate outside dimensions of 10 feet by 10 feet by 6 feet deep. The top of the tank lies approximately eight inches below ground surface.

Prior to removal, the tank would be inspected and its contents (if any) would be sampled and analyzed to characterize it for disposal. The tank contents (i.e., liquids and sludge) would be removed and disposed off-site at an appropriate disposal facility. The concrete blocks and any surrounding contaminated soils would then be excavated and removed using conventional excavation/construction equipment. The concrete blocks would be decontaminated to remove residual contaminants prior to off-site transport and disposal. The decontamination method to be used would be determined following inspection and sampling of tank contents. For the purposes of this FS, it is assumed that decontamination would be conducted using high-pressure steam and detergent.

Off-Site Disposal - Two off-site disposal options are under consideration:

A. Off-Base Disposal: Under this option, the decontaminated process leach tank concrete blocks and the associated contaminated soils would be transported off-base to appropriate hazardous or industrial waste-type landfills. Wipe sampling of the tank concrete blocks and TCLP testing of the soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the soils (at the designated disposal facility) would be conducted prior to disposal. For purposes of costing, it is assumed that the soils would be disposed in a hazardous waste (RCRA Subpart C) landfill and the tank would be disposed in an solid waste (RCRA Subpart D) landfill.
B. Disposal in On-Base Landfill: If Capping is selected as the remedial alternative for the Site 4 or Site 5 landfills and the tank concrete blocks and associated soils are determined not to be hazardous, then the tank materials and excavated soils from Site 26 would be consolidated into one of these existing landfills prior to capping. The concrete materials would be broken-up into small, cobble-sized pieces prior to disposal on the landfill. For this FS, it is assumed that under Alternative 2B the excavated materials from Site 26 would be placed at the Site 4 landfill.

Institutional Controls - Under Alternative 2, deed restrictions would be incorporated into the Base Master Plan to restrict the future use of Site 26 groundwater until natural attenuation has reduced contaminant concentrations to acceptable levels (GWQC). Use of untreated, contaminated Site 26 groundwater for drinking water would be prohibited.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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, groundwater would be sampled semi-annually to monitor the natural attenuation effectiveness and migration of contaminants from the site and 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 approximately four new and three existing monitoring wells. One of the four new monitoring wells will be located near the highest concentration of TCE in the plume, and the remaining three would be located downgradient of the currently delineated plume. All samples would be analyzed for site-specific contaminants (VOCs). The sampling results would be evaluated to assess whether natural attenuation is occurring as predicted (modeled) and to determine whether additional response actions are warranted.

Five-Year Reviews - Since contaminants remain in Site 26 groundwater, a review of site conditions and risks would be conducted every five 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.

3.4.2.3 Site 26 - Alternative 3: Reactive Wall Treatment (Source Removal, In-Situ Groundwater Treatment, Institutional Controls, and Long-Term Monitoring)

Under Alternative 3, the suspected source of groundwater contaminants (the process leach tank and associated VOC-contaminated soils) would be removed and the groundwater would be treated in-situ using permeable reactive wall technology. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQS are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every five years until the groundwater remediation is complete. Key components of Alternative 3 are identified on Table 3-7 and described below.

Treatability Studies - The technology evaluation presented in Section 2 identified the permeable reactive wall as an innovative treatment approach for the VOC-contaminated groundwater at Site 26. However it is a relatively new, innovative technology that has proven effective in bench- and pilot-scale studies, but is

not widely demonstrated in full scale remediation of groundwater with similar contaminants. The limited demonstration data for this technology and the highly site- and waste-specific nature of in-situ remediation make it impossible to determine the likely effectiveness of permeable reactive wall technology without a site-specific treatability study. Therefore, a treatability study would be necessary to evaluate the effectiveness of this technology. For a permeable reactive wall treatability study, groundwater samples would be obtained and used in column studies to assess the degradation rates of the chlorinated VOCs. The degradation rates will then be used in the reactive wall design.

Pre-Design Investigation - Pre-design investigations, consisting of a hydrogeologic evaluation and sampling and analysis of groundwater and aquifer materials, would be required to support the design of the in-situ treatment system. The hydrogeologic investigation would be used to better define steady-state aquifer characteristics (i.e. hydraulic conductivity, transmissivity, hydraulic gradient) in order to determine the sizing, placement, and design of the treatment system, and how best to hydraulically induce flow of contaminated groundwater through the reactive wall. The investigation would be tailored to the specific data requirements of the selected in-situ technology, and may include slug tests, pump tests, groundwater elevation monitoring, and physical analysis of aquifer materials.

Sampling and chemical analysis of groundwater and aquifer materials would be conducted to refine estimates of the extent of contamination and to better define the chemical composition of the groundwater and aquifer materials to aid in the design of an effective in-situ treatment system.

Design - As part of the design process, based on discussion with the technology developer, groundwater modeling may be performed to assess different configurations of impermeable walls and the reactive wall to design the flow of contaminated groundwater through the reactive wall such that there will be sufficient retention time for the effective degradation of VOCs.

The design of the permeable wall will need to take into account the aquifer characteristics, the contaminant types and concentrations, the desired treated concentrations, and the presence of other site-related chemicals.

Source Removal - The process leach tank and any associated VOC-contaminated soils in the vicinity of the tank would be removed and disposed away from Site (off-site) to eliminate the suspected source of contaminants to groundwater.

Prior to removal, the tank would be inspected and its contents (if any) would be sampled and analyzed to characterize it for disposal. The tank contents (i.e., liquids and sludge) would be removed and disposed

off-site at an appropriate disposal facility. The tank concrete blocks and any surrounding contaminated soils would then be excavated and removed using conventional excavation/construction equipment. The concrete blocks would be decontaminated to remove residual contaminants prior to off-site transport and disposal. The decontamination method to be used would be determined following inspection and sampling of tank contents. For the purposes of this FS, it is assumed that decontamination would be conducted using high-pressure steam and detergent.

Off-Site Disposal - Two off-site disposal options are under consideration:

A. Off-Base Disposal: Under this option, the decontaminated process leach tank concrete blocks and the associated contaminated soils would be transported off-base to appropriate hazardous or industrial waste-type landfills. Wipe sampling of the tank concrete blocks and TCLP testing of the soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the soils (at the designated disposal facility) would be conducted prior to disposal. For purposes of costing, it is assumed that the soils would be disposed in a hazardous waste (RCRA Subpart C) landfill and the tank concrete materials would be disposed in an solid waste (RCRA Subpart D) landfill.

B. Disposal in On-Base Landfill: If Capping is selected as the remedial alternative for the Site 4 or Site 5 landfills and the tank concrete blocks and associated soils are determined not to be hazardous, the tank and excavated soils from Site 26 would be consolidated into one of these existing landfills prior to capping. The concrete materials would be broken-up into small, cobble-sized pieces prior to disposal on the landfill. For this FS, it is assumed that under Alternative 3B the excavated materials from Site 26 would be placed at the Site 4 landfill.

In-Situ Treatment - A permeable reactive wall treatment system would be constructed immediately downgradient of the leading edge of the VOC contaminant plume to degrade the dissolved contaminants. The treatment process involves passive flow of contaminated groundwater through a permeable treatment wall composed of coarse grained reactive metal. The metal formulation degrades dissolved chlorinated organic compounds as they migrate through the wall by inducing reduction/oxidation conditions that cause substitution of halogen atoms by hydrogen atoms.

Standard excavation and construction techniques would be used to create the trench in which the reactive (iron) wall would be placed. Because of the depth of the trench, approximately 25 feet deep, the excavated trench would probably require properly designed bracing to prevent collapse of the wall as the reactive wall materials (vertical layers of pea gravel and iron) are emplaced.

Impermeable sheet pile or slurry wall would be used to funnel the contaminated groundwater toward the permeable wall where treatment occurs. Pilot studies would be required to determine treatment wall conditions which would be favorable for conditions at Site 26. The proposed treatment wall would be located in the southwest portion of the Site 26, downgradient of the delineated extent of the contaminant plume (Figure 3-6). The wall would be placed perpendicular to groundwater flow and would extend across the entire lateral extent of the plume. The treatment wall would be approximately 15 feet deep, extending from the water table to a clay aquitard identified at a depth of approximately 25 feet below ground surface. The treatment wall would be keyed into the clay layer to ensure complete capture of the contaminant plume. The exact location and design of the permeable treatment wall would be determined based upon results of the pre-design investigation. A cross-section of the proposed wall arrangement is presented on Figure 3-7.

In addition to the dehalogenation of the chlorinated VOCs by the reactive wall, natural attenuation of the VOCs will substantially contribute to their overall reduction and eventual disappearance.

Institutional Controls - Under Alternative 3, deed restrictions would be incorporated into the Base Master Plan to restrict the use of site groundwater until groundwater remediation is complete. Use of untreated site groundwater for drinking would be prohibited during the duration of the treatment period.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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 3, groundwater elevation monitoring would be conducted monthly to ensure that the plume is being effectively funneled through the permeable reactive wall. Quarterly monitoring of groundwater would be conducted to monitor the effectiveness of the in-situ remedial action. The data would be used to determine the need for additional actions and to determine when remediation goals have been achieved.

For the purpose of costing, it is assumed that quarterly groundwater samples would be collected from approximately six wells and analyzed by field screening methods. Laboratory analysis of samples from fifteen wells would be collected on an annual basis. At least four new monitoring wells would be installed. One of the new monitoring wells would be located near the highest concentration of TCE in the plume, and

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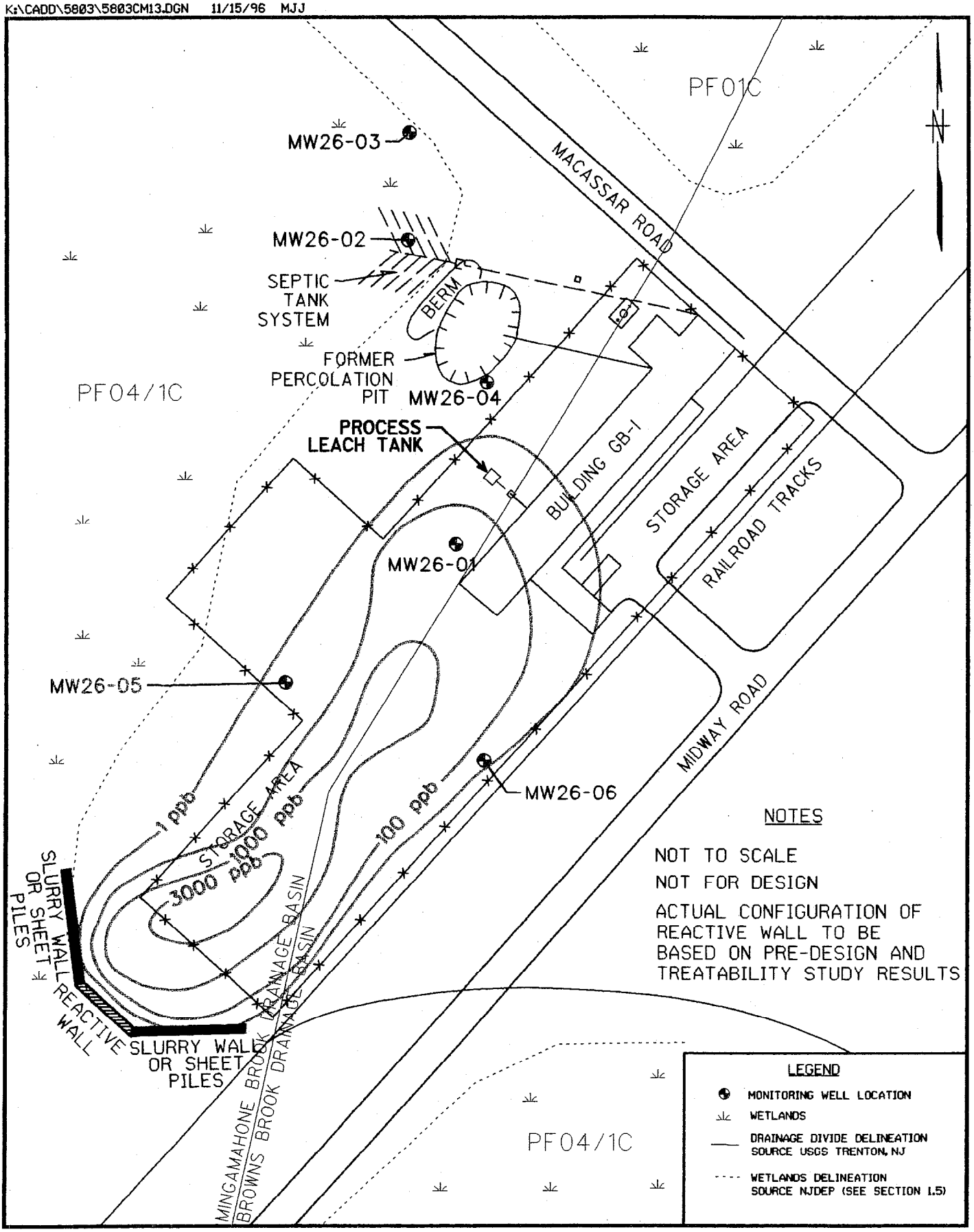


ALTERNATIVE 26-3 PERMEABLE REACTIVE WALL

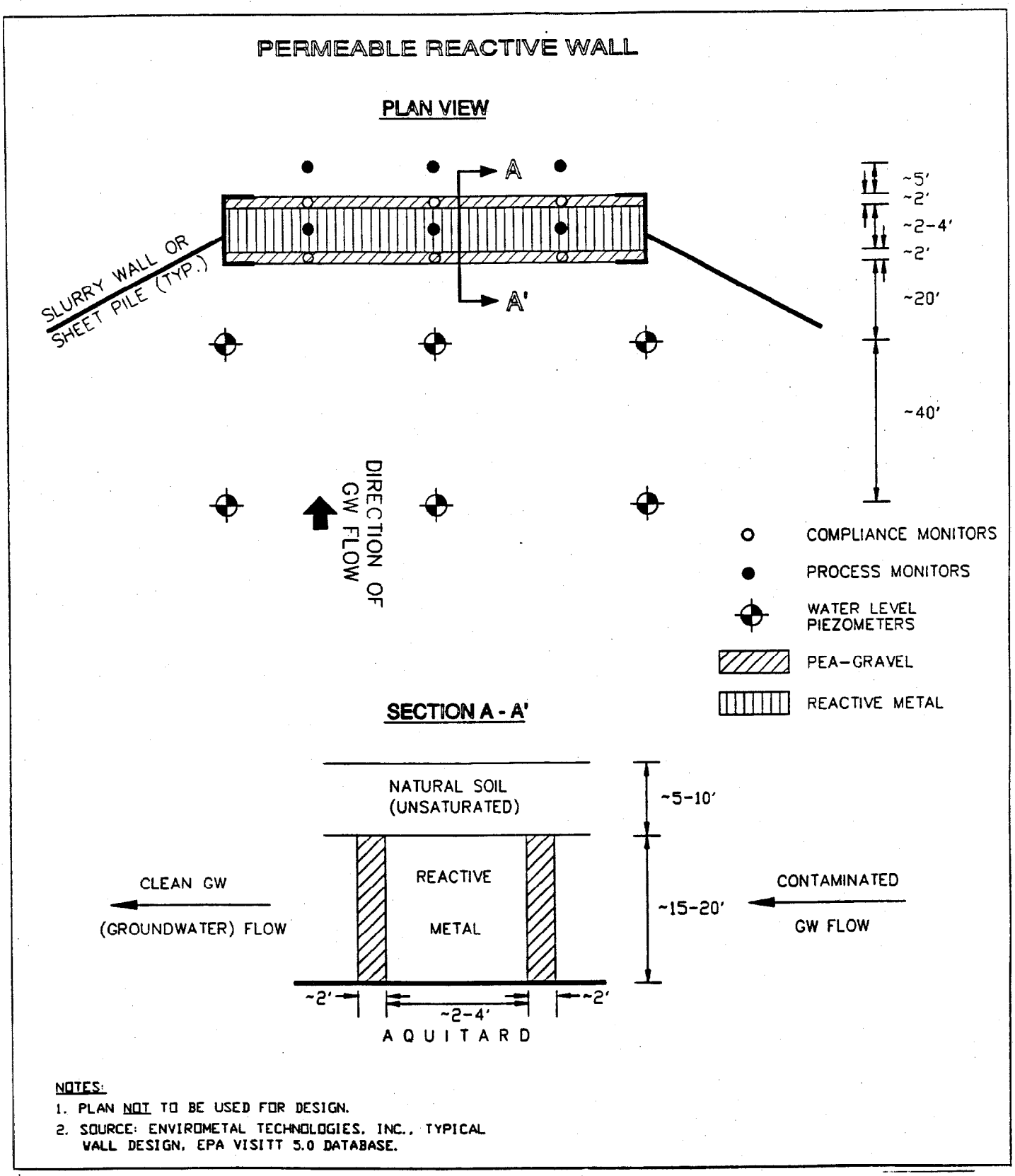
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 3-6

0 80 160

SCALE IN FEET

Brown & Root Environmental



ALTERNATIVE 26-3 PERMEABLE REACTIVE WALL
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 3-7

0 50 100
SCALE IN FEET

Brown & Root Environmental

the remaining three would be located downgradient of the currently delineated plume. All samples would be analyzed for site-specific contaminants (VOCs).

Five-Year Reviews - Since contaminants remain in Site 26 groundwater, a review of site conditions and risks would be conducted every five years until remediation goals have been achieved, 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.

3.4.2.4 Site 26 - Alternative 4: Pump-and-Treat (Source Removal, Groundwater Extraction and Treatment, Institutional Controls, and Long-Term Monitoring)

Under Alternative 4, the suspected source of groundwater contaminants (the process leach tank and associated VOC-contaminated soils) would be removed and a groundwater containment system would be emplaced. Extracted groundwater would be treated on the surface. Treated (clean) groundwater would be re-introduced to the aquifer via infiltration galleries downgradient of the extraction point. Institutional controls would be implemented to prevent exposure to untreated groundwater for the duration of the groundwater treatment period, until GWQS are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when remediation is complete. Site conditions and risks would be reviewed every five years until remediation is complete. Key components of Alternative 4 are identified on Table 3-7 and described below.

Pre-Design Investigation - Pre-design investigations, consisting of a hydrogeologic evaluation and sampling and analysis of groundwater and aquifer materials, would be required to support the design of the groundwater extraction and treatment systems. The hydrogeologic investigation would be used to better define steady-state aquifer characteristics (i.e., hydraulic conductivity, transmissivity, hydraulic gradient) in order to determine the sizing, placement, and design of the extraction and re-injection system. The investigation would include a single well aquifer pump test, groundwater elevation monitoring, and physical analysis of aquifer materials.

To aid in the design of an effective groundwater treatment system, extracted groundwater, representative of that which would ultimately be pumped into the treatment system, would be collected during the pump test and analyzed for chemical constituents. Groundwater collected from site monitoring wells or comparable sample locations would also be analyzed to better delineate the extent of contamination and optimize placement of the groundwater extraction system.

Source Removal - The process leach tank and any associated VOC-contaminated soils in the vicinity of the tank would be removed and disposed away from Site 26 (off-site) to eliminate the suspected source of contaminants to groundwater.

Prior to removal, the tank would be inspected, and its contents (if any) would be sampled and analyzed to characterize it for disposal. The tank contents (i.e., liquids and sludge) would be removed and disposed off-site at an appropriate disposal facility. The tank concrete blocks and any surrounding contaminated soils would then be excavated and removed using conventional excavation/construction equipment. The concrete blocks would be decontaminated to remove residual contaminants prior to off-site transport and disposal. The decontamination method to be used would be determined following inspection and sampling of tank contents. For the purposes of this FS, it is assumed that decontamination would be conducted using high-pressure steam and detergent.

Off-Site Disposal - Two off-site disposal options are under consideration:

A. Off-Base Disposal: Under this option, the decontaminated process leach tank concrete blocks and the associated contaminated soils would be transported off-base to appropriate hazardous or industrial waste-type landfills. Wipe sampling of the tank concrete blocks and TCLP testing of the soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the soils (at the designated disposal facility) would be conducted prior to disposal. For purposes of costing, it is assumed that the soils would be disposed in a hazardous waste (RCRA Subpart C) landfill and the tank concrete blocks would be disposed in an solid waste (RCRA Subpart D) landfill.

B. Disposal in On-Base Landfill: If Capping is selected as the remedial alternative for the Site 4 or Site 5 landfills and the tank concrete blocks and associated soils are determined not to be hazardous, the tank and excavated soils from Site 26 would be consolidated into one of these existing landfills prior to capping. The concrete blocks would be broken-up into small, cobble-sized pieces prior to disposal on the landfill. For this FS, it is assumed that under Alternative 4B the excavated materials from Site 26 would be placed at the Site 4 landfill.

Groundwater Extraction - A groundwater containment (extraction) system would be installed to a depth of approximately 25 feet in the overburden aquifer to capture the VOC contaminant plume. A groundwater containment system consisting of groundwater extraction wells would be placed near the downgradient edge of the plume. Preliminary calculations indicate that several (six or seven) wells, pumping at a combined rate of 2 gallons per minute will be sufficient to contain and capture the contaminated groundwater. Preliminary pumping rate calculations are included in Appendix A. The leading plume

edge extraction system would be situated just downgradient of the highest levels of contamination in order to maximize contaminant recovery and minimize the capture of uncontaminated groundwater. Additional groundwater extraction wells (estimated at six or seven) would be placed in the vicinity of the high-concentration plume area with an anticipated combined pumping rate of 2 gallons per minute. Extracted groundwater would be pumped to an ex-situ groundwater treatment system. The actual pumping rate and number and location of extraction wells will be determined based on the results of the pre-design investigations. The proposed location of the extraction system is shown on Figure 3-8.

Ex-Situ Treatment - Extracted groundwater would be treated in a plant on the surface of Site 26, using technology selected during the design phase. For the purpose of this FS, it is assumed that the groundwater treatment system would consist of an air stripper for removal of the majority of VOCs and aqueous phase activated carbon treatment unit for final polishing of VOCs to meet GWQS. Air stripping and activated carbon are both widely used and effective technologies for the removal of VOCs from groundwater. If necessary to prevent fouling of the air stripper or to meet discharge requirements, pre-treatment of the groundwater for removal of metals and suspended solids would be conducted. Pre-treatment may include sedimentation and filtration. Exhaust air from the air stripper may require treatment to remove VOCs prior to discharge to the atmosphere. If necessary, vapor phase carbon would be used to remove VOCs from the air stream. The final system design would be determined based on chemical characterization of groundwater extracted during the pump tests. The schematic of the proposed treatment process is presented on Figure 3-9. The treated (clean) groundwater would be re-introduced to the aquifer via an infiltration gallery downgradient of the extraction points.

Institutional Controls - Under Alternative 4, land use restrictions would be incorporated into the Base Master Plan to restrict the use of site groundwater until remediation is complete. Use of untreated groundwater for drinking would be prohibited during the duration of the treatment period.

Because site groundwater does not meet New Jersey groundwater quality standards, a classification exception area (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 4, groundwater elevation monitoring would be conducted monthly for the first year of system operation to monitor the effectiveness of the groundwater extraction

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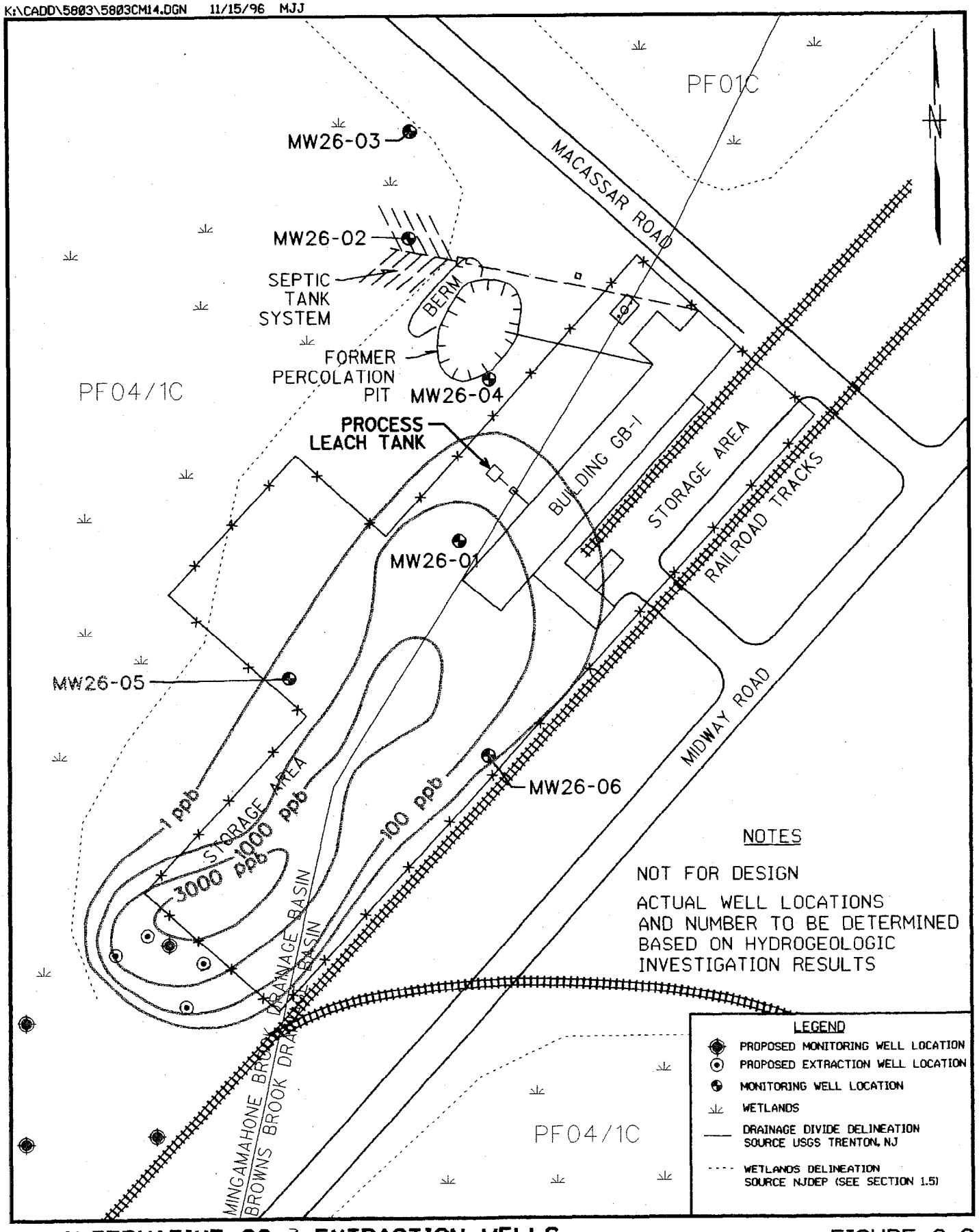

ALTERNATIVE 26-4 EXTRACTION WELLS
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 3-8

0 80 160
SCALE IN FEET

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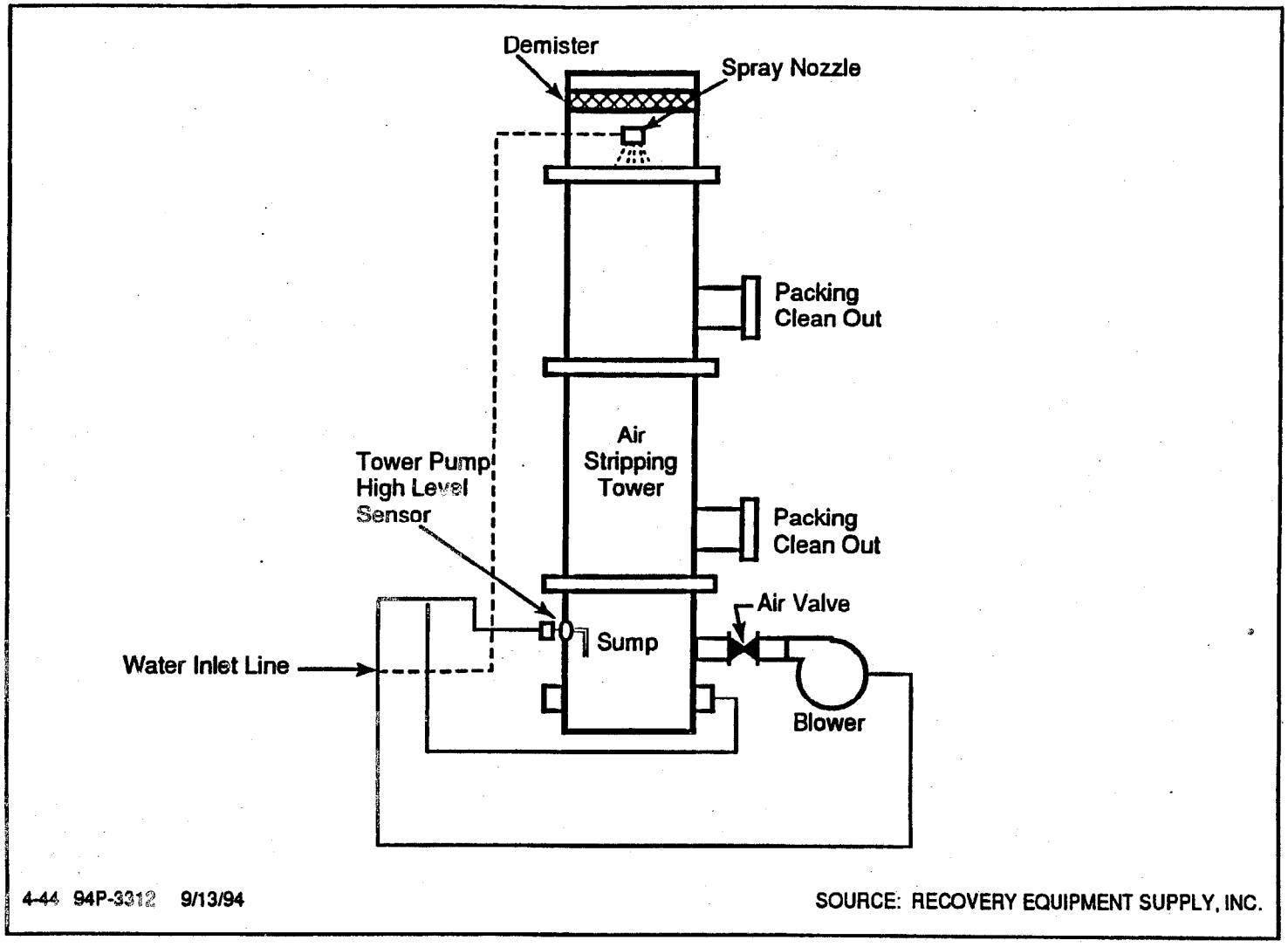

ALTERNATIVE 26-4 GROUNDWATER PUMP AND TREAT SYSTEM

SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 3-9

0 120 240
SCALE IN FEET

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system. Periodic (beginning as semi-annual) groundwater monitoring and chemical analysis would be conducted to monitor the effectiveness of the remedial action. The data would be used to determine the need for additional actions and to determine when remediation goals have been achieved.

Because of the flat water table and site aquifer characteristics, withdrawal of only an estimated 4 gallons per minute(gpm) is necessary to contain the plume. Thus, only a limited mass of contaminants would be removed by the extraction system. The contaminants remaining in the subsurface would be subject to natural attenuation processes. It is expected that natural attenuation of the contaminants will contribute a substantial portion of the overall reduction of TCE over the operating life of the system.

For the purpose of costing, it is assumed that groundwater samples would be collected from approximately four new and three existing monitoring wells. One of the four new monitoring wells will be located near the highest concentration of TCE in the plume, and the remaining three would be located downgradient of the currently delineated plume. All samples would be analyzed for site-specific contaminants (VOCs).

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

3.4.2.5 Site 26 - Alternative 5: Air Sparging with Soil Vapor Extraction (Source Removal, Institutional Controls, and Long-Term Monitoring)

Under Alternative 5, the suspected source of groundwater contaminants (the process leach tank and associated VOC-contaminated soils) would be removed and the VOCs present in groundwater and saturated soils would be removed from the aquifer through a combination of air sparging and soil vapor extraction (AS/SVE), which comprise an active in-situ remediation process. The VOCs would be collected above ground and sent off site for reuse, recycling, or destruction. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQC are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every 5 years until the groundwater remediation is complete. Key components of Alternative 5 are identified on Table 3-7 and are described below.

Pre-Design Investigation - Pre-design investigations would be required to support the design of an AS/SVE treatment system for Site 26 and to optimize placement of air injection and vapor extraction wells. A hydrogeologic evaluation and sampling and analysis of groundwater would be required to better define aquifer characteristics, identify extent and distribution of VOC contaminants, and identify potential "hot spots."

A pilot study would be conducted to identify key unsaturated soil factors such as the soil air permeability and radius of influence of the proposed vapor extraction system. A pilot system could be designed such that it may be expanded into a full-scale system; the pilot study results would be used to optimize the system operating conditions for VOC recovery. All equipment and piping and extraction wells used in the pilot system can be easily augmented into a full-scale system.

Source Removal - The process leach tank and any associated VOC-contaminated soils in the vicinity of the tank would be removed and disposed (off-site) of Site 26 to eliminate the suspected source of contaminants to groundwater. The tank is constructed of concrete block and has approximate outside dimensions of 10 feet by 10 feet by 6 feet deep. The top of the tank lies approximately 8 inches below ground surface.

Prior to removal, the tank would be inspected and its contents (if any) would be sampled and analyzed to characterize them for disposal. The tank contents (i.e., liquids and sludge) would be removed and disposed off site at an appropriate disposal facility. The tank concrete blocks and any surrounding contaminated soils would then be excavated and removed using conventional excavation/construction equipment. The concrete blocks would be decontaminated to remove residual contaminants prior to off-site transport and disposal. The decontamination method to be used would be determined following inspection and sampling of tank contents. For the purposes of this FS, it is assumed that decontamination would be conducted using high-pressure steam and detergent.

Off-Site Disposal - Two off-site disposal options are under consideration:

A. Off-Base Disposal: Under this option, the decontaminated process leach tank concrete blocks and the associated contaminated soils would be transported off-base to appropriate hazardous or industrial waste-type landfills. Wipe sampling of the tank concrete blocks and TCLP testing of the soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the soils (at the designated disposal facility) would be conducted prior to disposal. For purposes of costing, it is assumed that the soils would be disposed in a hazardous waste (RCRA

Subpart C) landfill and the tank concrete blocks would be disposed in an solid waste (RCRA Subpart D) landfill.

B. Disposal in On-Base Landfill: If capping is selected as the remedial alternative for the Site 4 or Site 5 landfills and the tank concrete blocks and associated soils are determined not to be hazardous, the tank and excavated soils from Site 26 would be consolidated into one of these existing landfills prior to capping. The concrete blocks would be broken-up into small, cobble-sized pieces prior to disposal on the landfill. For this FS, it is assumed that, under Alternative 5B, the excavated materials from Site 26 would be disposed at the Site 4 landfill.

Air Sparging and Soil Vapor Extraction (AS/SVE)

Under this alternative, a network of air injection wells would be employed to deliver clean air into groundwater below the water table, thus inducing the mass transfer (stripping) of VOCs present in the aqueous phase, or sorbed to soils, into the gas phase. (Alternatively, a comparable scheme consisting of in-well air-sparging could also be considered as representative of this technology.) As air bubbles move vertically through the saturated and unsaturated groundwater and soil zones (or within the groundwater in the in-well air-sparging well), VOC contaminants dissolved in the groundwater or adsorbed onto soil particles would partition into the gaseous phase and would be transported into the unsaturated zone where they are collected by the vapor extraction wells. VOCs currently present as vapors in the soil pore spaces in the unsaturated zone would also be captured by the vapor recovery wells. Depending on the actual concentrations of VOCs in the gas stream, vapor phase activated carbon may be required to treat captured vapors to meet applicable air emissions and subsequent disposal.

Air sparging wells would be installed below the water table and screened approximately 1 foot above the top of the clay confining layer. Compressors would be used to provide the air that would be conveyed by a network of PVC pipes into the saturated zone. Shallow vapor extraction wells would be installed in the unsaturated zone overlying the delineated groundwater plume area and connected to vacuum pumps at the ground surface. The vapor extraction wells and air sparging wells will have a staggered spacing to minimize stagnation points and are anticipated to be installed in a grid formation in the VOC-contaminated zone. Air sparging wells typically are constructed of Schedule 80, 2-inch ID PVC, with 1- to 2-foot screens. Vapor extraction wells are anticipated to be constructed of Schedule 80, 4-inch ID PVC piping, with 1- to 2-foot screen lengths. In-line knock-out tanks would used to remove moisture from the recovered gases to prevent damaging pumps or overloading of the vapor phase activated carbon emission controls. Insulation of the above-ground PVC piping will be required to prevent freezing of moisture-laden vapors during cold weather conditions. Multiple blowers will be used so that selected rows of air sparging or vapor extraction wells may

be brought on- or off-line as needed. An extraction rate of 50 scfm per well is estimated. Piping manifolds will be used to link each line of wells and each well will be individually valved for flexibility of applying vacuum or for injecting air in discrete areas.

Using the AS/SVE system for mass transfer, it is anticipated that the greater part of the chlorinated VOCs would be removed from groundwater and soils. However, the continuous introduction of air into the subsurface maintains a high dissolved oxygen level in both the saturated and unsaturated zones. High dissolved oxygen conditions are not generally favorable to anaerobic biological activity of the chlorinated VOCs in situ. Biodegradation of VOCs by the indigenous microbe population generally requires anaerobic conditions. Therefore, it is poposed that any AS/SVE remediation scheme would consist of a preliminary active AS/SVE period to treat the areas of significant TCE concentration, to remove the bulk of the mass of chlorinated hydrocarbons, followed by a period of long-term monitoring and natural attenuation of the chlorinated hydrocarbons in an anaerobic state.

AS/SVE systems have been demonstrated successfully for the treatment of VOC-contaminated soils and groundwater at numerous sites. Most demonstrations have involved remediation of petroleum contamination (gasoline and fuel oil), however, limited full-scale studies have shown the process to be effective in treating a wider range of contaminants, including halogenated VOCs and semi-volatile organics. The process has been effective in reducing TCE and PCE concentrations in groundwater at other sites.

As with other in-situ vapor extraction processes, the effectiveness of this process is dependent on geologic conditions. Highly stratified soils or variations in soil permeability may result in ineffective volatilization or increased lateral migration of contaminants within the saturated zone. Based on the RI soil boring and slug tests performed to date, Site 26 appears to have sandy soils with silt and clay. These soils exhibit moderate hydraulic conductivity, which may be suitable for AS/SVE.

Groundwater and subsurface soil samples would be collected and analyzed during the remediation period to check the progress of remediation.

One concern with the in-situ AS/SVE process is the potential of short-circuiting of the air pathways. An asphalt cap or impermeable membrane may be installed to minimize potential air short circuiting.

Once pre-design investigations have been completed, the estimate of the remediation duration would be refined. For the purpose of developing a cost estimate, it is assumed that the AS/SVE system would operated for a 5-year period. It is possible that after a period shorter than 5 years the rate of vapor recovery could decline asymptotically (where the groundwater TCE concentration remains steady). At

that time, evaluation of vapor recovery and groundwater contaminant concentration data may indicate that the system could be shut down since effective TCE removal has ended. Long-term periodic monitoring would continue to assess groundwater TCE concentration. If rebound occurs (i.e., increases in groundwater TCE concentrations are noted), then the AS/SVE system could readily be reactivated.

The schematic of the proposed treatment process is presented on Figure 3-10.

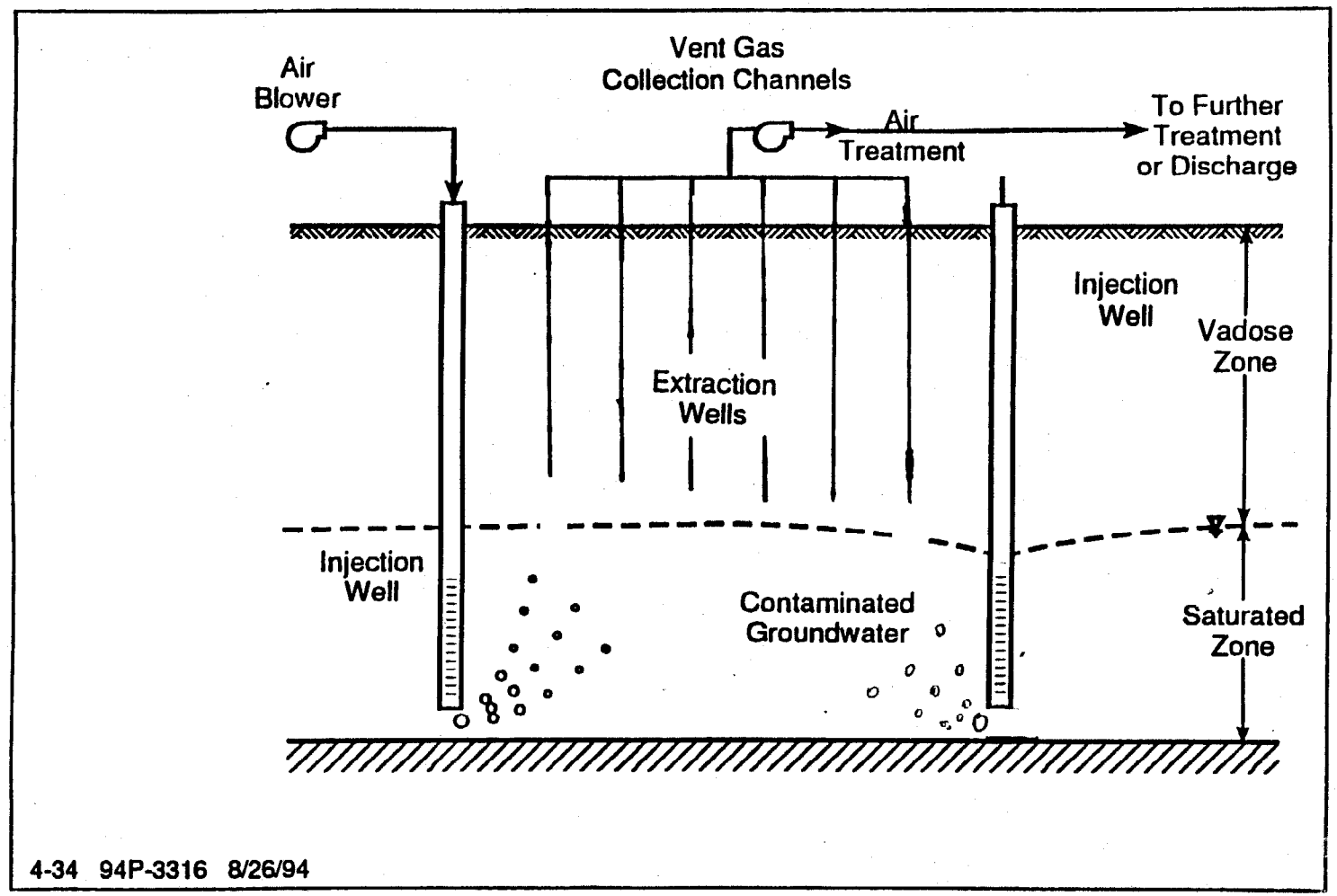
Institutional Controls - Under Alternative 5, land use restrictions would be incorporated into the Base Master Plan to restrict the use of site groundwater until groundwater remediation is complete. Use of untreated site groundwater for drinking water would be prohibited during the duration of the treatment period to prevent ingestion, inhalation, and dermal exposure to site contaminants.

Because site groundwater does not currently meet New Jersey groundwater quality criteria, a classification exception area (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 5, groundwater elevation monitoring would be conducted monthly for the first year of system operation to monitor the effectiveness of the AS/SVE system. Periodic (beginning as semi-annual) groundwater monitoring and chemical analysis would be conducted thereafter to monitor the effectiveness of the remedial action. The data would be used to determine the need for additional actions and to determine when remediation goals have been achieved.

For the purpose of costing, it is assumed that groundwater samples would be collected from approximately four new and three existing monitoring wells. One of the four new monitoring wells will be located near the highest concentration of TCE in the plume, and the remaining three would be located downgradient of the currently delineated plume. All samples would be analyzed for site-specific contaminants (VOCs).

Five-Year Reviews - If necessary, a review of site conditions and risks would be conducted every 5 years until remediation goals have been achieved, 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.



ALTERNATIVE 26-5 AIR SPARGING SYSTEM
SITE 26 - EXPLOSIVE "D" WASHOUT AREA

0 120 240
SCALE IN FEET

FIGURE 3-10

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3.4.2.6 Site 26 - Alternative 6: Engineered Bioremediation (Source Removal, Engineered Bioremediation, Institutional Controls, and Long-Term Monitoring)

Under Alternative 6, the suspected source of groundwater contaminants (the process leach tank and associated VOC-contaminated soils) would be removed and the VOCs present in groundwater and saturated soils would be actively bioremediated in-situ through engineered enhancement of natural processes. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQC are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every 5 years until the groundwater remediation is complete. Key components of Alternative 6 are identified on Table 3-7 and are described below.

Pre-Design Investigation - Pre-design investigations would be required to support the design of the engineered biotreatment system for Site 26 and to optimize placement of nutrient, methane, and oxygen addition points. A hydrogeologic evaluation and sampling and analysis of groundwater would be required to better define aquifer characteristics, identify extent and distribution of VOC contaminants, and identify potential "hot spots."

Treatability Studies - The technology evaluation presented in Section 2 identified engineered bioremediation as an innovative treatment approach for the VOC-contaminated groundwater at Site 26. However it is a relatively new, innovative technology that has proven effective in bench- and pilot-scale studies but is not widely demonstrated in full-scale remediation of groundwater with similar contaminants. The limited demonstration data for this technology and the highly site- and waste-specific nature of in-situ remediation make it impossible to determine the likely effectiveness and optimal conditions of engineered bioremediation without a site-specific treatability study. Therefore, a treatability study would be necessary to evaluate the effectiveness of this technology. For the treatability study, groundwater and/or soil samples would be obtained and used in stirred jar and column studies to assess the degradation rates of the chlorinated VOCs and the quantity and types of additives (e.g., methane, oxygen, and nutrients) needed to optimize the bioactivity. The degradation rates and additive requirements would then be used in the full-scale design.

A pilot study may also be conducted to identify key soil factors such as the soil permeability and radius of influence of the proposed methane and oxygen injection system. A pilot system can be designed such that it may be expanded into a full-scale system; the pilot study results would be used to optimize the

system operating conditions. All equipment , piping, and extraction wells used in the pilot system can be easily augmented into a full-scale system.

Source Removal - The process leach tank and any associated VOC-contaminated soils in the vicinity of the tank would be removed and disposed off site to eliminate the suspected source of contaminants to groundwater. The tank is constructed of concrete block and has approximate outside dimensions of 10 feet by 10 feet by 6 feet deep. The top of the tank lies approximately eight inches below ground surface.

Prior to removal, the tank would be inspected and its contents (if any) would be sampled and analyzed to characterize it for disposal. The tank contents (i.e., liquids and sludge) would be removed and disposed off of Site 26 (off-site) at an appropriate disposal facility. The tank concrete blocks and any surrounding contaminated soils would then be excavated and removed using conventional excavation/construction equipment. The concrete blocks would be decontaminated to remove residual contaminants prior to off-site transport and disposal. The decontamination method to be used would be determined following inspection and sampling of tank contents. For the purposes of this FS, it is assumed that decontamination would be conducted using high-pressure steam and detergent.

Off-Site Disposal - Two off-site disposal options are under consideration:

A. Off-Base Disposal: Under this option, the decontaminated process leach tank concrete blocks and the associated contaminated soils would be transported off-base to appropriate hazardous or industrial waste-type landfills. Wipe sampling of the tank concrete blocks and TCLP testing of the soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the materials (at the designated disposal facility) would be conducted prior to disposal. For purposes of costing, it is assumed that the soils would be disposed in a hazardous waste (RCRA Subpart C) landfill and the tank concrete blocks would be disposed in a solid waste (RCRA Subpart D) landfill.

B. Disposal in On-Base Landfill: If capping is selected as the remedial alternative for the Site 4 or Site 5 landfills and the tank concrete blocks and associated soils are determined not to be hazardous, the tank and excavated soils from Site 26 would be consolidated into one of these existing landfills prior to capping. The concrete blocks would be broken up into small, cobble-sized pieces prior to disposal on the landfill. For this FS, it is assumed that, under Alternative 6B, the excavated materials from Site 26 would be disposed at the Site 4 landfill.

Engineered Bioremediation

Engineered bioremediation systems have been demonstrated successfully for the treatment of contaminated soils and groundwater at numerous sites. However, most demonstrations have involved remediation of petroleum contamination (gasoline and fuel oil), and limited full-scale studies have been conducted in treating chlorinated VOCs. In the few studies conducted to date, the results indicate that engineered bioremediation has the potential to meet the groundwater clean-up criteria for Site 26 (Sutfin, 1996; Setzer, 1993). However, its successful application is by no means assured.

Under this alternative, a network of oxygen, methane, and nutrient (if necessary) injection points would be established to deliver the essential components for the creation of a thriving methanotroph community in the subsurface. Methanotrophs contain methane monooxygenase (MMO), a powerful enzyme that allows the methanotrophs to co-oxidize a variety of compounds, including chlorinated solvents (Sutfin, 1996). Based on the limited experience at other sites, it is postulated that the creation of a thriving methanotroph community will lead to the degradation of the chlorinated VOCs in the groundwater at a rate much faster than that for natural attenuation. It should be noted that stimulation of methanotrophs may be a patented process, and obtaining a license to apply the technology could be difficult.

Air and oxygen injection points would be installed below the water table and screened immediately above the top of the clay confining layer. Compressors would be used to pressurize the air and natural gas, which would be conveyed by a network of PVC pipes into the saturated zone. The air and methane injection points would be installed in a grid formation in the VOC-contaminated zone. Injection points typically are constructed of Schedule 80, 2-inch ID PVC, with 1- to 2-foot screens. Insulation of the aboveground PVC piping would be required to prevent freezing during cold weather conditions. Multiple compressors would be used so that selected rows of injection points could be brought on- or off-line as needed. Piping manifolds would be used to link each line of injection points, and each injection point would be individually valved for flexibility of injecting air and/or methane in discrete areas.

If necessary, a nutrient addition system would also be installed. Nutrient addition could be accomplished using the same delivery system as the one for the air and methane, or could be a separate system.

As with other in-situ vapor treatment processes, the effectiveness of this process is partly dependent on geologic conditions. Highly stratified soils or variations in soil permeability may result in ineffective delivery of the additives necessary to stimulate the subsurface microbial community. Based on the RI soil boring and slug tests performed to date, Site 26 appears to have sandy soils with silt and clay. It should be possible to deliver the additives properly to stimulate the microbial community at Site 26.

Groundwater, subsurface soil, and vapor samples would be collected from the subsurface and analyzed during the remediation period to check the progress of remediation.

Institutional Controls - Under Alternative 6, land use restrictions would be incorporated into the Base Master Plan to restrict the use of site groundwater until groundwater remediation is complete. Use of untreated site groundwater for drinking water would be prohibited during the duration of the treatment period to prevent ingestion, inhalation, and dermal exposure to site contaminants.

Because Site groundwater does not meet New Jersey groundwater quality criteria, a classification exception area (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 6, periodic groundwater, subsurface soil, and vapor monitoring would be conducted to monitor the effectiveness of the engineered bioremediation system. The sampling frequency initially would be more intensive to ensure proper system functioning. Once the system is performing as planned, the monitoring frequency could be reduced. Monitoring and chemical analysis data would be used to determine the need for additional actions and to determine when remediation goals have been achieved.

Five-Year Reviews - Since contaminants remain in Site groundwater, a review of site conditions and risks would be conducted every 5 years until remediation goals have been achieved, 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.

3.4.3 Site 26 - Alternatives Screening

In the screening process, alternatives are evaluated generally with regard to effectiveness, implementability, and cost. The purpose of the evaluation is to reduce the number of alternatives that will undergo a more thorough and extensive analysis so that the detailed evaluation in Section 4 focuses on the most plausible array of remedial alternatives. If possible, the alternatives carried forward for detailed evaluation should include the full range of alternatives recommended in the NCP and EPA RI/FS Guidance: no action, treatment, and containment.

The alternative screening process for Site 26 resulted in all but one of the identified alternatives being retained for further evaluation in order to preserve a full range of plausible remedial actions. Engineered bioremediation was eliminated because there is limited experience with the technology, its ultimate ability to achieve the groundwater criteria is uncertain, the preferred process is patented, and other innovative technology and activities treatment alternatives were retained for detailed analysis. Of the alternatives judged to be technically feasible and potentially effective, treatability studies would be required to confirm the effectiveness of the proposed in-situ treatment methods. The complete results of the alternatives screening evaluation for Site 26 are presented in Table 3-8.

TABLE 3-8
SITE 26 - SCREENING OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
1	No Action: (Long-term Monitoring & Five Year reviews)	Provides no additional protection of human health or the environment. Does not reduce potential for human exposure to contaminants in groundwater. 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.
2	Source Removal, Institutional Controls, Long-term Monitoring, Five-Year Reviews	Protects of human health and the environment through institutional controls and natural attenuation. Groundwater use would be restricted. Would offer reduction of contaminant leaching to groundwater through source removal. Reduction in toxicity, mobility, or volume of contaminants through treatment only through source treatment. Groundwater contaminants would naturally attentuate over time.	Readily implementable. No technical or administrative difficulties.	Capital: low O&M: low	Relative to Alt. 1, provides greater protectiveness in the long term. Would result in reduction of groundwater contaminant levels. Retained.
3	Reactive Wall Treatment: (Source Removal, In-Situ Groundwater Treatment, Institutional Controls, and Long-Term Monitoring)	Protects human health and the environment by removing the suspected source of VOC contamination leaching to groundwater. Would prevent continuing migration of TCE plume until treatment and natural attenuation remediate the contaminants. Groundwater use would be restricted. Toxicity and volume of contaminants would be reduced through treatment only through source treatment.	Implementable. Reactive Wall technology is innovative and is not well developed, but offers potential for in-situ treatment with no ex-situ treatment residuals. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are limited; currently only one commercial firm available to implement full-scale construction.	Capital: moderate - high O&M: moderate	This technology will likely degrade TCE in the subsurface. May offer comparable degree of protectiveness as Alt. 4. Retained

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
4	Pump-And-Treat: (Source Removal, Groundwater Extraction and Treatment, Institutional Controls, and Long-Term Monitoring)	Protects human health and the environment by removing suspected source of VOC contamination leaching to groundwater. Would prevent continuing migration of TCE plume until extraction/treatment and natural attenuation remediate the contaminants. Groundwater use would be restricted. Toxicity and volume of contaminants would be reduced through treatment.	Readily implementable. Specialized treatment equipment is required, but is available from several vendors. No technical or administrative difficulties. Personnel and materials necessary to implement alternative are widely available.	Capital: moderate O&M: moderate	Would employ well demonstrated treatment process options. Retained as representative treatment alternative.
5	Air Sparging Soil Vapor Extraction: (Source Removal, Institutional Controls, and Long-Term Monitoring)	Protects human health and the environment by removing suspected source of VOC contamination leaching to groundwater. Would actively reduce TCE concentrations in the plume by direct stripping and promoting biodegradation. Groundwater use would be restricted. Toxicity volume would be reduced through treatment	Implementable Technology is well proven and offers potential for active in-situ treatment, depending on actual site conditions. Pre-design and pilot studies would be required, but pilot system could easily be expanded to full-scale system in the field. System requires significant sampling and analysis to gauge impact across the wide volume of soil in the remediation zone.	Capital: moderate O&M moderate to high	This technology set offers the advantage of actively treating the large volume of contaminated media and could require less time than the passive treatment or capture and treatment of the plume at the leading plume edge. However, this technology is quite "intrusive," results in TCE migration through currently 'clean' vadose zone soils and requires substantial chemical and biological monitoring to control the process. Retain for further evaluation.

TABLE 3-8
SITE 26 - SCREENING OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
PAGE 3 OF 3

	ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENTS
6	Engineered Bioremediation: (Source Removal, In-Situ Engineered Bioremediation, Institutional Controls, and Long-Term Monitoring)	Protects human health and the environment by removing the suspected source of VOC contamination leaching to groundwater. Would actively remediate the entire plume by engineered bioremediation. Groundwater use would be restricted until cleanup levels are achieved. Toxicity and volume of contamination would be reduced through treatment	Implementable, although technology is patented. Technology is innovative and has rarely been applied on a full scale, but offers potential for in-situ treatment with no ex-situ treatment residuals. Personnel and materials necessary to implement are available; however, it is not clear how licensable the technology is.	Capital" moderate O&M moderate	This technology has the potential to degrade chlorinated VOCs in the subsurface, in a shorter time frame of all alternatives but Alternative 5. However, technology development is limited, and its licensability is uncertain. Because there are two other retained innovative technologies, including another active treatment technology, and the ultimate success of engineered bioremediation is uncertain, this technology is eliminated.

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. Site 4 alternatives are evaluated in Section 4.1; Site 5 alternatives are evaluated in Section 4.2; Site 19 alternatives are evaluated in Section 4.3; and Site 26 alternatives are evaluated in Section 4.4.

4.1 INDIVIDUAL ANALYSIS OF SITE 4 ALTERNATIVES

Detailed evaluations of the two Site 4 remedial alternatives retained for further evaluation are presented in this section. Detailed cost estimates and assumptions for each alternative are presented in Appendix B.

4.1.1 Site 4 - 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 five years.

Overall Protection of Human Health and the Environment

The No-Action Alternative would not provide protection of human health or the environment. Contaminants within the landfill materials would not be remediated or isolated and would continue to pose risk and adversely impact the environment.

Because precipitation would continue to infiltrate the landfill, the contaminants remaining in the landfill mass would continue to leach into the groundwater, causing continued exceedence of State GWQS and potentially affecting downgradient portions of the aquifer. Under a future residential land use scenario, exposure to contaminated groundwater beneath the site would pose potential carcinogenic and non-carcinogenic risks exceeding the EPA's target risk range (carcinogenic risk>1 E-04, and HI >1.0). Alternative 1 does not include implementation of institutional controls to restrict use of contaminated groundwater in the event of future change in land or groundwater use.

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 landfilled materials may pose health risks to humans and animals. Presently, most of the surface is covered with soil and vegetation, but exposed debris are evident

on the eastern side of the landfill. Over time as the landfill surface erodes, more contaminated subsurface materials may be exposed and become available for direct contact, resulting in increased human health and ecological risks. Additionally, increased migration of contaminated soils to the adjacent surface water and wetlands may result from surface runoff and wind erosion.

Long-term monitoring of groundwater, surface water, and sediment would make it possible to evaluate site conditions and risks. Frequency of monitoring can be set so that impacts on downgradient receptors may be identified early enough to provide additional protection of human health or the environment.

Compliance with ARARs

Alternative 1 would not comply with federal and state municipal landfill post-closure requirements [40 CFR 258.61 and N.J.A.C. 7:26-2A.9] for routine maintenance and repair of the existing cover, but it would comply with long-term monitoring requirements through the annual monitoring and evaluation of groundwater, surface water, and sediment monitoring requirements.

Because groundwater beneath Site 4 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 Site 4 human health 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 1.4 E-04 and an HI of 3.3 for non-carcinogenic exposures. These risk estimates slightly exceed EPA's target risk range. Because no actions would be taken to reduce contaminant leaching to groundwater and no institutional controls would be implemented to prohibit use of untreated contaminated groundwater, the risk to potential future residential users of the groundwater would remain. The groundwater underlying Site 4 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 the base (within approximately one mile upgradient of the site). If site land and groundwater usage changes in the future, potential residential users of groundwater would not be protected.

The potential health risks from direct exposure to landfill contaminants were not quantified in the RI; however, it is conservatively assumed that landfilled materials may pose health risks to humans and ecological receptors. Because this alternative includes no controls to prevent deterioration of the landfill surface, over time surface soils would likely erode, exposing landfill materials and potentially increasing the human health and ecological risks posed by direct contact with landfill materials. Erosion of the landfill surface would also result in increased migration of contaminants to the adjacent surface water and wetlands through wind and surface runoff.

Under ambient conditions, natural attenuation and degradation of some of the contaminants in landfill materials and site groundwater may occur; however, the process is likely to take many years. Five-year reviews would be required to assess whether threats or 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 the landfill mass 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 landfill materials.

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 personal protective equipment (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 constructibility, 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 five-year review processes.

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

Cost

No capital costs are associated with the No Action Alternative. The average annual O&M cost for long-term monitoring is $21,600 and five-year reviews are $15,500 per event. Over a 30-year period, the net present worth cost is $302,000 (at a 7 percent discount rate).

4.1.2 Site 4 - Alternative 3: Capping, Institutional Controls, and Long-Term Monitoring

Alternative 3 relies on containment and institutional controls to achieve RAOs. A low permeability enhanced 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. The perimeter of the landfill would be fenced to limit access to the covered area. Access restrictions would be emplaced to limit future uses of the site that may result in disturbance of the soil 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 naturally attenuate by chemical, physical, and biological (organics only) mechanisms. Long-term, periodic monitoring and five-year reviews would be required to 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 landfilled materials 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 and facilitating natural attenuation of groundwater contamination. Reducing leaching of contaminants from the landfill into the underlying groundwater will 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. Modeling predicts that an estimated 55 feet downgradient of the site was the maximum distance where metals in groundwater would exceed either GWQS or background levels (Table 2, Appendix A). 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 4 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 natural attenuation 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 through natural attenuation. 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 1.4 E-04 and an HI of 3.3 for non-carcinogenic exposures. These risk estimates slightly 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 natural attenuation of groundwater contamination. Containing the source of groundwater contamination will ultimately result in reduced risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through physical, chemical, and biological (VOCs only) mechanisms.

The groundwater underlying Site 4 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 the Base (within approximately one mile upgradient of the site), 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 landfilled materials may pose health risks to human and

ecological receptors. Alternatives 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, and whether groundwater is naturally attenuating. 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 and fencing are readily available and can be replaced. In the event of damage to the cap system, repairs would likely be performed without many difficulties. 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 was 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 vehicular 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 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 enhanced cap system. Erosion control measures such as hay bales and silt fences would be 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.

The criterion of availability of treatment technologies, TSD facilities, and capacity is not applicable.

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 five-year reviews.

Cost

The capital costs for Alternative 3 total $1,983,000. The average annual O&M costs are $29,600, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $2,400,000 (at a 7 percent discount rate).

4.1.3 Comparative Analysis of Site 4 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 two 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

Only Alternative 3 would be protective of human health and the environment. 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 3 is protective of human health and the environment. The enhanced cover system would reduce human health and ecological risks posed by contact with landfilled materials and would reduce leaching of contaminants to groundwater, thereby reducing contaminant migration into the environment and facilitating natural attenuation of groundwater contamination. 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.

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

CRITERION:	ALTERNATIVE 1: NO ACTION	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.	Enhanced 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 for drinking water.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. The cover system would reduce leaching of contaminants to groundwater, facilitating natural attenuation 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 downgradient, potentially affecting downgradient receptors.	The cover system would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.
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 by natural attenuation. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration.

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

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Location-Specific ARARs	Not Applicable.	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 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 1.4×10^{-4} excess cancer risk (ECR) and HI = 3.3 non-carcinogenic risks from exposure to site groundwater. Increased risk anticipated over time as landfill surface deteriorates.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} ECR and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Installation and maintenance of the cap would reduce direct exposure risks to less than 1×10^{-6} ECR and HI less than 1.0.
Adequacy and Reliability of Controls	No new controls implemented. Existing site features provide limited controls.	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.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT		
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	Groundwater contamination eventually eliminated by natural attenuation.

TABLE 4-1
SITE 4 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
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.
Worker Protection	No risk to workers anticipated if proper PPE is used during 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 significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.
Time Until Action is Complete	Not applicable.	1.5 years enhanced cap is in place. Natural attenuation will likely take longer.
IMPLEMENTABILITY		
Ability to Construct and Operate	No construction or operation involved.	No difficulties anticipated. Capping is a readily implementable technology.
Ease of Doing More Action if Needed	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 within.
Ability to Monitor Effectiveness	Monitoring would provide assessment of potential exposures, contaminant presence, migration, or changes in site conditions.	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.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	Same as Alternative 1.

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

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
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 construct cap and perform long-term maintenance, monitoring, and 5-year reviews.
Availability of Technology	Not required.	Common construction techniques and materials required for cap construction.
COST		
Capital Cost	$0	$1,983,000
First-Year Annual O&M Cost	$21,600	$29,600
Present Worth Cost*	$302,000	$2,400,000

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

Compliance with ARARs

Because Alternative 1 does not include any remedial actions, it 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 an enhanced cover system would be installed and a long-term maintenance and repair program would be implemented.

Both 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], Alternative 3 would comply by seeking a temporary exemption (CEA) from these requirements until the GWQS are achieved through natural attenuation.

Long-Term Effectiveness and Permanence

Alternative 3 is the only alternative that offers substantial 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.

Alternative 3 would reduce human and ecological risks due to direct exposure to landfilled materials by eliminating the potential for exposure. Long-term risks due to ingestion of site groundwater would be mitigated by reducing contaminant leaching into groundwater and natural attenuation of groundwater contaminants, and by implementing institutional controls to prohibit use of untreated, contaminated groundwater.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Because neither of the alternatives includes treatment, neither would reduce the toxicity, mobility, or volume through treatment. Alternative 3 would reduce the mobility of landfill contaminants by reducing precipitation infiltration.

Short-Term Effectiveness

The short-term effectiveness of the two 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 3 would present a greater opportunity for short-term impact due to site preparation, grading, and constructing the enhanced cover system.

Impacts to the environment are not anticipated under Alternative 1 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 enhanced cap construction.

Alternative 1 would not achieve any of the RAOs. Alternative 3 would achieve all RAOs within approximately 2.5 years, which would be the time to design and install the proposed cover, and to implement the CEA.

Implementability

Alternative 1 is the most easily implemented since the only activities proposed are long-term monitoring and five-year reviews. Alternative 3 would be more 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 Alternative 1. 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 to implement than Alternative 3.

4.2 INDIVIDUAL ANALYSIS OF SITE 5 ALTERNATIVES

Detailed evaluations of the two Site 5 remedial alternatives retained for further evaluation are presented in this section. Detailed cost estimates and assumptions for each alternative are presented in Appendix A.

4.2.1 Site 5 - 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 five years.

Overall Protection of Human Health and the Environment

The No-Action Alternative would not provide protection of human health or the environment. Contaminants within the landfill materials would not be remediated or isolated and would continue to pose risk and adversely impact the environment.

Because precipitation would continue to infiltrate the landfill, the contaminants remaining in the landfill mass would continue to leach into the groundwater, causing continued exceedence of State GWQS and potentially affecting downgradient portions of the aquifer. Under a future residential land use scenario, exposure to contaminated groundwater beneath the site would pose potential carcinogenic and non-carcinogenic risks exceeding the EPA's target risk range (carcinogenic risk>1 E-04, and HI >1.0). Alternative 1 does not include implementation of institutional controls to restrict use of contaminated groundwater in the event of future change in land or groundwater use.

The potential health risks from direct exposure to landfill contaminants were not quantified in the RI; however, it is conservatively assumed that direct contaminated landfill materials may pose health risks to humans and animals. Currently, the western 4 acres of the landfill is a wooded area, moderately vegetated with scrub pines and grasses; the soil cover over this portion of the landfill is estimated to be 1.5 to 3 feet thick (based on site inspection/hand augers samples collected by B & R Environmental in September 1996). The eastern one acre of the landfill surface is sparsely covered with low weeds and grasses; cover materials are reported to be thin in some areas. Because Alternative 1 does not include measures to prevent deterioration of the landfill surface, over time surface soils would erode, particularly in the sparsely vegetated areas, exposing contaminated subsurface materials and potentially increasing the human health and ecological risks posed by direct contact with landfilled materials.

Long-term monitoring of groundwater would make it possible to evaluate site conditions and risks. Frequency of monitoring can be set so that impacts on downgradient receptors may be identified early enough to provide additional protection of human health or the environment.

Compliance with ARARs

Alternative 1 would not comply with federal and state municipal landfill post-closure requirements [40 CFR 258.61 and N.J.A.C. 7:26-2A.9] for routine maintenance and repair of the existing cover, but it would comply with long-term monitoring requirements through the annual monitoring and evaluation of groundwater.

Because groundwater beneath Site 5 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 Site 5 human health 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 1.3 E-04 and an HI of 5.2 for non-carcinogenic exposures. These risk estimates slightly exceed EPA's target risk range. Because no actions would be taken to reduce contaminant leaching to groundwater and no institutional controls would be implemented to prohibit use of untreated contaminated groundwater, the risk to potential future residential users of the groundwater would remain. The groundwater underlying Site 5 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 the Base. If site land and groundwater usage changes in the future, potential residential users of groundwater would not be protected.

The potential health risks from direct exposure to landfill contaminants were not quantified in the RI; however, it is conservatively assumed that landfilled materials may pose health risks to humans and ecological receptors. Because this alternative includes no controls to prevent deterioration of the landfill surface, over time surface soils could erode, exposing landfilled materials and potentially increasing the human health and ecological risks posed by direct contact with landfilled materials. Surface erosion would be expected to be greatest in the eastern portion of the landfill. This area is sparsely vegetated with low weeds and grasses, and the cover materials are reported to be thin in some areas. The western portion of the site is a wooded area, moderately vegetated with scrub pines and grasses. The cover is reported to be 1.5 to 3 feet thick in this area. The pine trees and grass cover appear to be effectively limiting erosion of the landfill surface there.

Under ambient conditions, natural attenuation and degradation of some of the contaminants in landfill materials and site groundwater may occur; however, the process is likely to take many years. Five-year reviews would be required to assess whether threats or 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 the landfill mass 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 landfill materials.

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 constructibility, 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 five-year review processes.

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

Cost

No capital costs are associated with the No-Action Alternative. The average annual O&M cost for long-term monitoring is $15,800 and five-year reviews are $15,500 per event. Over a 30-year period, the net present worth cost is $230,000 (at a 7 percent discount rate).

4.2.2 Site 5 - Alternative 3: Capping, Institutional Controls, Long-Term Monitoring

Alternative 3 relies on containment and institutional controls to achieve RAOs. A low permeability cover system would be installed over the area of former active landfill operations to prevent potential human and animal contact with contaminants in the landfilled materials, reduce contaminant leaching to groundwater, and minimize contaminant migration via surface runoff and erosion. Access restrictions would be emplaced 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 naturally attenuate by chemical, physical, and biological (organics only) mechanisms. Routine inspection and maintenance of the entire landfill surface would be conducted to ensure the integrity of the existing and new cover systems. Long-term monitoring and five-year reviews would be required to assess contaminant status and potential threats to human health and the environment. The key components of Alternative 3 are identified on Table 3-3.

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 landfilled materials may pose health risks to humans and animals. Direct exposure risks would be reduced by installation of an enhanced cover system over the eastern side of the landfill and long-term inspection and maintenance of the entire landfill surface. Because the properly maintained cover system would effectively eliminate the direct exposure pathway, the direct contact risks would be eliminated by implementation of Alternative 3. The cover system would also prevent further erosion of the landfill surface and reduce 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 reduce infiltration of precipitation into the landfill, thereby reducing

contaminant leaching from the landfill materials to the underlying groundwater and facilitating natural attenuation of groundwater contamination. Reducing leaching of contaminants from the landfill into the underlying groundwater will 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.

Access restrictions would also 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 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 5 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 natural attenuation of contaminants and ultimately resulting in attainment of constituent standards. Alternative 3 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQS are achieved through natural attenuation. 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 1.3 E-04 and an HI of 5.2 for non-carcinogenic exposures. These risk estimates slightly exceed EPA's target risk range. Capping the eastern portion of the landfill, maintaining the enhanced cover system, 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 reduce infiltration of precipitation into the landfill, thereby reducing contaminant leaching from the landfill materials to the underlying groundwater and facilitating natural attenuation of groundwater contamination. Reducing leaching of contaminants from the landfill into the underlying groundwater would eventually result in reduced risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through physical, chemical, and biological (VOCs only) mechanisms.

The groundwater underlying Site 5 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 the Base, 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 landfilled materials may pose health risks to human and ecological receptors. The existing risks are expected to be greatest in the eastern portion of the landfill which has sparse vegetation and thin cover in some areas. The western portion of the landfill, which is covered by an approximately 1.5 to 3 feet thick soil layer, vegetated with pine trees and grasses, is expected to be sufficient to prevent direct contact exposure.

Capping the Site 5 landfill 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 existing and new cover systems would be required to ensure

their long-term protectiveness. With proper maintenance, the cover system would effectively provide long-term protection of human health and the environment.

The periodic monitoring and assessment of groundwater would allow the responsible agency to monitor the quality of groundwater beneath and leaving the site 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 and whether groundwater is naturally attenuating. These reviews would be based in large part on analytical data collected during periodic 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 are readily available and can be replaced. In the event of damage to the cap system, repairs would likely be performed without many difficulties. 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, institutional controls and monitoring would provide adequate short-term protection of human health until the cover system was 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 further reduced by placement of the low permeability cover system over the eastern portion of the landfill.

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 vehicular 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 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 enhanced cap system. Erosion control measures such as hay bales and silt fences would be 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 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.

The criterion of availability of treatment technologies, TSD facilities, and capacity is not applicable.

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

Cost

The capital costs for Alternative 3 total $588,000. The average annual O&M costs are $18,600, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $852,000 (at a 7 percent discount rate).

4.2.3 Comparative Analysis of Site 5 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 two alternatives are compared with respect to each of the evaluation criteria and differences are identified. Table 4-2 presents summaries of the evaluations for each alternative.

Overall Protection of Human Health and the Environment

Only Alternative 3 would be protective of human health and the environment. Because no actions are conducted, Alternative 1 would not reduce human health or ecological risk and would not reduce contaminant migration to the environment. Health risks and adverse impacts to the environment are expected to remain the same or increase over time.

Alternative 3 is protective of human health and the environment. The enhanced cover system would reduce human health and ecological risks posed by contact with landfilled materials and would reduce leaching of contaminants to groundwater, thereby reducing contaminant migration into the environment and facilitating natural attenuation of groundwater contamination. 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 Alternative 1 does not include any remedial actions, it 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 an enhanced cover system would be installed and a long-term maintenance and repair program would be implemented.

Both alternatives would comply with federal and state long-term monitoring requirements through the annual monitoring and evaluation of groundwater.

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

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT		
Prevent Human Exposure to Contaminated Landfill Soils and Materials	No action taken to prevent human exposure to landfilled materials. Existing risks would remain. Continued deterioration of the landfill surface, particularly the eastern portion, would expose more landfilled materials and result in increased direct exposure risks.	New cover system over eastern 1 acre of landfill and would prevent direct contact with contaminated materials. Existing soil/vegetative cover over western portion of landfill would limit direct contact with contaminated materials. Current direct contact risks were not quantified, but it is conservatively assumed that landfilled materials may pose excess health risk. Excess risks would be reduced by installing the new cap and maintaining the new and existing caps.
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 for drinking water.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. The enhanced cover system would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.
Minimize Contaminant Migration to Groundwater	No actions taken to reduce contaminant leaching to groundwater. Contaminants would continue to leach into groundwater and migrate downgradient, potentially affecting downgradient receptors.	The enhanced 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 4-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	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 by natural attenuation. A classification exception area (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.
Action-Specific ARARs	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 1.3×10^{-4} ECR and HI = 5.2 non-carcinogenic risks from exposure to site groundwater. Increased risk anticipated over time as landfill surface deteriorates, especially on eastern portion of landfill.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Installation of the new cap, maintenance of the new and existing caps, and implementation of access restrictions to prevent intrusion into contaminated materials would reduce direct exposure risks.
Adequacy and Reliability of Controls	No new controls implemented. Existing site features provide limited controls.	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.

TABLE 4-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Need for 5-Year Review	Review would be required since soil and groundwater contaminants would be left in place.	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.	Groundwater contamination eventually eliminated by natural attenuation.
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.
Worker Protection	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during cap construction and long-term monitoring.
Environmental Impacts	No adverse impacts to the environment anticipated.	No significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.
Time Until Action is Complete	Not applicable.	14 months until enhanced cap is in place. Natural attenuation will likely take longer.
IMPLEMENTABILITY		
Ability to Construct and Operate	No construction or operation involved.	No difficulties anticipated. Capping is a readily implementable technology.
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	If additional actions are warranted in the eastern portion of the landfill, the single barrier cover system may need to be opened to access contaminated materials within. Additional actions would be easily implemented in the western portion of the landfill.

TABLE 4-2
SITE 5 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 3: CAPPING, INSTITUTIONAL CONTROLS, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Ability to Monitor Effectiveness	Monitoring would provide assessment of potential exposures, contaminant presence, migration, or changes in site conditions.	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.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	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 construct cap and perform long-term maintenance, monitoring, and 5-year reviews.
Availability of Technology	Not required.	Common construction techniques and materials required for cap construction.
COST		
Capital Cost	$0	$588,000
First-Year Annual O&M Cost	$15,800	$18,600
Present Worth Cost*	$230,000	$852,000

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

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

Long-Term Effectiveness and Permanence

Alternative 3 is the only alternative that offers long-term protection of human health and the environment. Because no additional actions would be taken under Alternative 1 to contain wastes and limit deterioration of the landfill surface, risks would increase over time as the landfill surface erodes. 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.

Alternative 3 would reduce human and ecological risks due to direct exposure to landfilled materials by eliminating the potential for exposure. Long-term risks due to ingestion of site groundwater would be reduced by reducing contaminant leaching into groundwater and natural attenuation of groundwater contaminants, and by implementing institutional controls to prohibit use of untreated, contaminated groundwater.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Because neither of the alternatives includes treatment, neither would reduce the toxicity, mobility, or volume through treatment. Alternative 3 would reduce the mobility of landfill contaminants by reducing precipitation infiltration into the eastern portion of the landfill.

Short-Term Effectiveness

The short-term effectiveness of the two 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 3 would present a greater opportunity for short-term impact due to site preparation, grading, and constructing the cover system.

Impacts to the environment are not anticipated under Alternatives 1 since minimal activities would be implemented. Impacts to the environment would be minimized by implementing erosion and storm water control measures during cap construction under Alternative 3.

Alternative 1 would not achieve any of the RAOs. Alternative 3 would achieve all RAOs within approximately 2.5 years, requiring approximately 1.5 years for design and installation of the cover system, and an additional year to implement the CEA.

Implementability

Each of the alternatives would be implementable. Alternative 1 is the most easily implemented since the only activities proposed are long-term monitoring and five-year reviews. Alternative 3 would be more difficult to implement since it involves the construction of a cover system over several acres of land; however, no difficulties are anticipated, as covers are a commonly applied technology involving conventional construction methods and cover materials are available from several vendors.

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

Cost

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

4.3 INDIVIDUAL ANALYSIS OF SITE 19 ALTERNATIVES

Detailed evaluations of the three Site 19 remedial alternatives retained for further evaluation are presented in this section. Detailed cost estimates and assumptions for each alternative are presented in Appendix A.

4.3.1 Site 19 - Alternative 1: No-Action

The No Action-Alternative for Site 19 was developed as a baseline case, as required by the NCP. The only activities conducted under this alternative are annual monitoring to evaluate contaminant migration and a review of site conditions and risks every five 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 soil, sediment, or groundwater and no measures would be implemented to prevent future use of site groundwater. Contaminated soils and groundwater would continue to pose a potential health risk and adversely impact the environment.

The potential human health risks from ingestion, inhalation, and contact with contaminated groundwater would not be reduced under Alternative 1 because it 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), non-carcinogens, and lead (residential child).

Site contaminants would also continue to pose a threat to the wetlands adjacent to the site. Because contaminated soils in the topographic depression would remain uncovered and the overflow pipe that connects the topographic depression with the drainage ditch would remain intact, migration of contaminants from the topographic depression into the wetlands via surface water flow may occur under extreme storm conditions.

Leaving the contaminated soil and sediments in place would also pose potential lead poisoning risk to children exposed to site soils, dust, and groundwater under a future residential scenario. Additionally, the ecological risk assessment indicated that contaminated wetland sediments may pose moderate risk to ecological receptors as a result of chromium, zinc, and lead exposure.

Long-term monitoring of groundwater, surface water, and sediment would make it possible to evaluate site conditions and risks. Frequency of monitoring can be set so that impacts on downgradient receptors may be identified early enough to provide additional protection of human health or the environment.

Compliance with ARARs

Because groundwater beneath Site 19 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 this standard.

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 carcinogenic risk of 3.3 E-04 and potential non-carcinogenic risk (HI) of greater than 3.0 for four 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. Because Alternative 1 would not include any remedial response 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 19 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 the Base (within approximately one mile upgradient of the site). If site land and groundwater usage patterns change in the future, potential residential and industrial users of groundwater would not be protected.

Potential health risks from exposure to lead in site soils, dust, and groundwater were identified using the IEUBK Lead model. The results indicated that 15.5 percent of the children exposed to similar site conditions could have blood-lead levels greater than the EPA guideline of 10 μg/dl; these results exceed the EPA protective guideline of 5 percent of the maximum proportion of individuals. These risks would remain unchanged.

The ecological risk assessment concluded that chromium, zinc, and lead in contaminated wetland sediments may pose moderate risk to ecological receptors. These risks would not be mitigated under the No-Action Alternative because the sediments would remain in place. Because no measures would be taken to prevent surface water outflow from the topographic depression into the drainage ditch, risks to ecological receptors may increase over time as a result of continued migration of contaminated sediments from the depression into the drainage ditch and wetlands.

Under ambient conditions, natural attenuation of the contaminants in site soils, sediment, and groundwater may occur through physical and chemical mechanisms; however, the process is likely to take many years. Five-year reviews would be required to assess whether human health and ecological 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. Current risks would remain unabated.

None of the RAOs would be achieved. Short-term risks to workers conducting long-term monitoring would be mitigated by use of appropriate procedures and PPE.

Implementability

Since no response activities would occur, the No-Action Alternative is readily implementable. The technical feasibility criteria, including constructibility, 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 five-year review processes.

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

Cost

No capital costs are associated with the No Action Alternative. The average annual O&M cost for long-term monitoring is $21,600 and five-year reviews are $15,500 per event. Over a 30-year period, the net present worth cost is $302,000 (at a 7 percent discount rate).

4.3.2 Site 19 - Alternative 4: Excavation, On-Site Solidification, On-Site Disposal, and Long-term Monitoring

Alternative 4 employs soil treatment to limit exposure to hazardous substances and minimize migration of contaminants to groundwater and the adjacent wetlands. Contaminated sediments and soils from the drainage ditch and topographic depression would be excavated and treated by solidification to immobilize metals. Treated soils would be redeposited in the topographic depression and the depression would be backfilled to grade and closed with an asphalt cover to form a treated-soil containment cell. Contaminants in site groundwater would naturally attenuate over time through precipitation, absorption, dilution, and dispersion after leaching of contaminants from site soils and sediments is abated. Institutional controls would be enacted to limit future uses of the site that may result in intrusion into the treated-soil cell and prohibit the use of untreated groundwater for drinking water. Long-term, periodic monitoring of groundwater would be conducted to assess contaminant status and potential threats to human health and the environment. Site conditions and risks would be reviewed every five years since wastes are left on site. Key components of Alternative 4 are identified on Table 3-5.

Overall Protection of Human Health and the Environment

Alternative 4 would provide overall protection of human health and the environment by preventing direct exposure to contaminated soil and sediments, minimizing contaminant migration from site soils into groundwater and the adjacent wetlands, and instituting restrictions on the use of site groundwater.

The potential human health and ecological risks resulting from direct exposure to contaminants in site soils and sediments would be reduced to acceptable levels through excavation, treatment, and on-site containment of all contaminated soils and sediments. Treating and containing site soils and sediments will minimize the potential for direct human or ecological exposure and will thereby minimize excess risks. Treatment and containment of soils and sediments will also provide long term protection of the environment by reducing migration of contaminants to groundwater and the wetlands adjacent to the site.

The potential human health risks from ingestion, inhalation, and contact with contaminated groundwater would be reduced to acceptable levels under Alternative 4 through natural attenuation of groundwater contamination and implementation of institutional controls. Immobilization of contaminants in site soils and sediments will significantly reduce additional leaching of contaminants to the underlying groundwater. Eliminating the source of groundwater contamination will eventually result in a permanent reduction in human health risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through precipitation, absorption, dilution, and dispersion. The groundwater underlying Site 19 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 the Base (within approximately 1 mile upgradient of the site). If site land and groundwater usage changes in the future, implementation of institutional controls (access restrictions and CEA) to prohibit use of untreated site groundwater for drinking water will provide protection of human health in the interim, until GWQS are achieved.

Solidification and on-site containment of soils is expected to provide permanent protection from direct contact exposures. Access restrictions would provide additional assurance of long-term protection by restricting activities that could intrude into the treated soils. Solidification is potentially permanent in preventing metals leaching; however, long-term periodic monitoring of groundwater would be required to monitor its effectiveness.

The long-term monitoring program would allow the responsible agency to monitor the quality of groundwater leaving the site, evaluate the long-term effectiveness and reliability of solidification, and natural attenuation, assess potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary to protect human health or the environment.

Use of engineering controls to minimize generation of fugitive dusts and migration of suspended contaminants in surface water, 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 4 would comply with all ARARs identified in Tables 2-1 through 2-6.

Because Alternative 4 does not include active treatment of groundwater, initially, the groundwater beneath Site 19 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, solidification treatment of the contaminated soils and sediments would immobilize the metals, preventing further migration of contaminants into groundwater and facilitating natural attenuation of contaminants. Alternative 4 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQC are achieved through natural attenuation. 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 remediation on wetlands, floodplains, water bodies, and other sensitive receptors would be identified during the design of Alternative 4 and all necessary measures would be taken to comply with the federal and state location-specific ARARs identified in Tables 2-3 and 2-4. For example, to comply with federal and state wetlands protection rules [40 CFR 6, App. A & N.J.A.C. 7:7A] use of engineering controls would be required during excavation of drainage ditch sediments to minimize harm to the adjacent wetlands. The on-site treatment facility would be sited outside the 100-year floodplain in accordance with federal and state hazardous waste facility siting criteria [40 CFR 264.18(a) and N.J.A.C. 7:26-13]. It is expected that Alternative 4 would easily comply with all identified location-specific ARARs.

If excavated soils and sediments are determined to be hazardous wastes, the on-site treatment facility proposed under Alternative 4 would be constructed and operated in accordance with federal and state hazardous waste facility regulations [40 CFR 265 Subparts B, C, D, E; 40 CFR 264 Subpart X; and N.J.A.C. 7:26-9]. These regulations identify general facility requirements, groundwater monitoring, preparedness and prevention, contingency and emergency procedures, and recordkeeping requirements. Treatment would also be conducted in compliance with state treatment regulations [N.J.A.C. 7:26-11.7] which detail operating requirements, waste analyses and monitoring of treatment conditions, and handling and compatibility of wastes in chemical, physical, and biological treatment processes.

Alternative 4 would be implemented in compliance with RCRA Land Disposal Restrictions [40 CFR 268]. Only treated wastes that meet the LDR requirements would be disposed on-site.

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

Long-Term Effectiveness and Permanence

Alternative 4 would provide long term protection of human health and the environment and would result in permanent reduction in all identified health risks.

The risk assessment concluded that under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential carcinogenic risk of 3.3 E-04 and potential non-carcinogenic risk (HI) of greater than 3.0 for four 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. These risks would be reduced under Alternative 4 through natural attenuation of groundwater contamination and implementation of institutional controls. Solidification treatment of source area soils and sediments will immobilize the metals and prevent additional leaching of metals to the underlying groundwater. Eliminating the groundwater contaminant source will eventually result in a permanent reduction in human health risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through precipitation, absorption, dilution, and dispersion. The groundwater underlying Site 19 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 the Base (within approximately one mile upgradient of the site). If site land and groundwater usage changes in the future, implementation of institutional controls (access restrictions and CEA designation) to prohibit use of untreated site groundwater for drinking water will provide protection of human health in the interim, until GWQS are achieved.

Potential health risks from exposure to lead in site soils, dust, and groundwater were identified using the IEUBK lead model. The results indicated that 15.5 percent of the children exposed to similar site conditions could have blood-lead levels greater than 10 μg/dl these results exceed the EPA protective guideline of 5 percent of the maximum proportion of individuals. Treatment and on-site containment of contaminated soil and sediment and imposition of institutional controls that prohibit use of untreated groundwater would eliminate the potential for direct exposure to lead contaminated media and effectively eliminate excess health risk posed by lead-contaminated soil, sediment, and groundwater.

The ecological risk assessment concluded that chromium, zinc, and lead in contaminated wetland sediments may pose moderate risk to ecological receptors. These risks would be mitigated under Alternative 4 through

removal and treatment of contaminated drainage ditch sediments and immobilization of contaminants in source area soils to prevent redeposition of contaminants via surface water outflow.

Solidification is a reliable technology for long-term immobilization of metals in soils and sediments. Combined with backfilling and containment, solidification is expected to provide permanent protection from direct contact exposures. Access restrictions would provide additional assurance of long-term protection by restricting activities that could intrude into the treated soils. Solidification is a potentially permanent method for immobilization of metals; however, long-term periodic monitoring of groundwater would be required to evaluate its effectiveness.

The long-term monitoring program would allow the responsible agency to monitor the quality of groundwater leaving the Site, evaluate the long-term effectiveness and reliability of solidification, assess potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary to protect human health or the environment.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Implementation of Alternative 4 would reduce the mobility of contaminants in soil and sediments through treatment by solidification. Metals in site soils and sediments would be effectively immobilized through treatment. No reduction in toxicity or volume of soil and sediment contamination would be achieved. Alternative 4 would reduce the toxicity mobility, and volume of groundwater contaminants via natural attenuation.

Short-Term Effectiveness

Implementation of Alternative 4 is not expected to pose any significant risks to the Base personnel, the local community, site workers, or the environment.

During site preparation, excavation, and treatment of contaminated soils and sediments, short-term risks posed to Base personnel, site workers, and the environment would be mitigated through use of engineering controls and appropriate PPE. Adverse impacts 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 4 would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated soils/sediments and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

Erosion control measures such as hay bales and silt fences would be would be used to prevent damage to the environment from sediment suspension and migration during excavation of drainage ditch sediments. No permanent adverse impacts to the human health or the environment are anticipated to result from implementation of Alternative 4.

Alternative 4 soil and sediment remediation would require approximately 8 months to implement, including pre-design and design activities. Upon completion of soil and sediment treatment, Alternative 4 would achieve the RAO for protection of human health by preventing exposure to contaminated soils and the RAO for minimizing migration of contaminants to groundwater and the adjacent wetlands. The RAO for protection of human health by preventing exposure to contaminated groundwater will be achieved in the short item access restrictions are implemented and the groundwater CEA is established; these activities may take up to a year.

Implementability

Alternative 4 is implementable. There are no anticipated difficulties or uncertainties in excavating or treating contaminated soil and sediment, or disposing and covering treated materials. Common construction techniques are required for excavation and on-site disposal. Precautions may be required to minimize damage to the wetlands during excavation of drainage ditch sediments.

Solidification is a well demonstrated technology employing relatively common equipment and materials. Several vendors are available that could provide the necessary equipment, materials, and services necessary to treat the volume of materials at Site 19.

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.

Contaminant migration and exposure pathways can be adequately assessed during implementation of Alternative 4 by monitoring groundwater quality. Long-term periodic monitoring of groundwater would be effective for detecting changes in media quality that may indicate failure of the solidification treatment (leaching of contaminants from the treated soils) and for identifying potential impacts to downgradient receptors.

Permits would not be required under Alternative 4 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, excavation, treatment, disposal, and long-term monitoring. Regulatory personnel and environmental specialists are readily available to perform five-year reviews.

Cost

The capital costs for Alternative 4 total $491,000. The average annual O&M costs are $21,600, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $793,000 (at a 7 percent discount rate).

4.3.3 Site 19 - Alternative 5: Excavation and Disposal

This alternative would constitute closure of Site 19. All contaminated soils and sediments in excess of selected clean-up goals would be excavated and sent off site for disposal. Contaminants in site groundwater would naturally attenuate over time through precipitation, absorption, dilution, and dispersion after contaminated soils and sediments are removed. Institutional controls would be temporarily enacted to prohibit the use of untreated groundwater for drinking water until GWQS are met. Long-term, periodic monitoring of groundwater would be conducted to assess contaminant status and potential threats to human health and the environment. Site conditions and risks would be reviewed every five years since wastes are left in place. Key components of Alternative 5 are identified on Table 3-5, the two disposal options are described below.

A. Off-Base Disposal: Under this option, excavated soils would be transported off-base to an appropriate hazardous or industrial waste-type landfill. TCLP testing of soils would be necessary to determine the appropriate disposal facility. If necessary, off-site treatment of the soils will be conducted to immobilize metals prior to disposal.

B. Disposal in On-Base Landfill: If Capping is the selected remedial alternative for the Site 4 landfill, the excavated soils from Site 19 could be consolidated in their existing landfills prior to capping. While this option would not result in the soils leaving the Base, it would allow clean closure of Site 19 without significantly altering the remedial action at Site 4.

Overall Protection of Human Health and the Environment

Alternatives 5A and 5B

Alternatives 5A and 5B would provide overall protection of human health and the environment by eliminating the potential for direct exposure to contaminated soil and sediments, preventing contaminant migration from site soils into groundwater and the adjacent wetlands, and instituting restrictions on use of site groundwater.

The potential human health and ecological risks resulting from direct exposure to contaminants in site soils and sediments would be reduced to acceptable levels through excavation and off site disposal of all contaminated soils and sediments. Removal of site soils and sediments will eliminate the potential for direct human or ecological exposure, thereby eliminating excess risks, and will also provide long term protection of the environment by stopping migration of contaminants to groundwater and the wetlands adjacent to the site.

The potential human health risks from ingestion, inhalation, and contact with contaminated groundwater would be reduced to acceptable levels under Alternatives 5A and 5B through implementation of institutional controls. Removal of contaminated site soils and sediments will prevent additional leaching of contaminants to the underlying groundwater. Eliminating the source of groundwater contamination will eventually result in a permanent reduction in human health risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through precipitation, absorption, dilution and dispersion. The groundwater underlying Site 19 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 the Base (within approximately 1 mile upgradient of the site). If site land and groundwater usage changes in the future, implementation of institutional controls (access restrictions and CEA designation) to prohibit use of untreated site groundwater for drinking water will provide protection of human health in the interim, until GWQS are achieved.

Removal of contaminated soils and sediments will provide permanent protection from direct contact exposures and will permanently prevent leaching of contaminants to the groundwater underlying Site 19.

Long-term groundwater monitoring will allow the responsible agency to assess the progress of natural attenuation of groundwater contamination and evaluate potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary to protect human health or the environment.

Use of engineering controls to minimize generation of fugitive dusts and migration of suspended contaminants in surface water, 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

Alternatives 5A and 5B

Implementation of Alternatives 5A and 5B would comply with all ARARs identified in Tables 2-1 through 2-6.

Because active treatment of groundwater would not be conducted, initially, the groundwater beneath Site 19 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6].

However, excavation and removal of the contaminated soils and sediments in the topographic depression and drainage ditch would prevent further migration of contaminants into groundwater and facilitate natural attenuation of contaminants. Ultimately, natural attenuation would result in attainment of groundwater quality criteria (GWQC). Alternatives 5A and 5B include a provision to seek a temporary exemption (CEA) from these requirements until the GWQC are achieved through natural attenuation. 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 remediation on wetlands, floodplains, water bodies, and other sensitive receptors would be identified during the design of Alternatives 5A and 5B and all necessary measures would be taken to comply with the federal and state location-specific ARARs identified in Tables 2-3 and 2-4. For example, to comply with federal and state wetlands protection rules [40 CFR 6, App. A and N.J.A.C. 7:7A] use of engineering controls would be required during excavation of drainage ditch sediments to minimize harm to the adjacent wetlands. It is expected that Alternatives 5A and 5B would easily comply with all identified location-specific ARARs.

If excavated soils and sediments are determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 5A, if it is determined that soils and sediments are subject to RCRA Land Disposal Restrictions [40 CFR 268], soils would be treated off-site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed off-site at a RCRA Subtitle C facility.

Under Alternative 5B, only wastes that pass the RCRA characteristics tests (40 CFR 261) would be disposed at the existing on-base landfill. Any other wastes subject would be disposed off-site at a RCRA Subtitle C facility.

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

Long-Term Effectiveness and Permanence

Alternatives 5A and 5B

Alternatives 5A and 5B would provide long term protection of human health and the environment and would result in permanent reduction in all identified health risks.

The risk assessment concluded that under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential carcinogenic risk of 3.3 E-04 and potential non-carcinogenic risk (HI) of greater than 3.0 for four 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. These risks would be reduced under Alternatives 5A and 5B through natural attenuation of groundwater contamination and implementation of institutional controls. Removal of source area soils and sediments will prevent additional leaching of metals to the underlying groundwater. Eliminating the groundwater contaminant source will eventually result in a permanent reduction in human health risk as groundwater contaminant concentrations decrease to acceptable levels (GWQSs) through precipitation, absorption, dilution, and dispersion. The groundwater underlying Site 19 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 the base (within approximately one mile upgradient of the site). If site land and groundwater usage changes in the future, implementation of institutional controls (access restrictions and CEA designation) to prohibit use of untreated site groundwater for drinking water will provide protection of human health in the interim, until GWQS are achieved.

Potential health risks from exposure to lead in site soils, dust, and groundwater were identified using the IEUBK lead model. The results indicated that 15.5 percent of the children exposed to similar site conditions could have blood-lead levels greater than 10 μg/dl these results exceed the EPA protective guideline of 5 percent of the maximum proportion of individuals. Removal of contaminated soil and sediment and imposition of institutional controls that prohibit use of untreated groundwater would eliminate the potential for direct exposure to lead contaminated media and effectively eliminate excess health risk posed by lead-contaminated soil, sediment, and groundwater.

The ecological risk assessment concluded that chromium, zinc, and lead in contaminated wetland sediments may pose moderate risk to ecological receptors. These risks would be mitigated under Alternatives 5A and 5B through removal of contaminated drainage ditch sediments and removal of source area soils to prevent redeposition of contaminants via surface water outflow.

Long-term groundwater monitoring will allow the responsible agency to assess the progress of natural attenuation of groundwater contamination, evaluate potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary to protect human health or the environment.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 5A and 5B

Alternatives 5A and 5B would not reduce the toxicity, mobility, or volume of soil/sediment contaminants through treatment since no treatment would be conducted. The mobility of contaminants in the environment would be reduced only by placement of contaminated soil and sediment in a controlled landfill. Groundwater contaminants toxicity, mobility, and volume would be reduced by natural attenuation.

Short-Term Effectiveness

Alternative 5A

Implementation of Alternative 5A is not expected to pose any significant risks to the Base personnel, the local community, workers, or the environment.

During excavation of contaminated soils and sediments, short-term risks posed to Base personnel, site workers, and the environment would be mitigated through use of engineering controls and appropriate PPE. Adverse impacts 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 5A would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated soils/sediments, contaminant-laden dusts, and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

Erosion control measures such as hay bales and silt fences would be would be used to prevent damage to the environment from sediment suspension and migration during excavation of drainage ditch sediments. No permanent adverse impacts to the human health or the environment are anticipated to result from implementation of Alternative 5A.

Somewhat increased truck and heavy equipment vehicular traffic would occur for a short time as the result of excavation and off-base transport of contaminated soils/sediments. Coordination, routing, and scheduling of truck and heavy equipment traffic on public roads would be required to manage increased vehicular activity. Equipment such as covered trucks would be used (excavation and disposal of soil and sediments) to minimize spills and migration of contaminants during transport.

Alternative 5A, would require approximately 2.5 months to implement, including TCLP analysis of soils to determine the appropriate disposal facility. Upon completion of soil and sediment removal, Alternative 5A would achieve the RAO for protection of human health by preventing exposure to contaminated soils and the RAO for minimizing migration of contaminants to groundwater and the adjacent wetlands. The RAO for

protection of human health by preventing exposure to contaminated groundwater will be achieved in the short-term when access restrictions are implemented and the groundwater CEA is established (these activities may take up to a year); and in the long term by natural attenuation of groundwater contaminants.

Alternative 5B

The short-term effectiveness of Alternative 5B would be nearly identical to that of Alternative 5A. The only differences would be in transportation impacts and time to achieve RAOs.

Because Alternative 5B would involve disposal of contaminated soils and sediments on-base at Site 4, any impacts to the local community resulting from transportation of contaminated materials off-base would be eliminated. Any short-term impacts or inconvenience to local residents resulting from additional truck traffic on local roads would be minimal.

Somewhat increased truck and heavy equipment vehicular traffic on-base would occur for a short time as the result of excavation and on-base transport of contaminated materials to Site 4. The transportation impacts to the Base personnel and residents would be minimized by coordination, routing, and scheduling of truck traffic and use of equipment such as covered trucks to minimize spills and migration of contaminants during transport.

Alternative 5B may take somewhat longer to implement than Alternative 5A due to additional start-up time required for design of the landfill cap for Site 4 and preparation of the landfill for capping. These activities would require approximately 11 months to complete. Once excavation of Site 19 soils and sediments commences, it would require less than one month to complete. Upon completion of soil and sediment removal, Alternative 5B would achieve the RAO for protection of human health by preventing exposure to contaminated soils and the RAO for minimizing migration of contaminants to groundwater and the adjacent wetlands. The RAO for protection of human health by preventing exposure to contaminated groundwater will be achieved in the short term when access restrictions are implemented and the groundwater CEA is established (these activities may take up to a year).

Implementability

Alternative 5A

Alternative 5A is implementable. There are no anticipated difficulties or uncertainties in excavating or disposing of contaminated soil and sediment. Common construction techniques and equipment are required for excavation and off-base transport. Precautions may be required to minimize damage to the wetlands during excavation of drainage ditch sediments.

Sufficient commercial landfill capacity is available to handle the small volume (approximately 260 cubic yards) of contaminated materials that would require off-base disposal.

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.

Contaminant migration and exposure pathways can be adequately assessed during implementation of Alternative 5A by monitoring groundwater quality. Long-term monitoring of groundwater would be effective for monitoring the progress of natural attenuation and identifying potential impacts to downgradient receptors.

Permits (manifests) would be required and obtainable for off-base transportation and disposal of contaminated materials.

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

Alternative 5B

The implement ability of Alternative 5B would be nearly identical to that of Alternative 5A. The only differences would be that no off-base disposal capacity and no permits for off-base transportation or disposal would be required.

Sufficient area exists at the Site 4, landfill to accommodate the small volume of materials from Site 19 (approximately 260 cubic yards) without significantly altering the cap design or material requirements. The 260 cy of soils would cover 1 acre of land with a thickness of approximately 2 inches. The material from Site 19 could be used as subgrade in areas where the elevation needs to be raised to achieve the proper base grades.

Cost

Alternative 5A

The capital costs for Alternative 5A total $375,000. The average annual O&M costs are $21,600, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $677,000 (at a 7 percent discount rate).

Alternative 5B

The capital costs for Alternative 5B total $153,000. The average annual O&M costs are $21,600, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $455,000 (at a 7 percent discount rate).

4.3.4 Comparative Analysis of Site 19 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 two alternatives are compared with respect to each of the evaluation criteria and differences are identified. Table 4-3 presents summaries of the evaluations for each alternative.

Overall Protection of Human Health and the Environment

Alternatives 4 and 5 would be protective of human health and the environment. Because no actions are conducted, Alternative 1 would not reduce human health or ecological risk and would not reduce contaminant migration to the environment. Health risks and adverse impacts to the environment are expected to increase over time as the landfill surface deteriorates.

Alternatives 4 and 5 are similarly protective of human health and the environment. Both alternatives eliminate the potential for direct contact with contaminated materials. By reducing or preventing leaching of contaminants from site soils and sediments, both alternatives minimize contaminant migration into the environment and facilitate natural attenuation of groundwater contamination.

By excavating and transporting contaminated materials off-site, Alternative 5A results in permanent protection of health and the environment at Site 19. However, because the soils and sediments are not treated, the potential long-term risks and long-term monitoring considerations are transferred to another location: to an off-base landfill under Alternative 5A and to an on-base landfill under Alternative 5B.

In contrast, Alternative 4 incorporates treatment that immobilizes contaminants. The solidification technology has been widely demonstrated and would be expected to provide long-term protection, but monitoring would be required to ensure the continued effectiveness and permanence of this Alternative.

Both Alternatives 4 and 5 include institutional controls that would provide assurance that untreated contaminated groundwater is not used as a potable water source in the future; Alternative 1 would not include any institutional controls to protect future users of site groundwater.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT			
Prevent Human Exposure to Contaminated Soils.	No action taken to prevent human exposure to contaminated soils and sediments.	Excavation, treatment, and on-site disposal would prevent direct contact with contaminated materials.	Excavation and off-site disposal would prevent direct contact with contaminated materials.
Prevent Human Exposure to Contaminated 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 for drinking water.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. Excavation and solidification of soils would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use. Excavation and off-site disposal of soils would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.
Minimize Contaminant Migration to Groundwater and Adjacent Wetlands	No actions taken to reduce contaminant migration to groundwater or wetlands. Contaminants would continue to leach into groundwater and migrate into wetlands via surface runoff.	Excavation and solidification of contaminated soils would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.	Excavation and removal of contaminated soils would reduce leaching of contaminants to groundwater and would reduce migration of contaminants to the environment by surface water and wind erosion.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, 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 by natural attenuation. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration. Alternative 4 would be implemented in compliance with RCRA Land Disposal Restrictions.	Same as Alternative 4.
Location-Specific ARARs	Not Applicable.	Would comply with federal and state ARARs for wetlands, floodplains, and other sensitive receptors.	Same as Alternative 4.
Action-Specific ARARs	Not Applicable.	If soils and sediments are determined to be hazardous, Alternative 4 would comply with federal and state ARARs for siting and operation of hazardous waste treatment facilities.	If soils and sediments are determined to be hazardous, Alternative 5 would comply with federal and state ARARs for transport/disposal of hazardous waste.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
LONG-TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of Residual Risk	Existing risks would remain: Approximately 3.3 x 10^{-4} ECR and HI = 3.0 non-carcinogenic risks from exposure to site groundwater; Risks exceeding EPA's protective guideline for exposure to lead in soil, dust, and groundwater (estimated 15.5 percent children exposed may have blood lead levels >10μg/l vs guideline of maximum 5 percent).	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1 x 10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Excavation, treatment, and on-site containment of contaminated soils and sediments would reduce direct exposure risks to acceptable levels for lead exposure.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1 x 10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks. Excavation and off-site disposal of contaminated soils and sediments would reduce direct exposure risks to acceptable levels for lead exposure.
Adequacy and Reliability of Controls	No new controls implemented.	Solidification is a widely demonstrated, reliable technology for immobilization of metals in soils and sediments. Combined with on-site containment, solidification is expected to provide permanent protection from direct contact exposures and long-term reduction in contaminant leaching to groundwater.	Because contaminated soils and sediments would be removed, no controls would be necessary for preventing exposure and reducing contaminant migration to the environment. If implemented and enforced, institutional controls could prevent 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.	Review would be required since groundwater contaminants would remain, in excess of GWQC.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT			
Treatment Process Used	None.	Solidification/Natural Attenuation	Natural Attenuation
Amount Treated or Destroyed	None.	260 cubic yards of soil/sediment. All of contaminated groundwater.	All of contaminated groundwater.
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	Mobility of metals in soils and sediments reduced through treatment by solidification. Contaminated groundwater treated through natural attenuation.	Contaminated groundwater treated through natural attenuation.
Irreversible Treatment	Not Applicable	Solidification treatment is expected to provide effective long-term immobilization of contaminants. Since contaminants are immobilized, rather than destroyed, treatment may not be irreversible. Contaminatd groundwater irreversibly addressed by natural attenuation.	Contaminatd groundwater irreversibly addressed by natural attenuation.
Statutory Preference for Treatment	No	Yes	Yes
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.	Same as Alternative 4.
Worker Protection	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during remediation and long-term monitoring.	Same as Alternative 4.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
PAGE 5 OF 7

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Environmental Impacts	No adverse impacts to the environment anticipated.	No significant impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.	Same as Alternative 4.
Time Until Action is Complete	Not applicable.	8 months until RAOs for exposure to contaminated soils and sediments achieved. 1 year until RAOs for exposure to site groundwater are achieved.	Alternative 5A: 2.5 months until RAOs for exposure to contaminated soils and sediments achieved. Alternative 5A: 11months until RAOs for exposure to contaminated soils and sediments achieved (including time to prepare Site 4 landfill for acceptance of excavated soils). Both 5A and 5B: 1 year until RAOs for exposure to site groundwater are achieved.
IMPLEMENTABILITY			
Ability to Construct and Operate	No construction or operation involved.	No construction or operational difficulties anticipated. Common construction techniques used for excavation and on-site disposal. Precautions would be taken to minimize damage to wetlands during excavation. Solidification is a well demonstrated technology employing common equipment and materials.	No construction or operational difficulties anticipated. Common construction techniques and equipment used for excavation and off-site disposal. Precautions would be taken to minimize damage to wetlands during excavation.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
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CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	If additional actions are warranted, the solidified materials could be excavated and removed.	Same as Alternative 1.
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. Alt. 5A: manifests would be required for off-site transportation and disposal of contaminated materials.
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	No off-site TSD capacity or services required. Ample availability of companies to provide equipment and services for solidification treatment.	Alt. 5A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 5B: Sufficient area available for disposal of materials at the Site 4 landfill.
Availability of Equipment, Specialists, and Materials	Personnel and equipment available for implementation of long-term monitoring and 5- year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform excavation, treatment, disposal, long-term monitoring, and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform excavation, off-site disposal, long-term monitoring, and 5-year reviews.

TABLE 4-3
SITE 19 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY
PAGE 7 OF 7

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 4: EXCAVATION, ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING	ALTERNATIVE 5*: EXCAVATION, OFF-SITE DISPOSAL, NATURAL ATTENUATION, AND LONG-TERM MONITORING
Availability of Technology	Not required.	Solidification is a well demonstraded technology employing relative common and available equipment and materials. Several vendors are available that could provide the necessary equipment and materials.	Common construction techniques and materials required for excavation and off-site disposal
COST			
Capital Cost	$0	$491,000	Alt. 5A: $375,000 Alt. 5B: $153,000
First-Year Annual O&M Cost	$21,600	$21,600	Alt. 5A: $21,600 Alt. 5B: $21,600
Present Worth Cost**	$302,000,	$793,000	Alt. 5A: $677,000 Alt. 5B: $455,000

Notes:
* Evaluation presented pertains to Alternative 5A (off-base disposal) and Alternative 5B (on-base disposal) unless otherwise noted.
** Present worth cost is based on discount rate of 7%.

Compliance with ARARs

Alternative 1 would not comply with state ARARs for attainment of groundwater quality criteria [N.J.A.C. 7:9-6], or include a provision to seek a temporary exemption.

Implementation of Alternatives 4 and 5 would comply with all ARARs identified in Tables 2-1 through 2-6. Alternatives 4 and 5 would eventually meet GWQC through natural attenuation and both include a provision to seek a temporary exemption (CEA) from these requirements until the GWQC are achieved through natural attenuation. Compliance with location-specific ARARs would be the same under Alternatives 4 and 5. The potential effects on wetlands, floodplains, water bodies, and other sensitive receptors would be identified during the design of each alternative and all necessary measures would be taken to comply with the federal and state location-specific ARARs identified in Tables 2-3 and 2-4.

Alternative 4 would be constructed and operated in accordance with federal and state hazardous waste facility regulations [40 CFR 265 Subparts B, C, D, E; 40 CFR 264 Subpart X; and N.J.A.C. 7:26-9] if excavated soils and sediments are determined to be hazardous wastes.

Alternative 5 would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7] if excavated soils and sediments are determined to be hazardous wastes.

Both Alternative 4 and Alternative 5 would be implemented in compliance with RCRA Land Disposal Restrictions [40 CFR 268].

Long-Term Effectiveness and Permanence

Only Alternatives 4 and 5 offer long-term protection of human health and the environment. Since no remedial actions would occur under Alternative 1 to treat, contain, or remove contaminated soils and sediments, the current and future threats to human health and the environment from direct exposure to these media would remain and contaminant migration to groundwater would continue unabated. Because no institutional controls would be implemented to prohibit use of untreated contaminated groundwater, the risk to potential future users of the groundwater would remain unchanged.

Alternatives 4 and 5 would both reduce human and ecological risks due to direct exposure to site contaminants by eliminating the potential for exposure. Alternative 4 would achieve long-term protection by immobilizing contaminants and disposing treated soils in an on-site containment cell. Monitoring would ensure the long-term effectiveness and permanence of treatment. Alternative 5 would achieve long-term protection by excavating and disposing of soils off-site. The action would permanently reduce risks as Site

19, but contaminant mobility in the environment would not be reduced. The requirement for long-term monitoring would be transferred to the disposal location.

Long-term risks due to ingestion of site groundwater would be reduced under Alternatives 4 and 5 by reducing contaminant leaching into groundwater and natural attenuation of groundwater contaminants, and by implementing institutional controls to prohibit use of untreated, contaminated groundwater. Alternative 1 would not include any measures to reduce these risks.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Only Alternative 4 would reduce the mobility of soil/sediment contaminants through treatment. Because neither Alternative 1 or Alternative 5 includes soil/sediment treatment, neither would reduce the toxicity, mobility, or volume through treatment.

Natural attenuation would reduce the toxicity, mobility and volume of contaminated groundwater over time under all three alternatives, although GWQS would be met much faster under Alternatives 4 and 5.

Short-Term Effectiveness

The short-term effectiveness of the three 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, the only on-site action proposed under Alternative 1, would provide little opportunity for short-term impact to the local community or the environment.

Alternatives 4 and 5 would present a greater opportunity for short-term impacts to human health and the environment due to excavation and handling of contaminated soils and sediments. Alternative 5A would present the greatest opportunity for short-term impact, as it is the only alternative that includes off-Base transport of contaminated soils/sediments. In all cases, short-term /risks posed to Base personnel, site workers, and the environment under either alternative would be mitigated through use of engineering controls and appropriate PPE. No permanent adverse impacts to the human health or the environment are anticipated to result from implementation of Alternatives 4 or 5.

Implementability

Each of the alternatives would be implementable. Alternative 1 is the most easily implemented since the only activities proposed are long-term monitoring and five-year reviews.

Alternative 5A and 5B would be the next easiest to implement because it involves only excavation and off-site transport and disposal. There is ample availability of companies with the trained personnel, equipment, and materials to perform excavation, disposal, and long-term monitoring. Sufficient commercial landfill capacity is available to handle the small volume of contaminated materials (approximately 260 cubic yards) that would require off-base disposal under Alternative 5A. Under Alternative 5B, sufficient area exists at the Site 4 landfill to accommodate the small volume of materials from Site 19 without altering the cap design or material requirements.

Alternative 4 would be somewhat more difficult to implement because it would require mobilization and operation of an on-site treatment system. However, solidification is a well demonstrated technology employing relatively common equipment and materials and several vendors are available that could provide the necessary equipment, materials, and services.

If additional actions are warranted, they could be easily implemented under Alternatives 1 and 5. Under Alternative 4, additional actions could be implemented; however, excavation and removal of the solidified materials may be required.

Cost

The costs associated with each alternative are provided in Table 4-3. Alternative 1, No Action, would cost the least to implement and Alternative 4 would cost the most to implement. Alternative 5A costs more to implement than Alternative 5B.

4.4 INDIVIDUAL ANALYSIS OF SITE 26 ALTERNATIVES

Detailed evaluations of the five remedial alternatives retained for further evaluation in Section 3.4.3 are presented in this section. Detailed cost estimates and assumptions for each alternative are presented in Appendix A.

4.4.1 Site 26 - 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 five 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. The process leach tank and associated VOC-contaminated soils 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 for a period of greater than 50 years until contaminant concentrations were reduced to acceptable levels through natural attenuation.

The potential human health risks from ingestion, inhalation, and contact with contaminated groundwater would not be reduced under Alternative 1 because it 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. However, because only infrequent (annual) monitoring is proposed, potentially (although unlikely) impacts on downgradient receptors may not be identified early enough to prevent exposure.

Compliance with ARARs

Because groundwater beneath Site 26 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 carcinogenic risk of 1.7 E-04 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 26 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 the base (within approximately one mile northwest, cross-gradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would not be protected.

Under ambient conditions, natural attenuation of the contaminants in site groundwater would likely occur through physical 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 five-year review processes.

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

Cost

Capital costs associated with the No Action Alternative ($14,100) have been included in the first year O&M cost . The average annual O&M cost for long-term monitoring is $12,720 and five-year reviews are $15,500 per event. Over a 30-year period, the net present worth cost is $204,488 (at a 7 percent discount rate).

4.4.2 Site 26 - Alternative 2: Source Removal Institutional Controls, and Long-Term Monitoring)

Alternative 2 was developed as an option that relies on source removal and institutional controls to limit exposures to hazardous substances. No engineered treatment or containment would be employed to address contaminated groundwater; however, the suspected contaminant source (the process leach tank and associated soils) would be removed to abet natural attenuation of groundwater contamination. Institutional controls would be used to prohibit use of untreated groundwater. Long-term, annual monitoring would be conducted to monitor natural attenuation effectiveness and potential threats to human health and the environment. Site conditions and risks would be reviewed every five years.

Overall Protection of Human Health and the Environment

Alternative 2 would provide protection of human health through suspected source removal, natural attenuation of groundwater contaminants over time, and use of institutional controls to restrict use of untreated contaminated groundwater as drinking water until groundwater criteria are met. The effectiveness of this protection would depend upon adequate enforcement of institutional controls, because no actions would be taken to accelerate cleanup of contaminated groundwater. If groundwater use restrictions were not adequately enforced, health risks would remain for a period of approximately 45 years until contaminant concentrations decreased to acceptable levels through natural attenuation.

Removal of the suspected contaminant source (process leach tank and associated VOC-contaminated soils) would facilitate natural attenuation. Natural attenuation of the groundwater contamination would eventually result in contaminant concentrations decreasing to acceptable levels (GWQS). However, in the interim, contaminated groundwater would continue to migrate at the relatively slow velocity of less than 20 feet per year.

Long-term monitoring of groundwater would make it possible to evaluate site conditions and risks and the effectiveness of the natural attenuation process.

Compliance with ARARs

Implementation of Alternative 2 would comply with all ARARs and TBCs identified in Tables 2-1 through 2-6.

Because Alternative 2 does not include active treatment of groundwater, initially, the groundwater beneath Site 26 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, removal of the process leach tank and associated contaminated soils would reduce migration of contaminants into groundwater, facilitating natural attenuation of contaminants and ultimately resulting in attainment of groundwater quality criteria (GWQC). Alternative 2 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQC are achieved through natural attenuation. 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.

If the excavated process leach tank and/or soils are determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 2A, if it is determined that soils are subject to RCRA Land Disposal Restrictions [40 CFR 268], the source materials would be treated off-site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed of off-site at a RCRA Subtitle C facility.

Under Alternative 2B, only soils that pass the TCLP test and are determined to not be hazardous would be disposed of at the existing on-base landfill.

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

Long-Term Effectiveness and Permanence

Alternative 2 would provide long-term protection of human health and the environment and would result in a permanent reduction in all identified health risks. Protection of human health would be dependent on adequate enforcement of the proposed groundwater use restrictions. In absence of adequate enforcement, the current and future threats to human health from the groundwater would remain until the contaminants

naturally attenuate. Because no actions would be taken to reduce migration of contaminated groundwater, the size of the groundwater plume would initially increase until the contaminants naturally attenuate.

The risk assessment concluded that under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential carcinogenic risk of 1.7 E-04 and potential non-carcinogenic risk (HI) of greater than 1.0 for three target organs at current concentrations. 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. In absence of adequate enforcement of the proposed institutional controls prohibiting use of untreated contaminated groundwater, these risks would remain until groundwater concentrations are reduced to acceptable levels (GWQC) through natural attenuation.

Removal of the suspected contaminant source (process leach tank and associated VOC-contaminated soils) would facilitate natural attenuation of groundwater contamination. Natural attenuation of groundwater contaminants would eventually result in contaminant concentrations decreasing to acceptable levels (GWQS). However, in the interim, contaminated groundwater would continue to migrate at the relatively slow groundwater velocity of less than 20 feet per year.

The groundwater underlying Site 26 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 the base (within approximately one mile to the northwest, cross-gradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would not be protected if institutional controls are not enforced.

Long-term monitoring of groundwater would allow the responsible agency to monitor the effectiveness of natural attenuation, assess potential impacts to downgradient receptors, and determine whether additional remedial actions are necessary.

Five-year reviews would be required to 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 annual monitoring events. Review of the effectiveness of deed restrictions and the CEA in restricting use of contaminated groundwater would also be required.

No difficulties or uncertainties are anticipated in performing the long-term monitoring. Groundwater monitoring wells may require replacement if sedimentation or vandalism occur; the wells would be readily replaceable.

No controls would be used to manage site contaminants under Alternative 2; therefore, the evaluation of the adequacy and reliability of controls is not applicable.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 2 would reduce the toxicity, mobility, or volume of contamination through treatment if the suspected source materials require treatment prior to disposal. Otherwise, no treatment is used to address the contaminated media, other than that which occurs naturally.

Short-Term Effectiveness

Implementation of Alternative 2 is not expected to pose any significant risks to the base personnel, the local community, workers, or the environment. The actions proposed under this alternative are excavation and removal of the process leach tank and associated VOC-contaminated soils, decontamination of the leach tank concrete blocks, and long-term monitoring of groundwater. Any short-term risks posed to base personnel, site workers, and the environment would be mitigated through use of engineering controls and appropriate PPE.

During excavation and removal of contaminated soils and the leach tank, risks posed to base personnel by fugitive dust (bearing adsorbed contaminants) would be minimized by use of appropriate engineering control measures such as dust suppressants. Workers who implement Alternative 2 would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated soils or residue from the leach tank, contaminant-laden dusts, and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

Minimal increased truck and heavy equipment traffic would occur for a short time as the result of excavation and off-base transport of contaminated soils and the tank concrete blocks. Equipment such as truck bed covers would be used to minimize spills and migration of contaminants during transport.

No adverse impacts to the environment are anticipated to result from excavation and off-site disposal of the leach tank and associated soils.

Excavation and off-base disposal (Alt. 2A) of the process leach tank and associated contaminated soils would require approximately three months, including subcontracting and implementation. Because disposal at an on-base landfill could not commence until cap design and site preparation were completed (approximately 11 months), Alternative 2B would take longer to implement than Alternative 2A. From commencement of site activities, Alternative 2B would require approximately three weeks to complete.

Implementing deed restrictions and establishing the groundwater CEA would be the same under Alternatives 2A and 2B, requiring approximately one year. Upon implementation of groundwater use restrictions, Alternative 2 would achieve the RAO for protection of human health by limiting exposure to contaminated groundwater. The RAO for minimizing migration of groundwater contamination to potential receptors would be achieved under this alternative through natural attenuation.

Implementability

Alternative 2A

Alternative 2 is implementable. There are no anticipated difficulties or uncertainties in excavating, cleaning or disposing of the process leach tank concrete blocks or the contaminated soil. Common construction techniques and equipment are required for excavation and off-base transport.

Sufficient commercial landfill capacity is available to handle the roughly estimated small volume of contaminated soils (approximately 24 cubic yards) and decontaminated concrete block (approximately 6 cubic yards) that would require off-base disposal.

Long-term monitoring (sampling and analyses) only requires readily available resources. Incorporating deed restrictions into the Base Master Plan 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.

Contaminant migration and exposure pathways can be adequately assessed during implementation of Alternative 2 by monitoring groundwater quality. Long-term monitoring of groundwater would be effective for monitoring the progress of natural attenuation and identifying potential impacts to downgradient receptors.

Permits (manifests) would be required and obtainable for off-base transportation and disposal of contaminated materials.

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

Alternative 2B

The implementability of Alternative 2B would be nearly identical to that of Alternative 2A. The only differences would be that no off-base disposal capacity and no permits for off-base transportation or disposal would be required.

Sufficient area exists at both on-base landfills to accommodate the roughly estimated small volume of materials from Site 26 (approximately 24 cubic yards of contaminated soil and 6 cubic yards decontaminated concrete block) without significantly altering the cap design or material requirements.

Cost

Alternative 2A

The capital costs for Alternative 2A total $157,000. The average annual O&M costs are $12,700, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $348,000 (at a 7 percent discount rate).

Alternative 2B

The capital costs for Alternative 2B total $140,000. The average annual O&M costs are $12,700, and five-year reviews cost $15,500 per event. Over a 30-year period, the net present worth cost is $331,000 (at a 7 percent discount rate).

4.4.3 Site 26 - Alternative 3: Reactive Wall Treatment (Source Removal, In-Situ Permeable Reactive Wall Groundwater Treatment , Institutional Controls, and Long-Term Monitoring)

Alternative 3 employs suspected source removal, in-situ groundwater treatment, and institutional controls to protect human health and the environment. The suspected contaminant source (the process leach tank and associated VOC contaminated soils) would be removed and the groundwater would be treated in-situ using permeable reactive wall technology. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQS are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every five years until the groundwater remediation is complete.

A principal component of Alternative 3 is in-situ permeable reactive wall groundwater treatment. This technology is innovative, and does not yet have a track record of demonstrated success. Nevertheless, it is believed to be suitable for Site contaminants, and the following analysis assumes its application will prove successful.

Overall Protection of Human Health and the Environment

Alternative 3 would employ suspected source removal, in-situ groundwater treatment and institutional controls to provide long-term protection of human health and the environment. The permeable treatment wall

will act as a passive treatment barrier, which will effectively prevent off-site migration of contaminated groundwater; therefore, upon completion of the treatment wall, downgradient receptors would be protected. The treatment wall would not immediately protect potential receptors of contaminated groundwater beneath Site 26; long-term, permanent protection would be achieved after a treatment duration of approximately 45 years, which is the time predicted by the numerical model, assuming removal of the source (leach tank and associated soils). In the interim, contaminants would be removed both by the treatment wall and natural attenuation.

In the interim period, until remediation goals for site groundwater have been achieved, human health would be protected through use of institutional controls that would restrict use of untreated contaminated groundwater as drinking water. The effectiveness of this interim protection would depend entirely upon adequate enforcement. If groundwater use restrictions were not adequately enforced, existing health risks would remain until groundwater contaminant concentrations decreased to acceptable levels.

The groundwater underlying Site 26 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 the base (within approximately 1 mile crossgradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would be protected by institutional controls until GWQC are achieved.

Removal of the process leach tank and associated VOC-contaminated soils would facilitate elimination of groundwater contamination by eliminating the suspected continuing source of groundwater contaminants.

In-situ, permeable reaction wall treatment of groundwater and natural attenuation would provide permanent long-term protection by irreversibly degrading groundwater contaminants. The proposed institutional controls would provide additional assurance of the long-term protection by restricting use of contaminated groundwater.

Long-term monitoring of groundwater for the duration of the remediation period would make it possible to evaluate site conditions and risks and determine when remedial actions are complete. The proposed quarterly monitoring would allow adequate time to act in the event that additional actions are needed to protect human health or the environment.

Compliance with ARARs

Implementation of Alternative 3 would comply with all ARARs and TBCs identified in Tables 2-1 through 2-6

Initially, and throughout the remediation period, the groundwater beneath Site 26 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, removal of the

process leach tank and associated contaminated soils would reduce migration of contaminants into groundwater, and natural attenuation and the in-situ groundwater treatment system would ultimately result in attainment of groundwater quality criteria (GWQC). Alternative 3 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQC 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.

If the excavated process leach tank and/or soils are determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 3A, if it is determined that soils are subject to RCRA Land Disposal Restrictions [40 CFR 268], soils would be treated off-site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed of off-site at a RCRA Subtitle C facility.

Under Alternative 3B, only soils that pass the TCLP test and are determined to not be hazardous would be disposed of at the existing on-base landfill.

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

Long-Term Effectiveness and Permanence

Alternative 3 would provide long term protection of human health and the environment and would result in permanent reduction in all identified health risks. During cleanup, protection of human health would be dependent on adequate enforcement of the groundwater use restrictions.

The risk assessment concluded that under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential carcinogenic risk of 1.7 E-04 and potential non-carcinogenic risk (HI) of greater than 1.0 for three target organs at current concentrations. 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. Upon completion of Alternative 3, these risks would all be reduced to acceptable levels. In the interim, protection of human health would be dependent on adequate enforcement of the proposed groundwater use restrictions. In absence of adequate enforcement, the current and future threats to human health would remain until remediation goals are attained.

The groundwater underlying Site 26 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 the base (within approximately one mile northwest, cross-gradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would not be protected if institutional controls are not enforced.

Upon installation of the permeable reactive wall, the RAO for protection of the environment would be achieved. Potential impacts to downgradient receptors or the environment would be eliminated since contaminants would be degraded as they pass through the treatment wall, thereby preventing downgradient migration of contaminated groundwater.

Removal of the contaminant source (process leach tank and associated VOC-contaminated soils) would facilitate in-situ treatment and natural attenuation of groundwater contamination by eliminating the continuing source of contaminants.

In-situ, permeable reactive wall treatment of groundwater should provide permanent long-term protection of human health and the environment by irreversibly degrading groundwater contaminants. However, there is some uncertainty about its likely effectiveness because the technology is a new and innovative process that has not been widely demonstrated in large scale, long-term projects. Demonstrations to date have shown that the technology has promise for treating chlorinated VOCs like those present in Site 26 groundwater, but the scientific basis for the technology's effectiveness and the long-term performance characteristics of the system are not well understood. Treatability studies would be required to determine the likely effectiveness of the system.

Process monitoring would be required for the duration of the treatment period to verify the system's continued effectiveness. Process monitoring would include collection and chemical analysis of groundwater within and downgradient of the treatment wall and groundwater elevation monitoring to ensure that the contaminant plume is being effectively channeled through the treatment wall.

Periodic maintenance of the treatment wall may also be required to ensure its long-term effectiveness. A potential long-term concern is the accumulation of inorganic precipitates (such as hydroxides) within the reactive wall. The accumulated solids may clog the wall's pore spaces, adversely affecting the hydraulics of the system or reducing the contact area between groundwater and the reactive metal, thereby slowing the degradation of contaminants. One technology vendor recommends agitation of the reactive wall materials every 5 to 10 years to liberate deposited inorganic precipitates.

If the wall became irreparably clogged and ineffective, the reactive metal fill material would have to be replaced. If the wall failed, and its failure went undetected, the risks to downgradient receptors and the environment would increase as a result of the continued migration of contaminants. However, these risks would be minimized by regular monitoring of the process to reduce the risk of total failure. The proposed institutional controls would provide additional assurance of the long-term protection of human health by restricting use of contaminated groundwater.

Long-term monitoring of groundwater for the duration of the remediation period would allow the responsible agency to monitor the quality of groundwater beneath and leaving the Site, assess potential impacts to downgradient receptors, determine whether additional remedial actions are necessary, and determine when remedial actions are complete. The proposed quarterly monitoring should allow adequate time to act in the event that additional actions or maintenance of the wall are needed to protect human health or the environment.

Five-year reviews would be required for the duration of the groundwater remediation period to 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 quarterly monitoring events. Review of the effectiveness of deed restrictions and the CEA in restricting use of contaminated groundwater would also be required.

No difficulties or uncertainties are anticipated in performing the long-term monitoring. Groundwater monitoring wells may require replacement if sedimentation or vandalism occur; the wells would be readily replaceable.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 3 would reduce the toxicity, mobility, and volume of contamination through in-situ treatment of contaminated groundwater and, possibly, of the suspected source material before disposal. The permeable reactive wall treatment system and natural attenuation should effectively and completely degrade TCE and the other chlorinated VOCs present in site groundwater to meet the remediation goals.

The proposed treatment system would be designed to address the entire groundwater contaminant plume width exceeding PRGs). Approximately 2880 gallons/day (2 gpm) of contaminated groundwater with an average initial concentration of 705 μg/l would be treated by the reactive wall. Approximately 8 grams/day of TCE, the principal contaminant of concern, would be removed on average over the projected 45 year period. VOC removal rates would decrease non-linearly over time as concentrations in the aquifer decline. Natural attenuation would supplement TCE removal by the reactive wall.

Treatment by the permeable reactive wall and natural attenuation would be irreversible, because contaminants are chemically degraded by reduction/oxidation reactions that cause substitution of halogen atoms by hydrogen atoms, forming non-toxic compounds such as ethene and ethane.

No treatment residuals would remain from in-situ reactive wall treatment.

Short-Term Effectiveness

Implementation of Alternative 3 is not expected to pose any significant risks to the base personnel, the local community, workers, or the environment. The actions proposed under this alternative are excavation and removal of the process leach tank and associated VOC-contaminated soils, decontamination of the leach tank concrete blocks, installation of the in-situ treatment wall, and long-term monitoring of groundwater. Any short-term risks posed to base personnel, site workers, and the environment would be mitigated through use of engineering controls and appropriate PPE.

During all excavation activities, risks posed to base personnel by fugitive dust (bearing adsorbed contaminants) would be minimized by use of appropriate engineering control measures such as dust suppressants. Workers who implement Alternative 3 would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated soils or residue from the leach tank, contaminant-laden dusts, and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

Increased truck and heavy equipment vehicular traffic would occur as the result of the import of treatment wall materials and construction of the permeable treatment wall. Coordination and scheduling of truck and heavy equipment traffic on public roads would be required to manage increased vehicular activity. Minimal increased truck and heavy equipment traffic would occur for a short time as the result of excavation and off-base transport of contaminated source area soils and the tank concrete blocks. Equipment such as truck covers would be used to minimize spills and migration of contaminants during transport.

No permanent adverse impacts to the environment are anticipated to result from implementation of Alternative 3. Erosion control measures such as hay bales and silt fences would be would be used to prevent damage to the environment from sediment runoff during reactive wall construction.

Alternative 3 would require approximately 10 months to put in place, including treatability studies, pre-design, and design activities. Upon completion of the treatment wall, Alternative 3 would achieve the RAO for minimizing migration of groundwater contamination. The RAO for protection of human health by preventing exposure to contaminated groundwater would be achieved upon implementation of deed restrictions and

establishment of the groundwater CEA; this may take a year or longer. If the process leach tank and associated soils are disposed of at one of the on-base landfills (Alt. 3B), the implementation period may be extended approximately 2 months for completion of cap design and site preparation.

Implementability

Alternative 3 is implementable. There are no anticipated difficulties or uncertainties in excavating cleaning or disposing of the process leach tank concrete blocks or the contaminated soil. Common construction techniques and equipment are required for excavation and off-base transport. There are no significant difficulties or uncertainties associated with construction of the treatment wall. Construction of the treatment wall involves common construction equipment; however, the techniques used to excavate the trench and construct the permeable wall are somewhat specialized. Treatment wall construction could be conducted by non-specialized construction crews, if instruction and oversight were provided by the technology vendor.

Additional actions can be easily implemented in the future, if warranted.

Contaminant migration and exposure pathways and natural attenuation effectiveness can be adequately assessed during implementation of Alternative 3 by monitoring groundwater quality. Long-term monitoring of groundwater would be effective for monitoring the progress of in-situ groundwater remediation and identifying potential impacts to downgradient receptors.

Permits (manifests) would be required and obtainable for off-base transportation and disposal of contaminated materials from the source area (Alt. 3A). Permits would not be required for on-base disposal or other on-site activities. Coordination with other agencies may be required as part of the long-term monitoring and five-year review processes.

Currently, permeable reactive wall technology is available from only one vendor, but the equipment, materials, and personnel required to implement this system are available from several vendors/companies. The treatment wall vendor conducts treatability studies and provides assistance in design and construction of the treatment wall, but does not provide complete installation service. The materials that comprise the wall are provided by several vendors. Construction crews capable of constructing the treatment wall are readily available. Although the availability of the technology design is limited to one company, this lack of capacity should not prevent implementation.

Sufficient commercial and on-base landfill capacity is available to handle the roughly estimated small volume of materials from the source area (approximately 24 cubic yards contaminated soil and 6 cubic yards of decontaminated concrete block) that would require off-site disposal.

Long-term monitoring (sampling and analyses) only requires readily available resources. Incorporating deed restrictions into the Base Master Plan 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. There is ample availability of companies with the trained personnel, equipment, and materials to perform excavation, disposal, and long-term monitoring. Regulatory personnel and environmental specialists are readily available to perform five-year reviews.

Cost

Alternative 3A

The capital costs for Alternative 3A total $1,637,000. The average annual O&M costs are $60,100 for the first 5 years, and $53,100 thereafter, and five-year reviews cost $28,500 per event. Over a 30-year period, the net present worth cost is $2,386,000 (at a 7 percent discount rate).

Alternative 3B

The capital costs for Alternative 3B total $1,620,000. The average annual O&M costs are $60,100 for the first 5 years and $53,100 thereafter, and five-year reviews cost $28,500 per event. Over a 30-year period, the net present worth cost is $2,369,000 (at a 7 percent discount rate).

4.4.4 Site 26 - Alternative 4: Pump-And-Treat (Source Removal, Groundwater Extraction, Groundwater Treatment by Air Stripping, Institutional Controls, and Long-Term Monitoring)

Alternative 4 employs suspected source removal, groundwater pumping and treatment, and institutional controls to protect human health and the environment. The suspected contaminant source (the process leach tank and associated VOC contaminated soils) would be removed. A groundwater containment system consisting of groundwater extraction wells would be placed near the downgradient edge of the plume, and the groundwater would be extracted and treated above ground by air stripping. Additional groundwater extraction wells would be placed in the vicinity of the high-concentration plume area, also for groundwater pumping and above-ground treatment. Because of the relatively slow groundwater velocity, a significant portion of the groundwater contaminants will naturally attenuate before they are captured by the groundwater extraction system. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQC are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every five years until the groundwater remediation is complete.

Overall Protection of Human Health and the Environment

Alternative 4 would employ suspected source removal, groundwater extraction and treatment and natural attenuation to provide long-term protection of human health and the environment. The groundwater extraction system would be designed to prevent off-site migration of contaminated groundwater; therefore, upon completion of the extraction system, downgradient receptors of contaminated groundwater would be protected. However, potential users of contaminated groundwater beneath Site 26 would not be protected by Alternative 4 until groundwater remediation goals were achieved throughout the plume. It is anticipated that long-term, permanent protection would be achieved after a treatment duration of less than 45 years. During this period, groundwater contaminants would be removed both by the extraction system and through natural attenuation.

In the interim period, until remediation goals for site groundwater have been achieved, human health would be protected through use of institutional controls that would restrict use of untreated contaminated groundwater as drinking water. The effectiveness of this interim protection would depend entirely upon adequate enforcement. If groundwater use restrictions were not adequately enforced, existing health risks would remain until groundwater contaminant concentrations decreased to acceptable levels.

The groundwater underlying Site 26 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 the base (within approximately 1 mile crossgradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would be protected by institutional controls until GWQC are achieved by in-situ treatment.

Removal of the process leach tank and associated VOC-contaminated soils would facilitate remediation of the groundwater contaminant plume by eliminating the suspected continuing source of contaminants.

Extraction and treatment of groundwater provide permanent long-term protection by removing contaminants from site groundwater. The proposed institutional controls would provide additional assurance of the long-term protection by restricting use of contaminated groundwater.

Long-term monitoring of groundwater for the duration of the remediation period would make it possible to evaluate site conditions and risks and determine when remedial actions are complete. The proposed quarterly monitoring would allow adequate time to act in the event that additional actions are needed to protect human health or the environment.

Compliance with ARARs

Implementation of Alternative 4 would comply with all ARARs and TBCs identified in Tables 2-1 through 2-6.

Initially, and throughout the remediation period, the groundwater beneath Site 26 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, removal of the process leach tank and associated contaminated soils would reduce migration of contaminants into groundwater, and operation of the groundwater extraction and treatment system, in conjunction with natural attenuation, would ultimately result in attainment of groundwater quality criteria (GWQC). Alternative 4 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQC 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.

If the excavated process leach tank and/or soils are determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 4A, if it is determined that the source materials are subject to RCRA Land Disposal Restrictions [40 CFR 268], the source materials would be treated off-site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed off-site at a RCRA Subtitle C facility.

Under Alternative 4B, only soils that pass the TCLP test and are determined to not be hazardous would be disposed of at the existing on-base landfill.

The on-site treatment facility proposed under Alternative 4 would be constructed and operated in accordance with federal and state hazardous waste facility regulations [40 CFR 265 Subparts B, C, D, E; 40 CFR 264 Subpart X; and N.J.A.C. 7:26-9]. These regulations identify general facility requirements, groundwater monitoring, preparedness and prevention, contingency and emergency procedures, and recordkeeping requirements. Treatment would also be conducted in compliance with state treatment regulations [N.J.A.C. 7:26-11.7] which detail operating requirements, waste analyses and monitoring of treatment conditions, and handling and compatibility of wastes in chemical, physical, and biological treatment processes.

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

Long-Term Effectiveness and Permanence

Alternative 4 would provide long term protection of human health and the environment and would result in permanent reduction in all identified health risks. During cleanup, protection of human health would be dependent on adequate enforcement of the groundwater use restrictions.

The risk assessment concluded that under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential carcinogenic risk of 1.7 E-04 and potential non-carcinogenic risk (HI) of greater than 1.0 for three target organs at current concentrations. 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. Upon completion of groundwater remediation, these risks would all be reduced to acceptable levels. In the interim, protection of human health would be dependent on adequate enforcement of the proposed groundwater use restrictions. In absence of adequate enforcement, the current and future threats to human health would remain until remediation goals are attained.

The groundwater underlying Site 26 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 the base (within approximately one mile northwest, cross-gradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would not be protected if institutional controls are not enforced.

Upon installation and start-up of the groundwater extraction and treatment system, the RAO for protection of the environment would be achieved. Potential impacts to downgradient receptors or the environment would be eliminated since downgradient migration of contaminated groundwater would be halted by the groundwater extraction system.

Removal of the suspected contaminant source (process leach tank and associated VOC-contaminated soils) would facilitate remediation of groundwater by eliminating the continuing source of contaminants.

The reliability of the pump-and-treat system is expected to be high. Groundwater extraction and ex-situ treatment by air stripping is a widely used, effective technology for remediation of VOC-contaminated groundwater. The process would be easily monitored and maintained. Routine maintenance and replacement of system components could be accomplished with little interruption of system operation and no adverse impact to human health or the environment.

Long-term monitoring of groundwater for the duration of the remediation period would allow the responsible agency to monitor the quality of groundwater beneath the Site, assess potential impacts to downgradient receptors, determine whether additional remedial actions are necessary, and determine when remedial actions are complete. The proposed quarterly monitoring should allow adequate time to act in the event that additional actions are needed to protect human health or the environment.

Five-year reviews would be required for the duration of the groundwater remediation period to 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 quarterly monitoring events. Review of the effectiveness of deed restrictions and the CEA in restricting use of contaminated groundwater would also be required.

No difficulties or uncertainties are anticipated in performing the long-term monitoring. Groundwater monitoring wells may require replacement if sedimentation or vandalism occur; the wells would be readily replaceable.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 4 would reduce the toxicity, mobility, and volume of contamination through extraction and treatment of contaminated groundwater, and possibly, through treatment of the suspected source materials prior to disposal. The treatment system and natural attenuation will remove TCE and the other chlorinated VOCs present in site groundwater to meet the remediation goals.

The proposed groundwater containment system would be designed to address the entire groundwater contaminant plume exceeding PRGs. Approximately 6000 gallons/day (4 gpm) of contaminated groundwater with an average initial concentration of 705 μg/l would be treated by the stripper system. Approximately 16 grams/day of TCE, the principal contaminant of concern, would be removed during the period of treatment. VOC removal rates would decrease non-linearly over time as concentrations in the aquifer decline. Natural attenuation would supplement TCE removal by the pump-and-treat system.

The only air stripping treatment residuals that would remain would be spent carbon from the aqueous phase carbon polishing unit and possibly spent vapor phase carbon from treatment of gaseous emissions from the air stripper. Adsorbed contaminants would be destroyed off site.

Short-Term Effectiveness

Implementation of Alternative 4 is not expected to pose any significant risks to the base personnel, the local community, workers, or the environment. The actions proposed under this alternative are excavation and removal of the process leach tank and associated VOC-contaminated soils, decontamination of the leach tank concrete blocks, installation of the groundwater extraction and treatment systems, and long-term monitoring of groundwater quality and treatment plant operations. Any short-term risks posed to base personnel, site workers, and the environment would be mitigated through use of engineering controls and appropriate PPE.

During all excavation activities, risks posed to base personnel by fugitive dust (bearing adsorbed contaminants) would be minimized by use of appropriate engineering control measures such as dust suppressants. Workers who implement Alternative 4 would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated soils or residue from the leach tank, contaminant-laden dusts, and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

Somewhat increased truck and heavy equipment vehicular traffic would occur as the result of the construction of the groundwater extraction and treatment systems and the excavation and off-base transport of contaminated source area soils and the tank concrete blocks.. Coordination and scheduling of truck and heavy equipment traffic on public roads would be required to manage increased vehicular activity. Equipment such as truck bed covers would be used to minimize spills and migration of contaminants during transport.

No permanent adverse impacts to the environment are anticipated to result from implementation of Alternative 4. Erosion control measures such as hay bales and silt fences would be would be used as necessary to prevent damage to the environment from sediment runoff during construction.

Alternative 4 would require approximately seven months to put in place, including treatability studies, pre-design, and design activities. Upon start-up of the groundwater extraction and treatment systems, Alternative 4 would achieve the RAO for minimizing migration of groundwater contamination. The RAO for protection of human health by preventing exposure to contaminated groundwater would be achieved upon implementation of deed restrictions and establishment of the groundwater CEA; this may take a year or longer. If the process leach tank and associated soils are disposed at one of the on-base landfills (Alt. 4B), the implementation period may be extended approximately 5 months for completion of cap design and site preparation.

Implementability

Alternative 4 is implementable. There are no technical difficulties or uncertainties anticipated in constructing and operating the groundwater extraction and treatment systems or excavating, cleaning, and disposing of the process leach tank concrete blocks and contaminated soil.

The proposed treatment technologies are proven and have been widely used in full-scale application. Common construction techniques and equipment are required for excavation and off-base transport of the leach tank and associated soils.

If warranted, additional actions can be easily implemented in the future while the groundwater treatment system is operating. Contaminant migration and exposure pathways and natural attenuation effectiveness can be adequately assessed during implementation of Alternative 4 by monitoring groundwater quality. Long-term monitoring of groundwater would be effective for monitoring the progress of groundwater remediation and identifying potential impacts to downgradient receptors and the need for additional actions.

Permits (manifests) would be required and obtainable for off-base transportation and disposal of contaminated materials from the source area (Alt. 4A). Permits would not be required for on-base disposal or other on-site activities. Coordination with other agencies may be required as part of the long-term monitoring and five-year review processes.

The proposed low-profile, modular air stripping units are widely available and easily installed. Routine maintenance, including periodic cleaning of the stripping trays, would be easily implemented. Maintenance of the carbon polishing and air treatment systems would require only periodic replacement of spent carbon canisters. Extraction system equipment (pumps, valves, controls) will require periodic service or replacement. Well screens may require periodic cleaning to remove iron and manganese buildup.

Long-term monitoring (sampling and analyses) only requires readily available resources. Incorporating deed restrictions into the Base Master Plan 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.

Many companies exist with the trained personnel, equipment, and materials to design, install, and operate extraction and treatment systems and implement long-term groundwater monitoring. There is ample availability of companies with the trained personnel, equipment, and materials to perform long-term monitoring. Regulatory personnel and environmental specialists are readily available to perform five-year reviews.

Sufficient commercial and on-base landfill capacity is available to handle the roughly estimated small volume of materials from the source area (approximately 24 cubic yards of contaminated soil and 6 cubic yards of decontaminated concrete block) that would require off-site disposal.

Cost

Alternative 4A

The capital costs for Alternative 4A total $588,000. The average annual O&M costs are $215,700, and 5-year reviews cost $15,500 per event. Over a 30-year period, the net present-worth cost is $3,100,000 (at a 7 percent discount rate).

Alternative 4B

The capital costs for Alternative 4B total $605,000. The average annual O&M costs are $214,900, and 5-year reviews cost $15,500 per event. Over a 30-year period, the net present-worth cost is $3,073,000 (at a 7 percent discount rate).

4.4.5 Site 26 - Alternative 5: Air Sparging with Soil Vapor Extraction (Source Removal, Institutional Controls, and Long-Term Monitoring)

Under Alternative 5, the suspected source of groundwater contaminants (the process leach tank and associated VOC-contaminated soils) would be removed for off-site disposal, and the bulk of VOCs present in groundwater and saturated soils would be removed from the aquifer through a combination of air sparging and soil vapor extraction (AS/SVE), which comprises an active in-situ remediation process. The VOCs would be collected above ground and sent off site for reuse, recycling, or destruction. Residual VOCs remaining after active AS/SVE treatment reaches its site-specific natural limit physical removal endpoint would be permitted to naturally attenuate under anaerobic conditions in-situ. Institutional controls would be implemented to prevent exposure to contaminated groundwater for the duration of the groundwater treatment period, until GWQC are achieved. Long-term monitoring would be conducted for the duration of the remediation period to assess the effectiveness of the remedial action and to determine when the remediation is complete. Site conditions and risks would be reviewed every 5 years until the groundwater remediation is complete.

Overall Protection of Human Health and the Environment

Alternative 5 would employ suspected source removal and in-situ groundwater treatment to provide long-term protection of human health and the environment. The groundwater treatment system would be designed to reduce volume and concentration of contaminated groundwater; therefore, upon successful start-up of the treatment system (the plume area could actually widen during initial operations), downgradient receptors of contaminated groundwater would begin to be protected. However, potential users of contaminated groundwater beneath Site 26 would not be protected by Alternative 5 until groundwater remediation goals were achieved throughout the plume. It is anticipated that long-term, permanent protection would be achieved after a treatment duration of approximately 5 years. During this period, groundwater contaminants would be removed both by the AS/SVE, which comprises an active in-situ remediation process extraction system, and through natural attenuation.

In the interim period, until remediation goals for site groundwater have been achieved, human health would be protected through use of institutional controls that would restrict use of untreated contaminated groundwater as drinking water. The effectiveness of this interim protection would depend entirely upon

adequate enforcement. If groundwater use restrictions were not adequately enforced, existing health risks would remain until groundwater contaminant concentrations decreased to acceptable levels.

The groundwater underlying Site 26 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 the base (within approximately 1 mile crossgradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would be protected by institutional controls until GWQC are achieved by in-situ treatment.

Removal of the process leach tank and associated VOC-contaminated soils would facilitate remediation of the groundwater contaminant plume by eliminating the suspected source of contaminants.

Air sparging and soil vapor extraction of groundwater and provides permanent long-term protection by removing contaminants from site groundwater. The proposed institutional controls would provide additional assurance of the long-term protection by restricting use of contaminated groundwater.

Long-term monitoring of groundwater and the extracted vapors for the duration of the remediation period would make it possible to evaluate site conditions and risks and determine when remedial actions are complete. The proposed quarterly monitoring would allow adequate time to act in the event that additional actions are needed to protect human health or the environment.

Compliance with ARARs

Implementation of Alternative 5 would comply with all ARARs and TBCs identified in Tables 2-1 through 2-6.

Initially, and throughout the remediation period, the groundwater beneath Site 26 would not meet the constituent concentrations specified in the New Jersey GWQS [N.J.A.C. 7:9-6]. However, removal of the process leach tank and associated contaminated soils would reduce migration of contaminants into groundwater. Operation of the AS/SVE groundwater treatment system to remove the bulk of the TCE, followed by natural attenuation and long-term monitoring, would ultimately result in attainment of GWQC. Alternative 5 includes a provision to seek a temporary exemption (CEA) from these requirements until the GWQC 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.

If the excavated process leach tank and/or soils are determined to be hazardous wastes, their handling, management, and off-site transport would be conducted in accordance with RCRA hazardous waste

generator and transporter requirements [40 CFR Parts 262 and 263] and New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7].

Under Alternative 5A, if it is determined that the source materials are subject to RCRA Land Disposal Restrictions [40 CFR 268], the source materials would be treated off site prior to disposal, in accordance with these regulations. Any wastes determined to be subject to LDRs would be disposed off site at a RCRA Subtitle C facility.

Under Alternative 5B, only source materials that pass the TCLP test and are determined to not be hazardous would be disposed at the existing on-base landfill.

The on-site treatment facilities proposed under Alternative 5 would be constructed and operated in accordance with federal and state hazardous waste facility regulations [40 CFR 265 Subparts B, C, D, E; 40 CFR 264 Subpart X; and N.J.A.C. 7:26-9]. These regulations identify general facility requirements, groundwater monitoring, preparedness and prevention, contingency and emergency procedures, and recordkeeping requirements. Treatment would also be conducted in compliance with state treatment regulations [N.J.A.C. 7:26-11.7] which detail operating requirements, waste analyses and monitoring of treatment conditions, and handling and compatibility of wastes in chemical, physical, and biological treatment processes.

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

Long-Term Effectiveness and Permanence

Alternative 5 would provide long-term protection of human health and the environment and would result in permanent reduction in all identified health risks. During cleanup, protection of human health would be dependent on adequate enforcement of the groundwater use restrictions.

The risk assessment concluded that, under a future residential land use scenario, exposure to contaminated groundwater beneath the site would result in potential carcinogenic risk of 1.7 E-04 and potential non-carcinogenic risk (HI) of greater than 1.0 for three target organs at current concentrations. 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. Upon completion of groundwater remediation, these risks would all be reduced to acceptable levels. In the interim, protection of human health would be dependent on adequate enforcement of the proposed groundwater use restrictions. In absence of adequate

enforcement, the current and future threats to human health would remain until remediation goals are attained.

The groundwater underlying Site 26 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 the base (within approximately 1 mile northwest, cross-gradient of the site). If site land and groundwater usage changes in the future, potential residential and industrial users of groundwater would not be protected if institutional controls are not enforced.

Upon successful start-up of the groundwater treatment system (after an initial period of plume widening), the RAO for protection of the environment would be achieved. Potential impacts to downgradient receptors or the environment would be eliminated since contaminated groundwater concentrations would begin to be reduced by the groundwater treatment system and natural attenuation.

Removal of the suspected contaminant source (process leach tank and associated VOC-contaminated soils) would facilitate remediation of groundwater by eliminating the suspected source of contaminants.

The reliability of the AS/SVE system is expected to be high. Air sparging and soil vapor extraction groundwater in-situ treatment is a widely used, effective technology for remediation of VOC-contaminated groundwater. The process would be easily monitored and maintained. Routine maintenance and replacement of system components could be accomplished with little interruption of system operation and no adverse impact to human health or the environment.

Long-term monitoring of groundwater and extracted vapors for the duration of the remediation period would allow the responsible agency to monitor the quality of groundwater beneath the site, assess potential impacts to downgradient receptors, determine whether additional remedial actions are necessary, and determine when remedial actions are complete. The proposed quarterly monitoring should allow adequate time to act in the event that additional actions are needed to protect human health or the environment.

Five-year reviews would be required for the duration of the groundwater remediation period to 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 quarterly monitoring events. Review of the effectiveness of deed restrictions and the CEA in restricting use of contaminated groundwater would also be required.

No difficulties or uncertainties are anticipated in performing the long-term monitoring. Groundwater monitoring wells may require replacement if sedimentation or vandalism occur; the wells would be readily replaceable.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 5 would reduce the toxicity, mobility, and volume of contamination through in-situ treatment of contaminated groundwater and, possibly, through treatment of the suspected source materials prior to disposal. The treatment system and natural attenuation will remove TCE and the other chlorinated VOCs present in site groundwater to meet the remediation goals.

The proposed groundwater treatment system would address the entire groundwater contaminant plume exceeding PRGs, beginning with the areas of highest concentration, then expanding to additional areas that could benefit from active AS/SVE treatment, given the site-specific limits, which are to be determined. Groundwater in a volume of approximately 400 feet by 60 feet on the surface, down to a depth of approximately 25 feet, would be treated. Passive remediation (natural attenuation) would supplement active TCE removal by the AS/SVE system.

Treatment residuals that would remain would include spent carbon from the vapor phase carbon polishing unit and possibly condensed liquids from the system knock-out pot receivers. Liquid wastes and adsorbed contaminants would be treated off site.

Short-Term Effectiveness

Implementation of Alternative 5 is not expected to pose any significant risks to the base personnel, the local community, workers, or the environment. The actions proposed under this alternative are excavation and removal of the process leach tank and associated VOC-contaminated soils, decontamination of the leach tank concrete blocks, installation of the groundwater AS/SVE treatment systems, and long-term monitoring of groundwater quality and treatment plant operations. Any short-term risks posed to base personnel, site workers, and the environment would be mitigated through use of engineering controls and appropriate PPE.

During all excavation activities, risks posed to base personnel by fugitive dust (bearing adsorbed contaminants) would be minimized by use of appropriate engineering control measures such as dust suppressants. Workers who implement Alternative 5 would be adequately safeguarded by using appropriate PPE to prevent exposure to contaminated soils or residue from the leach tank, contaminant-laden dusts, and airborne VOCs. OSHA standards would be followed and proper PPE would be used during all remedial activities.

Somewhat increased truck and heavy equipment vehicular traffic would occur as the result of the construction of the groundwater treatment systems and the excavation and off-base transport of contaminated source area soils and the tank concrete blocks. Coordination and scheduling of truck and heavy equipment traffic on public roads would be required to manage increased vehicular activity.

Equipment such as truck bed covers would be used to minimize spills and migration of contaminants during transport.

No permanent adverse impacts to the environment are anticipated to result from implementation of Alternative 5, although, during initial operations, a widening of the plume area is anticipated while the treatment and natural attenuation of contaminated groundwater at the leading edge of the plume catches up with the relatively slow groundwater flow rate. Erosion control measures such as hay bales and silt fences would be would be used as necessary to prevent damage to the environment from sediment runoff during construction. A vapor treatment system would be applied to protect human health and the environment during the AS/SVE system operation.

Alternative 5 would require approximately 8 months to put in place, including treatability studies, pre-design, and design activities. After a start-up period of up to 1 to 2 months, the AS/SVE treatment system acting under Alternative 5 would achieve the RAO for minimizing migration of groundwater contamination in approximately 5 years. The RAO for protection of human health by preventing exposure to contaminated groundwater would be achieved upon implementation of land use restrictions and establishment of the groundwater CEA; this may take a year or longer. If the process leach tank and associated soils are disposed at one of the on-base landfills (Alternative 5B), the implementation period may be extended approximately 5 months for completion of cap design and site preparation. It is expected that the remediation would be completed in approximately 5 years.

Implementability

Alternative 5 is implementable. There are no technical difficulties or uncertainties anticipated in constructing and operating the groundwater treatment system or excavating, cleaning, and disposing of the process leach tank concrete blocks and contaminated soil.

The proposed treatment technologies are proven and have been widely used in full-scale application. Common construction techniques and equipment are required for excavation and off-base transport of the leach tank and associated soils.

If warranted, additional actions can be easily implemented in the future while the groundwater treatment system is operating. Long-term monitoring of groundwater and extracted vapors would be effective for monitoring the progress of groundwater remediation and identifying potential impacts to downgradient receptors and the need for additional actions.

Permits (manifests) would be required and obtainable for off-base transportation and disposal of contaminated materials from the source area (Alt. 5A). Permits would not be required for on-base disposal or other on-site activities. Coordination with other agencies may be required as part of the long-term monitoring and 5-year review processes.

The components for the proposed AS/SVE systems are widely available and easily installed. Routine maintenance, including periodic cleaning and regular adjustments, would be easily implemented. Maintenance of the AS/SVE and air treatment systems would require periodic operator supervision and monitoring and periodic replacement of spent carbon canisters. Extraction/injection system equipment (air and vacuum pumps, valves, controls) will require periodic service or replacement. Well screens may require periodic cleaning to remove iron and manganese buildup.

Long-term monitoring (sampling and analyses) requires only readily available resources. Incorporating land use restrictions into the Base Master Plan 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.

Many companies exist with the trained personnel, equipment, and materials to design, install, and operate AS/SVE treatment systems and implement long-term groundwater monitoring. There is ample availability of companies with the trained personnel, equipment, and materials to perform long-term monitoring. Regulatory personnel and environmental specialists are readily available to perform 5-year reviews.

Sufficient commercial and on-base landfill capacity is available to handle the roughly estimated small volume of materials from the source area (approximately 24 cubic yards of contaminated soil and 6 cubic yards of decontaminated concrete block) that would require off-site disposal.

Cost

Alternative 5A

The capital costs for Alternative 5A total $1,698,000. The average annual O&M costs are $499,000, and 5-year reviews cost $15,500 per event. Over an estimated 5-year period, the net present-worth cost is $3,755,000 (at a 7 percent discount rate).

Alternative 5B

The capital costs for Alternative 5B total $1,680,000. The average annual O&M costs are $499,000, and five-year reviews cost $15,500 per event. Over an estimated 5-year period, the net present worth cost is $3,738,000 (at a 7 percent discount rate).

4.4.6 Comparative Analysis of Site 26 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 five alternatives are compared with respect to each of the evaluation criteria and differences are identified. Table 4-4 presents summaries of the evaluations for each alternative.

Overall Protection of Human Health and the Environment

Alternative 1 would provide no additional protection of human health or the environment because no actions would be taken to prevent human exposure to groundwater or mitigate migration of contaminated groundwater.

Alternative 2 would provide protection of human health, through implementation of groundwater use restrictions. No actions would be taken to mitigate migration of contaminated groundwater. Removal of the suspected source of groundwater contamination should promote natural attenuation of groundwater contamination. The effectiveness of this alternative for interim protection of human health (until natural attenuation is complete) is dependent on enforcement of institutional controls.

Alternatives 3, 4, and 5 would all provide protection of both human health and the environment through treatment of contaminated groundwater and implementation of institutional controls. Removal of the suspected source of groundwater contamination should facilitate the remediation of contaminated groundwater. The effectiveness of this alternative for interim protection of human health (until groundwater remediation is complete) is dependent on enforcement of institutional controls.

Alternative 5 would result in remediation in a significantly shorter timeframe than all other alternatives. Alternative 5 is projected to require 5 years, compared to up to 45 years for Alternative 4, approximately 45 years for Alternative 3, approximately 45 years for Alternative 2, and greater than 50 years for alternative 1.

Compliance with ARARs

Implementation of Alternatives 2, 3, 4, and 5 would comply with all ARARs and TBCs identified in Tables 2-1 through 2-6, with the exception of the New Jersey GWQS [N.J.A.C. 7:9-6]. None of the alternatives would initially comply with these state ARARs for attainment of groundwater quality criteria; however, Alternatives 2, 3, 4, and 5 would include a provision to seek a temporary exemption (CEA) from these requirements until the GWQC are achieved through natural attenuation (Alternative 2 only) or treatment. Alternative 1 would not comply with these standards or include a provision to seek temporary exemption.

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES
FEASIBILITY STUDY
NWS EARLE, COLTS NECK, NEW JERSEY

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT				
Prevent Human Exposure to Contaminated Groundwater	Provides no additional protection against human exposure to contaminated groundwater. Carcinogenic and non-carcinogenic risks exceeding EPA's target risk range would remain. No institutional controls implemented to restrict use of untreated contaminated groundwater for drinking water. No actions taken to reduce contaminant leaching to groundwater from process leach tank and associated contaminated soils. Time required for natural attenuation to reduce contaminants to levels that would not pose risk may be longer than in Alternative 2.	Institutional controls would minimize potential exposure to site groundwater by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating natural attenuation of contaminants. In time, contaminant concentrations would reach levels that would not pose excess risk.	The proposed in-situ system would immediately prevent exposure to downgradient receptors by treating the advancing plume while natural attenuation would ultimately reduce groundwater contaminant concentrations at the site to levels that would not pose excess risk. Institutional controls would minimize potential exposure to site groundwater during the treatment period by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating groundwater remediation.	Provides collection and ex-situ treatment of the advancing contaminant plume which would immediately prevent exposure to downgradient receptors while natural attenuation ultimately reduces groundwater contaminant concentrations to levels that would not pose excess risk. Institutional controls would minimize potential exposure to site groundwater during the treatment period by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating groundwater remediation.
Mitigate Migration of VOC Contaminated Groundwater	No actions taken to reduce migration of contaminated groundwater. Relies on natural attenuation.	Same as Alternative 1.	The permeable reactive wall treatment system, installed immediately downgradient of the contaminant plume, would prevent further migration of contaminated groundwater by degrading dissolved contaminants as they migrate through the wall.	The groundwater extraction and treatment system would contain and treat the contaminant plume, preventing further migration of contaminated groundwater.

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
COMPLIANCE WITH ARARS				
Chemical-Specific ARARs	Would not comply with state groundwater quality standards or statutory requirements.	Groundwater contaminant concentrations would initially exceed state GWQC; over time GWQC would be achieved by natural attenuation. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration. Alternative 2 would be implemented in compliance with RCRA Land Disposal Restrictions.	Groundwater contaminant concentrations would initially exceed GWQC: over time treatment and natural attenuation would reduce contaminant levels below GWQC. A classification exception area (CEA) would be established to provide the state official notification that standards would not be met for a specified duration. Alternative 3 would be implemented in compliance with RCRA Land Disposal Restrictions	Same as Alternative 3
Location-Specific ARARs	Not Applicable.	Not Applicable.	Not Applicable.	Not Applicable.
Action-Specific ARARs	Not Applicable.	If soils and sediments are determined to be hazardous, Alternative 2 would comply with federal and state ARARs for generation, transport, and disposal of hazardous wastes.	Same as Alternative 2.	If soils and sediments are determined to be hazardous, Alternative 4 would comply with federal and state ARARs for transport of hazardous waste. The on-site treatment facility would be constructed and operated in accordance with federal and state hazardous waste facility regulations.

FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
LONG-TERM EFFECTIVENESS AND PERMANENCE				
Magnitude of Residual Risk	Existing risks would remain. Future residential receptor of site groundwater: 1.7×10^{-4} carcinogenic and HI > 1 non-carcinogenic risks for three target organs. Future industrial receptor of site groundwater: HI > 1 non-carcinogenic risks for three target organs.	Implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0. Over time, natural attenuation would result in permanently reduced risks.	Groundwater treatment would result in permanent reduction of risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0. In the interim, until groundwater remediation goals are achieved, implementation and enforcement of institutional controls would reduce risks from exposure to site groundwater to less than 1×10^{-6} and HI less than 1.0.	Same as Alternative 3.
Adequacy and Reliability of Controls	No new controls implemented.	Long-term enforcement of institutional controls would be required to ensure their effectiveness for preventing use of contaminated groundwater.	Permeable reactive wall treatment is a new and innovative process that has been demonstrated primarily in bench- and pilot-scale projects over the past five years. Although the technology shows promise, its long-term effectiveness is uncertain. Potential limitations include biofouling, coating of the reactive materials, or reduced permeability due to buildup of precipitated inorganics. The likelihood of these problems occurring and the reparability of the wall in the event that problems occur are not known. The technology vendor recommends agitation of the reactive wall materials every 5 to 10 years to liberate deposited	Groundwater extraction and air stripping are widely used, effective technologies for the remediation of VOC contaminated groundwater. There is little uncertainty associated with long-term operation or maintenance of the system. The process would be easily monitored and maintained. Routine maintenance and replacement of system components could be accomplished with little interruption of system operation. Long-term enforcement of installation controls would be required to ensure their effectiveness for preventing use of contaminanted groundwater.

FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
			inorganic precipitates. If the wall became ineffective and could not be repaired, the reactive metal materials or the entire wall would have to be replaced. Regular process monitoring would effectively identify any changes in the effectiveness of the process. Long-term enforcement of institutional controls would be required to ensure their effectiveness for preventing use of contaminated groundwater.	
Need for 5-Year Review	Review would be required since groundwater contaminants would be left in place.	Review would be required since groundwater contaminants would be left in place and institutional controls would be implemented.	Review would be required for the duration of the groundwater remediation period since groundwater contaminants would remain above remediation goals and institutional controls would be implemented.	Same as Alternative 3.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT				
Treatment Process Used	None.	None.	In-situ permeable reactive wall.	Air stripping with activated carbon polishing.
Amount Treated or Destroyed	None.	None.	1 million gallons contaminated groundwater, containing 2800 grams TCE plus other VOCs, remediated per year.	Same as Alternative 3.
Reduction of Toxicity, Mobility, or Volume Through Treatment	No reduction, since no treatment would be employed.	Same as Alternative 1.	The In-situ treatment system would contain the contaminant plume and degrade the chlorinated VOCs to reduce the toxicity, mobility, and volume of contaminated groundwater. Over a period of approximately 45 years, the contaminants of concern in site groundwater would be reduced to acceptable levels.	The groundwater extraction and treatment system would contain the contaminant plume and remove the VOCs to reduce the toxicity, mobility, and volume of contaminated groundwater. Over a period of approximately 45 years, the contaminants of concern in site groundwater would be reduced to acceptable levels.

FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
Irreversible Treatment	Not Applicable	Not Applicable	Yes, contaminants are degraded to form non-toxic compounds.	Yes, contaminants are removed from groundwater.
Statutory Preference for Treatment	No	No	Yes	Yes
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.	Same as Alternative 2.	Same as Alternative 2.
Worker Protection	No risk to workers anticipated if proper PPE is used during long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, and long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, installation of the permeable reaction wall, and long-term monitoring.	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, installation and operation of the groundwater extraction and treatment systems, and long-term monitoring.
Environmental Impacts	No adverse impacts to the environment anticipated.	No adverse impacts to the environment anticipated. Engineering controls would be used during implementation to mitigate risks.	Same as Alternative 2.	Same as Alternative 2.
Time Until Action is Complete	Not applicable.	1 year until RAO for preventing exposure to site groundwater is achieved. Would not meet RAO for mitigating migration of VOC contaminated groundwater. 50 years until contaminants are reduced to acceptable concentrations by natural attenuation.	1 year until RAO for preventing exposure to site groundwater is achieved. 10 months until RAO for mitigating migration of VOC contaminated groundwater is achieved. 45 years until contaminants are reduced to acceptable concentrations by in-situ groundwater treatment.	1 year until RAO for preventing exposure to site groundwater is achieved. 7 months until RAO for mitigating migration of VOC contaminated groundwater is achieved. 45 years until contaminants are reduced to acceptable concentrations by extraction and treatment of groundwater.

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION	ALTERNATIVE 3: REACTIVE WALL	ALTERNATIVE 4: PUMP-AND-TREAT
IMPLEMENTABILITY				
Ability to Construct and Operate	No construction or operation involved.	No construction or operational difficulties anticipated. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.	No significant construction or operational difficulties anticipated. Common construction equipment and somewhat specialized construction techniques used for installation of treatment wall. With vendor training and oversight, wall could be installed by non-specialized construction crews. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.	No construction or operational difficulties anticipated. Common well installation and construction techniques and equipment used to installation of extraction system. Modular treatment system would be easily constructed. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.
Ease of Doing More Action if Needed	Additional actions would be easily implemented if required.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Ability to Monitor Effectiveness	Groundwater monitoring would provide assessment of contaminant presence, migration, and changes in site conditions.	Same as Alternative 1.	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. Permits would be required and obtainable for off-base transportation and disposal of contaminated source area soils. Permits would not be required for on-base disposal.	Same as Alternative 2.	Same as Alternative 2.

FINAL

CRITERION:	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: NATURAL ATTENUATION		ALTERNATIVE 3: REACTIVE WALL		ALTERNATIVE 4: PUMP-AND-TREAT	
Availability of Treatment, Storage Capacities, and Disposal Services	None required.	Alt. 2A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 2B: Sufficient area available for disposal of materials at both on-base landfills.		Alt. 3A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 3B: Sufficient area available for disposal of materials at both on-base landfills.		Alt. 4A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 4B: Sufficient area available for disposal of materials at both on-base landfills.	
Availability of Equipment, Specialists, and Materials	Personnel and equipment available for implementation of long-term monitoring and 5-year reviews.	Ample availability of companies with trained personnel, equipment, and materials to perform source removal, long-term monitoring, and 5-year reviews.		Ample availability of companies with trained personnel, equipment, and materials to perform source removal, treatment system installation and operation, long-term monitoring, and 5-year reviews.		Ample availability of companies with trained personnel, equipment, and materials to perform source removal, extraction and treatment system installation and operation, long-term monitoring, and 5-year reviews.	
Availability of Technology	Not required.	Not required.		Reactive wall technology only available from one vendor, but the equipment, materials, and personnel required to construct treatment system are available from several vendors/companies.		Groundwater extraction and air stripping are widely used, conventional technologies available from a variety of companies.	
COST							
		2A	2B	3A	3B	4A	4B
Capital Cost	$14,100	$157,000	$140,000	$1,637,000	$1,620,000	$712,000	$695,000
First-Year Annual O&M Cost	$12,700	$12,700		$60,100		$215,700	$214,900
Five-Year Reviews	$ 15,500	$15,500		$28,500		$15,500	
Present Worth Cost*	$204,000	$348,000	$331,000	$2,386,000	$2,369,000	$3,100,000	$3,073,000

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

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Prevent Human Exposure to Contaminated Groundwater	Air sparging and soil vapor extraction treatment processes, combined with enhanced biodegradation and natural attenuation would initially result in a wider plume volume/area, but would actively reduce the concentration of contaminants in the entire plume. This treatment alternative would be expected to reduce overall contaminant concentration of the entire plume more quickly than other Alternatives Institutional controls would minimize potential exposure to site groundwater during the treatment period by prohibiting its use as drinking water. Excavation and off-site disposal of the process leach tank and associated contaminated soils would reduce leaching of contaminants to groundwater, facilitating groundwater remediation.
Mitigate Migration of VOC Contaminated Groundwater	The groundwater plume would initially widen, but the overall treatment period would be shorter than other alternatives.
COMPLIANCE WITH ARARS	
Chemical-Specific ARARs	Same as Alternative 3.
Location-Specific ARARs	Not Applicable
Action-Specific ARARs	Same as Alternative 4.

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
PAGE 9 OF 12

FINAL

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	Same as Alternative 3
Adequacy and Reliability of Controls	Air sparging and soil vapor extraction are widely used, effective technologies for the remediation of VOC contaminated groundwater. There is little uncertainty associated with long-term operation or maintenance of the system. The process would be easily monitored and maintained. Routine maintenance and replacement of system components could be accomplished with little interruption of system operation. Regular process monitoring would effectively identify any changes in the effectiveness of the process. Long-term enforcement of institutional controls would be required to ensure their effectiveness for preventing use of contaminated groundwater.
Need for 5-Year Review	Same as Alternative 3
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT	
Treatment Process Used	Air Sparging/soil vapor extraction with air emissions control
Amount Treated or Destroyed	Entire plume
Reduction of Toxicity, Mobility, or Volume Through Treatment	Toxicity is reduced by actively stripping VOCs from the plume volume. Mobility is not affected, although as remediation progresses, the plume edge is expected to retreat. The volume of the plume (contaminated with VOC above GWQC) is expected to grow during initial treatment, but to diminish with time

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
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FINAL

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
Irreversible Treatment	Yes, contaminants are removed and/or treated to form non-toxic compounds
Statutory Preference for Treatment	Yes
SHORT-TERM EFFECTIVENESS	
Community Protection	Same as Alternative 2
Worker Protection	No significant risk to workers anticipated if proper PPE is used during source removal and decontamination, installation and operation of the groundwater air sparging and soil vapor extraction systems, and long-term monitoring.
Environmental Impacts	Same as Alternative 2
Time Until Action is Complete	1 year until RAO for preventing exposure to site groundwater is achieved through implementation of Institutional Controls. Approximately 5 years until RAO for mitigating migration of VOC contaminated groundwater is achieved. Approximately 5 years until contaminants are reduced to acceptable concentrations by air sparging/soil vapor extraction and biodegration in groundwater.
IMPLEMENTABILITY	
Ability to Construct and Operate	No construction or operational difficulties anticipated. Common well installation and construction techniques and equipment used for installation of treatment system. Modular treatment system would be easily constructed. Common construction techniques used for excavation and off-site disposal of the concrete block leach tank and associated contaminated soils.

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction
Ease of Doing More Action if Needed	Same as Alternative 1.
Ability to Monitor Effectiveness	Same as Alternative 1.
Ability to Obtain Approvals and Coordinate with Other Agencies	Same as Alternative 2
Availability of Treatment, Storage Capacities, and Disposal Services	Alt. 5A: Sufficient commercial landfill capacity available for materials requiring disposal. Alt. 5B: Sufficient area available for disposal of materials at both on-base landfills.
Availability of Equipment, Specialists, and Materials	Ample availability of companies with trained personnel, equipment, and materials to perform source removal, AS/SVE treatment system installation and operation, long-term monitoring, and 5-year reviews.
Availability of Technology	AS/SVE is a widely used readily available combination of equipment/techniques provided by a variety of companies.

TABLE 4-4
SITE 26 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FEASIBILITY STUDY - NWS EARLE, COLTS NECK, NEW JERSEY
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FINAL

CRITERION:	ALTERNATIVE 5 Air Sparging Soil Vapor Extraction	
COST	5A	5B
Capital Cost	$1,698,000	$1,680,000
First Year O&M Cost	$499,000 (average year)	
Five-Year Reviews	$15,500	
Present Worth Cost*	$3,755,000	$3,738,000

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

Because no wetlands, floodplains, water bodies, or other sensitive receptors are believed to be present at Site 26, no location-specific ARARs were identified for this site. If any such receptors are identified during pre-design investigations, the corresponding location-specific ARARs would be identified during the remedial design and all necessary measures would be taken to comply with the federal and state location-specific ARARs.

Because no actions would be implemented, no action-specific ARARs were identified for Alternative 1.

If materials from the suspected source area are determined to be hazardous, their transport and disposal under Alternatives 2, 3, 4, and 5 would comply with RCRA hazardous waste generator and transporter requirements [40 CFR parts 262 and 263], New Jersey labeling, records, and transportation requirements [N.J.A.C. 7:26-7], and RCRA Land Disposal Restrictions [40 CFR 268].

The on-site treatment facilities proposed under Alternatives 4 and 5 would be constructed and operated in accordance with federal and state hazardous waste facility regulations [40 CFR 265 Subparts B, C, D, E; 40 CFR 264 Subpart X; and N.J.A.C. 7:26-9]

Long-Term Effectiveness and Permanence

Only Alternatives 3, 4 and 5 offer long-term protection of both human health and the environment. Alternative 2 does not include actions to protect the environment, but provides protection of human health through use of institutional controls. Alternative 1 does not provide any additional protection of human health or the environment.

Alternatives 3, 4 and 5 all employ groundwater treatment, institutional controls, and removal of the suspected source of groundwater contaminants to protect human health and the environment. All three would result in permanent reduction in risks from exposure to site groundwater to less than $1x10^{-6}$ carcinogenic risk and HI less than 1.0.

Alternatives 3 and 4 would provide identical protectiveness: downgradient receptors and the environment would be protected upon installation and start-up of the treatment systems because both systems would be designed to capture and treat the contaminated groundwater, preventing further migration; the groundwater treatment systems would eventually (in approximately 45 years) decrease contaminant concentrations in site groundwater to acceptable levels, providing permanent protection of human health and the environment; institutional controls would be used to prevent exposure to contaminated groundwater in the interim period until remediation goals have been achieved. Alternative 5 would provide similar protectiveness in a shorter period of time. Protection of downgradient receptors may initially take somewhat longer to achieve, since the

plume area may actually widen during initial operation of the air-sparging system, but complete remediation of the contaminant plume and long-term protection of on-site and downgradient receptors is expected to be achieved in approximately 5 years. Under all of these alternatives, the effectiveness of the interim protection would depend upon enforcement of institutional controls; if groundwater use restrictions were not enforced, protection of human health would not be achieved until the groundwater remediation is complete.

Under Alternative 2 protection of human health (for on-site and downgradient receptors) would be provided by institutional controls that place limitations on use of contaminated groundwater as drinking water. As with Alternatives 3, 4, and 5, the effectiveness of these controls depends on enforcement. If groundwater use restrictions were not enforced, protection of human health would not be achieved until the groundwater contaminant concentrations decreased to acceptable levels through natural attenuation (an estimated 50 years).

The adequacy and reliability of the proposed alternatives differ among the three treatment alternatives (3, 4, and 5).

Considerable uncertainty is associated with the long-term effectiveness and reliability of Alternative 3, which employs an innovative in-situ technology to treat contaminated groundwater. The technology shows great promise for treating contaminated groundwater, but it has not been demonstrated in long-term full-scale projects. The reliability of Alternatives 4 and 5 are expected to be high; both employ treatment systems that have been widely demonstrated for remediation of VOC-contaminated groundwater.

Long-term monitoring and five year reviews would be required for all five alternatives until groundwater contaminant concentrations decrease to acceptable levels through treatment or natural attenuation. Regular monitoring would allow the responsible agency to assess changes in contaminant status and identify potential impacts to downgradient receptors.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 3, 4, and 5 would reduce the toxicity, mobility, and volume of contaminants through treatment of contaminated groundwater, and possibly through treatment of the suspected source materials prior to disposal. All three treatment alternatives would be designed to address the same mass of contaminants: the entire groundwater contaminant plume and any source area materials requiring treatment.

Alternative 2 may reduce the toxicity, mobility, and volume of source area contaminants through treatment of the suspected source materials prior to disposal; it would not reduce groundwater contamination through treatment. Alternative 1 would not reduce the toxicity, mobility, or volume of contaminants through treatment.

Depending on VOC concentrations in air from the air stripper and AS/SVE systems, Alternatives 4 and 5 may generate spent carbon as a treatment residual from the vapor phase carbon polishing unit. The SVE system (Alt. 5) may also generate condensed liquids from the system knock-out pot receivers. None of the other alternatives would generate treatment residuals.

Short-Term Effectiveness

The short-term effectiveness of all five 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, the only on-site action proposed under Alternative 1, would provide little opportunity for short-term impact to the local community or the environment.

Alternative 2 would present a somewhat greater opportunity for short-term impacts to human health and the environment due to excavation, handling, and decontamination of contaminated materials from the suspected source area. Alternatives 3, 4, and 5 would present the greatest opportunity for short-term impacts due to installation and operation of the groundwater treatment systems. In all cases, short-term risks posed to base personnel, site workers, and the environment would be mitigated through use of engineering controls, transportation planning, and appropriate PPE. No permanent adverse impacts to the human health or the environment are anticipated to result from implementation of Alternatives 2, 3, 4 or 5.

Alternative 5 would result in remediation in a significantly shorter timeframe than all other alternatives. Alternative 5 is projected to require 5 years, compared to up to 45 years for alternative 4, approximately 45 years for alternative 3, approximately 45 years for alternative 2, and greater than 50 years for alternative 1.

Implementability

Each of the alternatives would be implementable. Alternative 1 is the most easily implemented since the only activities proposed are long-term monitoring and five-year reviews.

Alternative 2 would be the next easiest to implement because it involves only excavation and off-site transport and disposal. There is a sufficient number of companies available with the trained personnel, equipment, and materials to perform excavation, disposal, and long-term monitoring. Sufficient commercial landfill capacity is available to handle the small volume of contaminated materials (approximately 30 cubic yards) that would require off-base disposal under Alternative 5B. Under Alternative 5A, sufficient area exists

at both on-base landfills to accommodate the small volume of materials from Site 26 without altering the cap design or material requirements.

Alternatives 4 and 5 would be somewhat more difficult to implement because both would require installation and operation of an on-site treatment system. However, no difficulties are anticipated in implementing either alternative because both alternatives include well- demonstrated technologies that employ relatively common equipment and materials. Several vendors are available that could provide the necessary equipment, materials, and services.

Alternative 3 may be somewhat more difficult to implement because it would require installation and operation of a new and innovative in-situ treatment technology. Reactive wall technology is available from only one vendor, but the equipment, materials, and personnel required to construct the system are available from several sources. No significant difficulties are anticipated in implementing this alternative.

If additional actions are warranted, they could be easily implemented under any of the Alternatives.

Cost

The costs associated with each alternative are provided in Table 4-4. Alternative 1, No Action, would be the least expensive to implement and Alternative 5 would be the most expensive to implement.

APPENDIX A

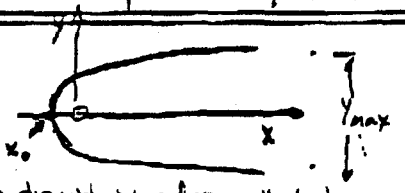
GROUNDWATER MODELING

SITE 26 PRELIMINARY GROUNDWATER PUMPING RATE CALCULATIONS

CALCULATION WORKSHEET Order No. 19116 (01-91) PAGE 1 OF 3

CLIENT		JOB NUMBER	
SUBJECT: NWS EARLE - SITE 26 extraction well Capture Zone Analysis			
BASED ON		DRAWING NUMBER	
BY: D. McKenna	CHECKED BY	APPROVED BY	DATE: 2/5/97

CAPTURE ZONE ANALYSIS: UNCONFINED AQUIFER



ASSUME $Q = 1$ gpm $= 193\ ft^3/day$ — based on drawdown calcs, attached

$K = 2$ ft/day (from RI)

$r_2 = 1'$ $h_2 = 9$

$r_1 = 36'$ $h_1 = 15$

$L = 35'$ (dist $r_1 \to r_2$)

based on drawdown calcs. attached

r = radius to monitoring well along axis of flow direction

Grubb (1993) Eqns from Fetter

① $$Y_{max} = \pm \frac{QL}{K(h_1^2 - h_2^2)} = \frac{(193\ ft^3/d)(35\ ft)}{(2\ ft/day)(15^2 - 9^2)} = 23'$$

Y_{max} = max width of capture zone

② $$X_o = \frac{-QL}{\pi K(h_1^2 - h_2)} = 7.5'$$

X_o = stagnation point

③ $$x = \frac{-y}{\tan[\pi K(h_1^2 - h_2^2)y/QL]}$$

x = distance from extraction well (along x axis)

$$x = \frac{-y}{\tan\left(\frac{\pi(2)(15^2 - 9^2)y}{(193)(35)}\right)}$$

(tan in radians)

$$x = \frac{-y}{\tan(.134y)}$$

y	x
23	377
22	111
21	61.5
20	40
19	28
17	14.5
15	7
13	2.2
12	.43
11	-1
9	-3.4

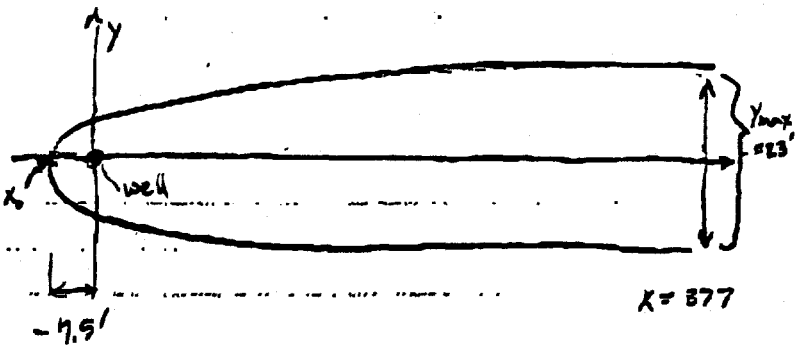
probably sign

y = 19 - 19

x = 7 - 28

r @ well ≈ 6'

∴ max capture width = 23' @ x = 377' upgrad.



CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT		JOB NUMBER	
SUBJECT	CAPTURE ZONE ANALYSIS SUMMARY		
BASED ON		DRAWING NUMBER	
BY D. McKenna	CHECKED BY	APPROVED BY	DATE 2/5/97

Summary Capture Zone Analysis

- Pump at lower rates - assume 1 gpm, but probably pump @ lower rate
- very small radius of influence at well (≈6')

AT DISTANCE UPGRADIENT X	CAPTURE WIDTH (not radius) Y
.43	12
2.2	13
7	15
14.5	17
28	19

BASED ON GRUBB (1993) Equations, (Fetter p 504)

Summary Drawdown Calcs, Unconfined Aquifer

ASSUMING $Q_{pump} = 1$ gpm
$T = 30$ ft²/day
$S_y = .13$
$K_V = K_H$ (isotropic)

Drawdown at well ≈ .6' @ t = 30 days

Drawdown at r = 36' ≈ 0.015 @ t = 30 days

CALCULATION WORKSHEET Order No. 18116 (01-91)

CLIENT	JOB NUMBER
SUBJECT: Drawdown Estimates & CAPTURE ZONE ANALYSIS	
BASED ON	DRAWING NUMBER
BY: D. McKenna / CHECKED BY	APPROVED BY / DATE: 2/5/97

Drawdown Calculation - Unconfined Aquifer

Neuman Eqn: $\Delta h = \frac{Q}{4\pi T} \underbrace{W(u_A, u_B, \Gamma)}_{\text{well function}}$ → Table A-6, Fetter

$u_A = \frac{r^2 S}{4Tt}$ Early drawdown

$\boxed{u_B = \frac{r^2 S_y}{4Tt}}$ later drawdown ← assume 30 days is later drawdown

$\Gamma = \frac{r^2 K_v}{b^2 K_h}$ ← assume $K_v = K_h$

r = radial distance from pumping well

S = storativity assume .2 (Fetter range .02-.3) ($S = bS_s \therefore S_s = .013$) S_s = elastic storativity (spec. storage)

T = transmissivity = Kb = 30 ft²/day

t = time to steady state = assume 30 days

S_y = specific yield = assume ($10 \times S_s$) = .13

b = initial saturated thickness = 15 ft

K_v, K_h = vert & hyd. cond. → assume isotropic ($K_v = K_h$) = 2 ft/day

Q = 2 gpm ≈ 386 ft³/day

try different values for r - 1st assume plume width = 290 ∴ r = 145 ft

$u_A = \frac{r^2(.2)}{(4)(30\frac{ft^2}{day})(30d)} = (r^2)5.55\times10^{-5}$

use later drawdown

$u_B = \frac{(r^2)(.13)}{(4)(30)(30)} = (r^2)(3.6\times10^{-5})$

	u_A	$1/u_A$		u_B	$1/u_B$
r = 145	u_A = 1.17	.85	r = 145	u_B = .76	1.31
r = 75	u_A = .31	3.22	r = 75	u_B = .20	5
r = 35	u_A = .068	14.7	r = 35	u_B = .044	22.7
			r = 1	u_B = 3.6×10^{-5}	2.8×10^{4}

Γ = 93 r = 145
Γ = 25 r = 75
Γ = 5.4 r = 35
Γ = .004 r = 1

W = 1.20×10^{1}

→ Assume r ≈ 36 Γ = 6.0 u_B = .0486 W ≈ 3.05×10^{-2}

DRAWDOWN assuming Q = 2 gpm

r = 36: $\Delta h = \left(\frac{386\ ft^3/day}{4\pi\ 30\ ft^2/day}\right)(3.05\times10^{-2}) = .03'$

↓ DIFFERENT Q ↓

Q = 193 Δh = .015

r = 1': Δh = (↓)(12) = 12.2' ← too much

Δh = 6' Q = 193 ft³/day pump ≈ 1 gpm

Δh = 3.3' Q = 105 ft³/day

To: Liyang Chu/Wilmington

From: J.D. Chiou/Pittsburgh JDC

Subject: ECTran modeling of TCE contaminant plume
NWS Earle Site 26
CTO 279, Job No. 7452.0201

Date: Nov. 11, 1996

BASIC ASSUMPTIONS:

- Effective Porosity = 0.25
- Groundwater Velocity = 0.008 x 2 ft/day x 1/0.25 = 0.064 ft/day = 23.36 ft/yr
- foc in the aquifer = 0.001
- TCE KOC = 166 l/kg
- K_d = KOC x foc = 0.166
- TCE half life = 4.5 years
- TCE is vertically well mixed in the saturated zone.
- TCE can migrate laterally with groundwater at any concentration.

TASK 1 - CLEANUP TIME ESTIMATION:

The current groundwater contamination was conceptualized as a 140 ft W x 400 ft L x 15 ft D TCE plume with an uniform TCE concentration. Using the area vs. concentration information provided by you, an average TCE concentration of 705 ug/l was calculated. This concentration was assigned as the current concentration of the TCE plume. An ECTran simulation was first conducted to produce the concentration vs. time curves within and at a distance 9000 feet down gradient from the current plume. Table 1 shows the ECTran output for this simulation. As shown in Table 1, it will take about 37 years for the average concentration within the current plume to decrease to 1 ug/l. TCE is not expected to reach 9000 ft down gradient.

A concentration of 2500 ug/l was then assigned as the current average TCE concentration in a sensitivity test simulation. Table 2 shows the ECTran output of this simulation. It will take about 44 years for the average concentration within the current plume to decrease from 2500 ug/l to 1 ug/l. TCE is still not expected to reach 9000 ft down gradient.

TASK 2 - SOURCE LOADING ESTIMATION:

In order to evaluate the possible existence of DNAPL at the suspected source area, a simple transport calibration simulation was conducted. A possible source loading scenario was developed during this calibration simulation. The calibration results will either confirm the current measurements or indicate possible TCE hot spots not yet being detected.

The leach tank by Building GB-1 was conceptualized as a 10 ft x 10 ft source area. TCE loading at 3.5% concentration was assumed to last for 5 years which was then stopped about 10 years ago. A leaking rate of 3 feet per year was also assumed. Tables 3 and 4 show the ECTran outputs for this assumed source loading scenario. As shown in Table 3, the TCE concentrations under the leach tank and 350 feet down gradient from the tank (i.e., the current hot spot) are similar to the measured TCE concentrations in these

two areas. These results confirm that the current TCE plume can be caused by a historical loading from the leach tank. Because the released TCE have migrated laterally in the aquifer, the TCE concentrations at the original source area have decreased to the currently measured levels while the hot spot of the plume is now a few hundred feet down gradient.

Based on the measured and simulated TCE conditions, it is unlikely that any significant amount of TCE currently exists as DNAPL in the aquifer. This means that TCE in the saturated zone can and is migrating laterally with groundwater. A simple sorption/desorption process can be used to describe the dissolved and adsorb phase TCE currently in the aquifer.

Table 4 shows the ECTran output for the same source loading scenario with longer simulation time. The groundwater cleanup time at the current hot spot location (not the average as estimated in Task 1) is about 50 years.

TABLE - 1 CLEANUP TIME ESTIMATION

Copyright 1996

BROWN & ROOT ENVIRONMENTAL

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

SITE: NWS EARLE SITE 26

INVESTIGATOR: WYU

DATE: 11/15/96

CONTAMINANT: TCE

HALF-LIFE (YRS):	
LAYER 2:	4.50E+00
UNSAT. AQUIFER	4.50E+00
SAT. AQUIFER	4.50E+00

UNSAT. SOURCE	AREA:	LAYER 2		SATURATED AQUIFER		AQUIFER CHARACTERISTICS			
INFILT (FT/YR):	0					B (FT):	15	Vzo (FT/YR):	0.8
LENGTH (FT):	400					GW Q3 (L/DAY):	9.52E+02		
WIDTH (FT):	140	Kd (L/KG):	1.66E-01	Kd (L/KG):	1.66E-01	GW V. (FT/YR):	23.36	Kd (L/KG):	0.166
POROSITY 2:	0.25	SATURATION:	0.13	SATURATION:	1.00	H (FT):	15.0000	RETARDATION:	2.18192
POROSITY GMA:	0.25	THICKNESS (FT):	0.00	THICKNESS (FT):	15.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.78	DECAY (1/DAY):	4.22E-04	DECAY (1/DAY):	4.22E-04	DISPERSIVITY:		DECAY (1/YR):	1.5E-01
DENSITY GMA (G/CM3):	1.78	CAo (PPB)	0.00E+00	CBo (PPB):	7.05E+02	Az (FT):	0.35		
				CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY):	0.00E+00	Q2 (L/DAY):	9.52E+02	Av (FT):	33.33	DISTANCE TO F.L. (FT):	9000

TIME INTERVAL (YRS)	1	LAYER 2 LEACHATE CONC.	SOURCE AREA CONC.(CURRENT PLUME)	DOWN-GRADIENT EXPOSURE POINT
ELAPSED TIME - YRS	LAYER 1(PPB)	(UG/L)	(UG/L)	(UG/L)
0	0.00E+00	0.00E+00	7.05E+02	0.00E+00
1	0.00E+00	0.00E+00	5.88E+02	0.00E+00
2	0.00E+00	0.00E+00	4.91E+02	0.00E+00
3	0.00E+00	0.00E+00	4.10E+02	0.00E+00
4	0.00E+00	0.00E+00	3.42E+02	0.00E+00
5	0.00E+00	0.00E+00	2.85E+02	0.00E+00
6	0.00E+00	0.00E+00	2.38E+02	0.00E+00
7	0.00E+00	0.00E+00	1.99E+02	0.00E+00
8	0.00E+00	0.00E+00	1.66E+02	0.00E+00
9	0.00E+00	0.00E+00	1.39E+02	0.00E+00
10	0.00E+00	0.00E+00	1.16E+02	0.00E+00
11	0.00E+00	0.00E+00	9.65E+01	0.00E+00
12	0.00E+00	0.00E+00	8.05E+01	0.00E+00
13	0.00E+00	0.00E+00	6.72E+01	0.00E+00
14	0.00E+00	0.00E+00	5.61E+01	0.00E+00
15	0.00E+00	0.00E+00	4.68E+01	0.00E+00
16	0.00E+00	0.00E+00	3.91E+01	0.00E+00
17	0.00E+00	0.00E+00	3.26E+01	0.00E+00
18	0.00E+00	0.00E+00	2.72E+01	0.00E+00
19	0.00E+00	0.00E+00	2.27E+01	0.00E+00
20	0.00E+00	0.00E+00	1.90E+01	0.00E+00
21	0.00E+00	0.00E+00	1.58E+01	0.00E+00
22	0.00E+00	0.00E+00	1.32E+01	0.00E+00
23	0.00E+00	0.00E+00	1.10E+01	0.00E+00
24	0.00E+00	0.00E+00	9.20E+00	0.00E+00
25	0.00E+00	0.00E+00	7.68E+00	0.00E+00
26	0.00E+00	0.00E+00	6.41E+00	0.00E+00
27	0.00E+00	0.00E+00	5.35E+00	0.00E+00
28	0.00E+00	0.00E+00	4.46E+00	0.00E+00
29	0.00E+00	0.00E+00	3.72E+00	0.00E+00
30	0.00E+00	0.00E+00	3.11E+00	0.00E+00
31	0.00E+00	0.00E+00	2.59E+00	0.00E+00
32	0.00E+00	0.00E+00	2.16E+00	0.00E+00
33	0.00E+00	0.00E+00	1.81E+00	0.00E+00
34	0.00E+00	0.00E+00	1.51E+00	0.00E+00
35	0.00E+00	0.00E+00	1.26E+00	0.00E+00
36	0.00E+00	0.00E+00	1.05E+00	0.00E+00
37	0.00E+00	0.00E+00	8.77E-01	0.00E+00
38	0.00E+00	0.00E+00	7.32E-01	0.00E+00
39	0.00E+00	0.00E+00	6.11E-01	0.00E+00
40	0.00E+00	0.00E+00	5.10E-01	0.00E+00
41	0.00E+00	0.00E+00	4.25E-01	0.00E+00
42	0.00E+00	0.00E+00	3.55E-01	0.00E+00
43	0.00E+00	0.00E+00	2.96E-01	0.00E+00
44	0.00E+00	0.00E+00	2.47E-01	0.00E+00
45	0.00E+00	0.00E+00	2.06E-01	0.00E+00
46	0.00E+00	0.00E+00	1.72E-01	0.00E+00
47	0.00E+00	0.00E+00	1.44E-01	0.00E+00
48	0.00E+00	0.00E+00	1.20E-01	0.00E+00
49	0.00E+00	0.00E+00	1.00E-01	0.00E+00
50	0.00E+00	0.00E+00	8.36E-02	0.00E+00
MAXIMUM:	0.00E+00	0.00E+00	7.05E+02	0.00E+00

TABLE - 2 CLEANUP TIME ESTIMATION

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BROWN & ROOT ENVIRONMENTAL

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

E: NWS EARLE SITE 26

INVESTIGATOR: WYU

DATE: 11/15/96

CONTAMINANT:	TCE
HALF-LIFE (YRS):	
LAYER 2:	4.50E+00
UNSAT. AQUIFER	4.50E+00
SAT. AQUIFER	4.50E+00

UNSAT. SOURCE	AREA:	LAYER 2		SATURATED AQUIFER		AQUIFER CHARACTERISTICS			
INFILT (FT/YR):	0					B (FT):	15	Vzo (FT/YR):	0.8
LENGTH (FT):	400					GW Q3 (L/DAY):	9.52E+02		
WIDTH (FT):	140	Kd (L/KG):	1.66E-01	Kd (L/KG):	1.66E-01	GW V. (FT/YR):	23.36	Kd (L/KG):	0.166
POROSITY 2:	0.25	SATURATION:	0.13	SATURATION:	1.00	H (FT):	15.0000	RETARDATION:	2.18192
POROSITY GMA:	0.25	THICKNESS (FT):	0.00	THICKNESS (FT):	15.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.78	DECAY (1/DAY):	4.22E-04	DECAY (1/DAY):	4.22E-04	DISPERSIVITY:		DECAY (1/YR):	1.5E-01
DENSITY GMA (G/CM3):	1.78	CAo (PPB)	0.00E+00	CBo (PPB):	2.50E+03	Az (FT):	0.35		
				CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY):	0.00E+00	Q2 (L/DAY):	9.52E+02	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	9000

TIME INTERVAL (YRS)	1	LAYER 2 LEACHATE CONC.	SOURCE AREA CONC.(CURRENT PLUME)	DOWN-GRADIENT EXPOSURE POINT
ELAPSED TIME - YRS	LAYER 1(PPB)	(UG/L)	(UG/L)	(UG/L)
0	0.00E+00	0.00E+00	2.50E+03	0.00E+00
1	0.00E+00	0.00E+00	2.09E+03	0.00E+00
2	0.00E+00	0.00E+00	1.74E+03	0.00E+00
3	0.00E+00	0.00E+00	1.45E+03	0.00E+00
4	0.00E+00	0.00E+00	1.21E+03	0.00E+00
5	0.00E+00	0.00E+00	1.01E+03	0.00E+00
6	0.00E+00	0.00E+00	8.45E+02	0.00E+00
7	0.00E+00	0.00E+00	7.05E+02	0.00E+00
8	0.00E+00	0.00E+00	5.89E+02	0.00E+00
9	0.00E+00	0.00E+00	4.91E+02	0.00E+00
10	0.00E+00	0.00E+00	4.10E+02	0.00E+00
11	0.00E+00	0.00E+00	3.42E+02	0.00E+00
12	0.00E+00	0.00E+00	2.86E+02	0.00E+00
13	0.00E+00	0.00E+00	2.38E+02	0.00E+00
14	0.00E+00	0.00E+00	1.99E+02	0.00E+00
15	0.00E+00	0.00E+00	1.66E+02	0.00E+00
16	0.00E+00	0.00E+00	1.39E+02	0.00E+00
17	0.00E+00	0.00E+00	1.16E+02	0.00E+00
18	0.00E+00	0.00E+00	9.65E+01	0.00E+00
19	0.00E+00	0.00E+00	8.05E+01	0.00E+00
20	0.00E+00	0.00E+00	6.72E+01	0.00E+00
21	0.00E+00	0.00E+00	5.61E+01	0.00E+00
22	0.00E+00	0.00E+00	4.68E+01	0.00E+00
23	0.00E+00	0.00E+00	3.91E+01	0.00E+00
24	0.00E+00	0.00E+00	3.26E+01	0.00E+00
25	0.00E+00	0.00E+00	2.72E+01	0.00E+00
26	0.00E+00	0.00E+00	2.27E+01	0.00E+00
27	0.00E+00	0.00E+00	1.90E+01	0.00E+00
28	0.00E+00	0.00E+00	1.58E+01	0.00E+00
29	0.00E+00	0.00E+00	1.32E+01	0.00E+00
30	0.00E+00	0.00E+00	1.10E+01	0.00E+00
31	0.00E+00	0.00E+00	9.20E+00	0.00E+00
32	0.00E+00	0.00E+00	7.68E+00	0.00E+00
33	0.00E+00	0.00E+00	6.41E+00	0.00E+00
34	0.00E+00	0.00E+00	5.35E+00	0.00E+00
35	0.00E+00	0.00E+00	4.46E+00	0.00E+00
36	0.00E+00	0.00E+00	3.72E+00	0.00E+00
37	0.00E+00	0.00E+00	3.11E+00	0.00E+00
38	0.00E+00	0.00E+00	2.59E+00	0.00E+00
39	0.00E+00	0.00E+00	2.17E+00	0.00E+00
40	0.00E+00	0.00E+00	1.81E+00	0.00E+00
41	0.00E+00	0.00E+00	1.51E+00	0.00E+00
42	0.00E+00	0.00E+00	1.26E+00	0.00E+00
43	0.00E+00	0.00E+00	1.05E+00	0.00E+00
44	0.00E+00	0.00E+00	8.77E-01	0.00E+00
45	0.00E+00	0.00E+00	7.32E-01	0.00E+00
46	0.00E+00	0.00E+00	6.11E-01	0.00E+00
47	0.00E+00	0.00E+00	5.10E-01	0.00E+00
48	0.00E+00	0.00E+00	4.25E-01	0.00E+00
49	0.00E+00	0.00E+00	3.55E-01	0.00E+00
50	0.00E+00	0.00E+00	2.96E-01	0.00E+00
MAXIMUM:	0.00E+00	0.00E+00	2.50E+03	0.00E+00

TABLE - 3 SOURCE LOADING ESTIMATION

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

SITE: NWS EARLE SITE 26

INVESTIGATOR: WYU
DATE: 11/12/96

CONTAMINANT: TCE

HALF-LIFE (YRS):	
LAYER 2:	4.50E+00
UNSAT. AQUIFER	4.50E+00
SAT. AQUIFER	4.50E+00

UNSAT. SOURCE	AREA:	LAYER 2		SATURATED AQUIFER		AQUIFER CHARACTERISTICS			
INFILT (FT/YR):	3					B (FT):	15	Vzo (FT/YR):	0.8
LENGTH (FT):	10					GW Q3 (L/DAY):	9.12E+01		
WIDTH (FT):	10	Kd (L/KG):	1.66E-01	Kd (L/KG):	1.66E-01	GW V. (FT/YR):	23.36	Kd (L/KG):	0.166
POROSITY 2:	0.25	SATURATION:	0.13	SATURATION:	1.00	H (FT):	15.0000	RETARDATION:	2.18192
POROSITY GMA:	0.25	THICKNESS (FT):	0.00	THICKNESS (FT):	15.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.78	DECAY (1/DAY):	4.22E-04	DECAY (1/DAY):	4.22E-04	DISPERSIVITY:		DECAY (1/YR):	1.5E-01
DENSITY GMA (G/CM3):	1.78	CAo (PPB)	0.00E+00	CBo (PPB):	0.00E+00	Az (FT):	0.35		
				CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY):	2.33E+01	Q2 (L/DAY):	6.80E+01	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	350

TIME INTERVAL (YRS)	1	LAYER 2 LEACHATE CONC.	SOURCE AREA CONC.(LEACH TANK))	CURRENT HOT SPOT
ELAPSED TIME - YRS	LAYER 1(PPB)	(UG/L)	(UG/L)	(UG/L)
0	3.50E+07	3.50E+07	0.00E+00	0.00E+00
1	3.50E+07	3.50E+07	6.42E+06	0.00E+00
2	3.50E+07	3.50E+07	7.73E+06	1.71E-08
3	3.50E+07	3.50E+07	8.00E+06	3.50E-02
4	3.50E+07	3.50E+07	8.05E+06	4.52E+00
5	3.50E+07	3.50E+07	8.06E+06	5.15E+01
6	0.00E+00	0.00E+00	1.64E+06	2.23E+02
7	0.00E+00	0.00E+00	3.34E+05	5.88E+02
8	0.00E+00	0.00E+00	6.80E+04	1.17E+03
9	0.00E+00	0.00E+00	1.38E+04	1.92E+03
10	0.00E+00	0.00E+00	2.82E+03	2.76E+03
11	0.00E+00	0.00E+00	5.73E+02	3.54E+03
12	0.00E+00	0.00E+00	1.17E+02	4.13E+03
13	0.00E+00	0.00E+00	2.38E+01	4.49E+03
14	0.00E+00	0.00E+00	4.84E+00	4.62E+03
15	0.00E+00	0.00E+00	9.84E-01	4.55E+03
16	0.00E+00	0.00E+00	2.00E-01	4.35E+03
17	0.00E+00	0.00E+00	4.08E-02	4.04E+03
18	0.00E+00	0.00E+00	8.30E-03	3.69E+03
19	0.00E+00	0.00E+00	1.69E-03	3.31E+03
20	0.00E+00	0.00E+00	3.44E-04	2.94E+03
21	0.00E+00	0.00E+00	7.00E-05	2.58E+03
22	0.00E+00	0.00E+00	1.43E-05	2.25E+03
23	0.00E+00	0.00E+00	2.90E-06	1.95E+03
24	0.00E+00	0.00E+00	5.91E-07	1.68E+03
25	0.00E+00	0.00E+00	1.20E-07	1.44E+03
26	0.00E+00	0.00E+00	2.45E-08	1.23E+03
27	0.00E+00	0.00E+00	4.98E-09	1.05E+03
28	0.00E+00	0.00E+00	1.01E-09	8.87E+02
29	0.00E+00	0.00E+00	2.06E-10	7.51E+02
30	0.00E+00	0.00E+00	4.20E-11	6.34E+02
31	0.00E+00	0.00E+00	8.55E-12	5.35E+02
32	0.00E+00	0.00E+00	1.74E-12	4.50E+02
33	0.00E+00	0.00E+00	3.54E-13	3.79E+02
34	0.00E+00	0.00E+00	7.21E-14	3.18E+02
35	0.00E+00	0.00E+00	1.47E-14	2.67E+02
36	0.00E+00	0.00E+00	2.99E-15	2.23E+02
37	0.00E+00	0.00E+00	6.08E-16	1.87E+02
38	0.00E+00	0.00E+00	1.24E-16	1.57E+02
39	0.00E+00	0.00E+00	2.52E-17	1.31E+02
40	0.00E+00	0.00E+00	5.13E-18	1.09E+02
41	0.00E+00	0.00E+00	1.04E-18	9.14E+01
42	0.00E+00	0.00E+00	2.13E-19	7.63E+01
43	0.00E+00	0.00E+00	4.33E-20	6.37E+01
44	0.00E+00	0.00E+00	8.81E-21	5.32E+01
45	0.00E+00	0.00E+00	1.79E-21	4.43E+01
46	0.00E+00	0.00E+00	3.65E-22	3.70E+01
47	0.00E+00	0.00E+00	7.43E-23	3.08E+01
48	0.00E+00	0.00E+00	1.51E-23	2.57E+01
49	0.00E+00	0.00E+00	3.08E-24	2.14E+01
50	0.00E+00	0.00E+00	6.26E-25	1.78E+01
MAXIMUM:	3.50E+07	3.50E+07	8.06E+06	4.62E+03

TABLE - 4 SOURCE LOADING ESTIMATION

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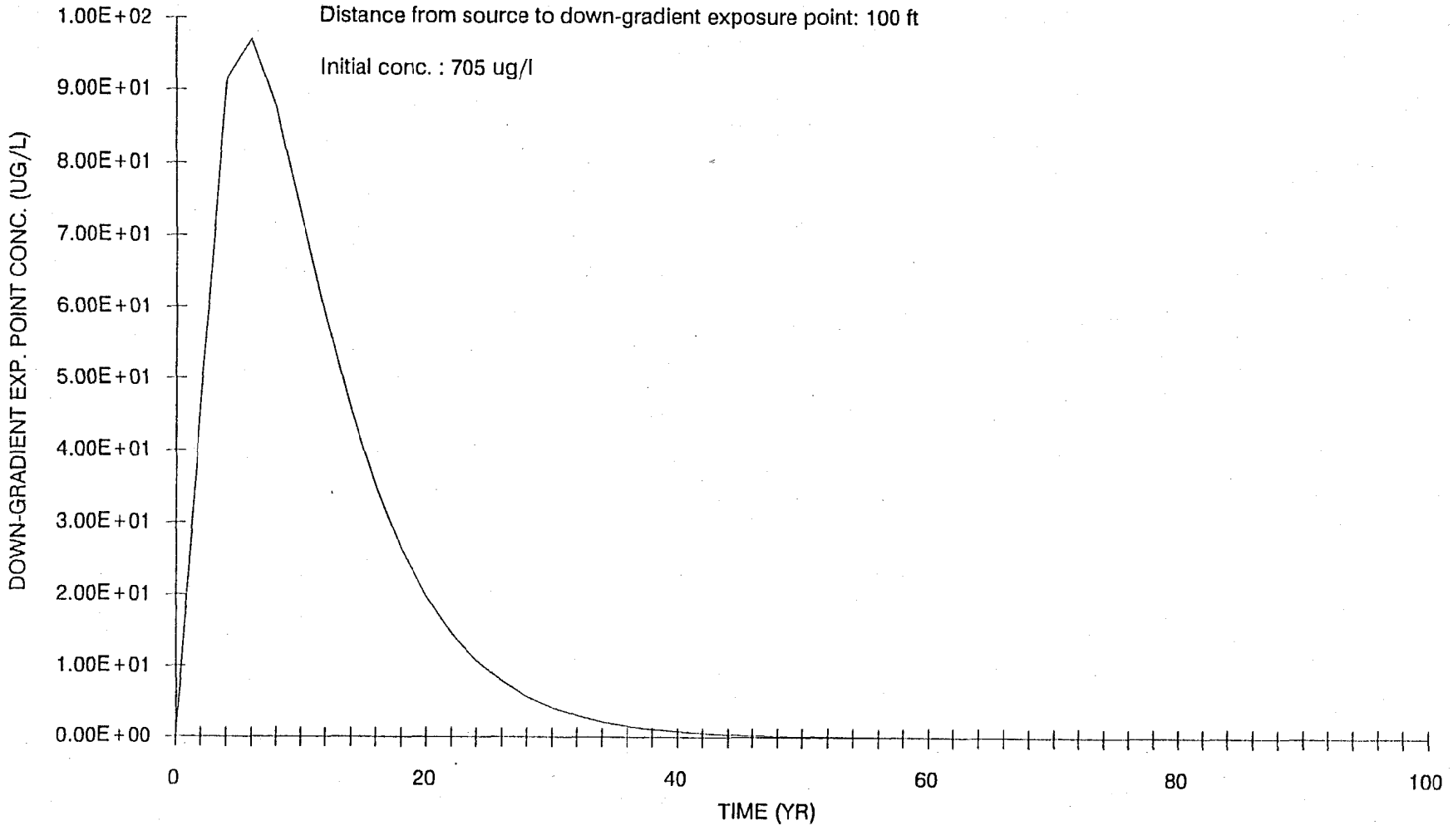
BROWN & ROOT ENVIRONMENTAL

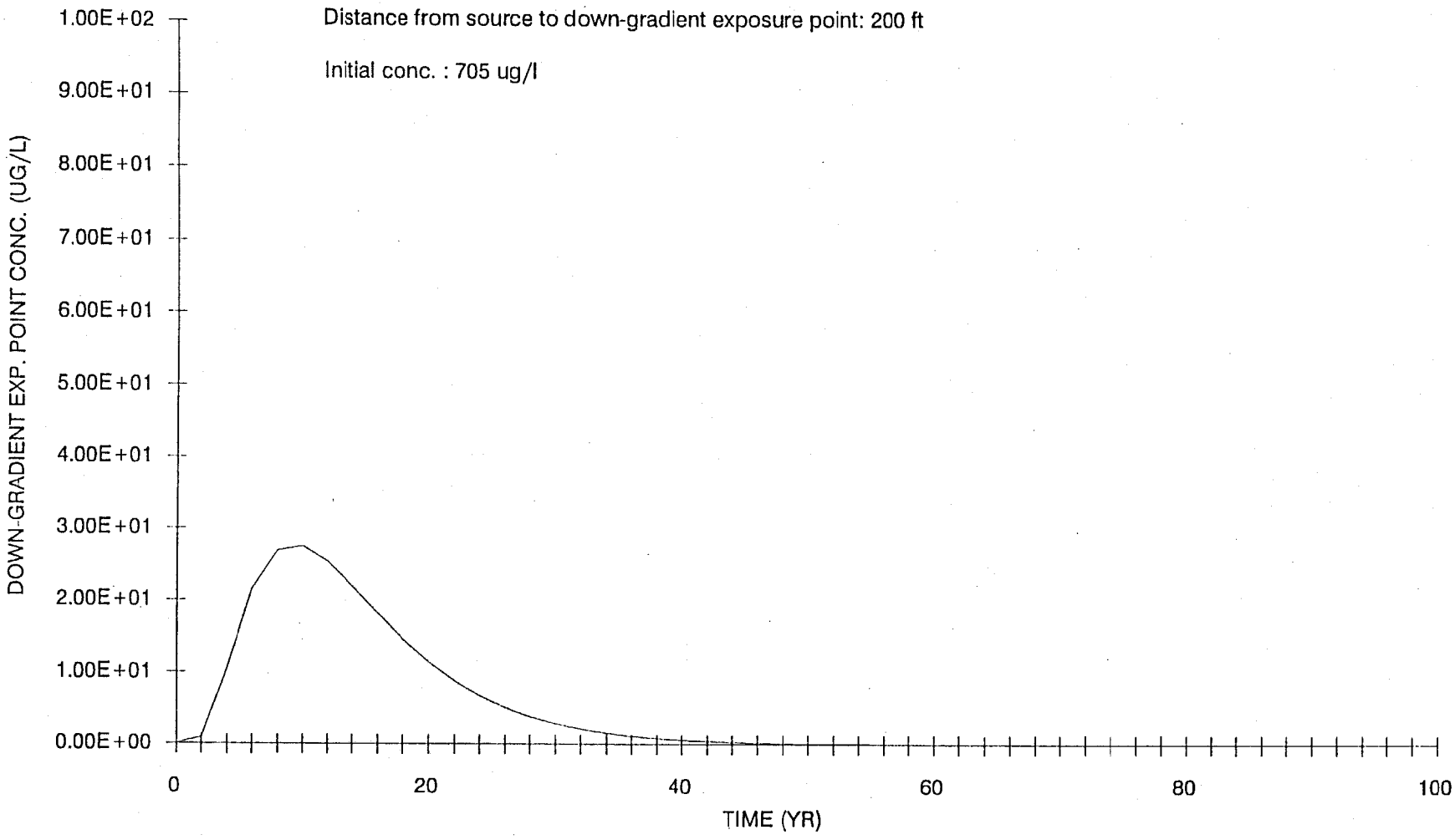
SCREENING-LEVEL EXCEL-CRYSTAL BALL TRANSPORT (ECTran) MODEL

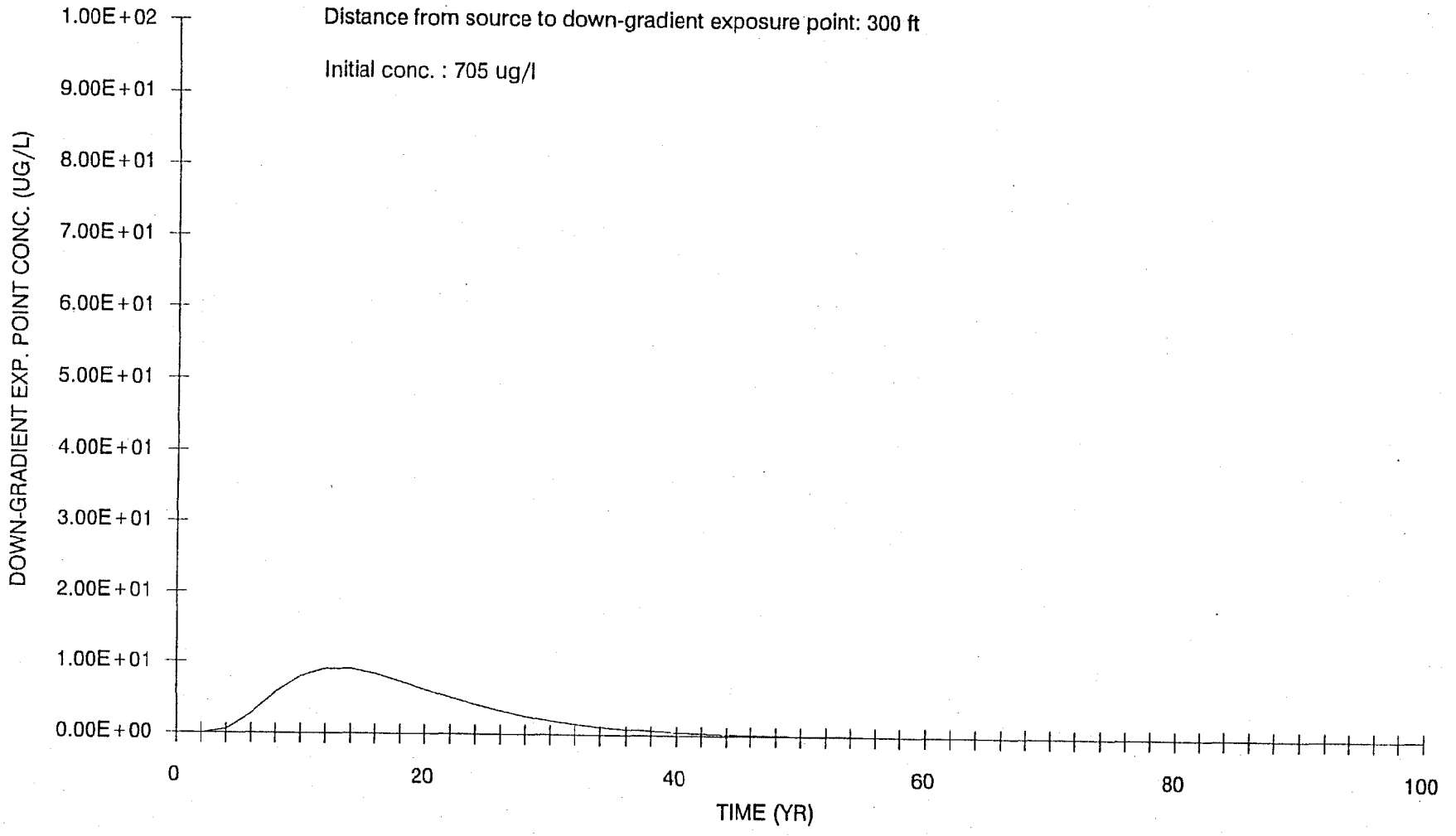
SITE:	NWS EARLE SITE 26	CONTAMINANT:	TCE
		HALF-LIFE (YRS):	
		LAYER 2:	4.50E+00
INVESTIGATOR:	WYU	UNSAT. AQUIFER	4.50E+00
DATE:	11/12/96	SAT. AQUIFER	4.50E+00

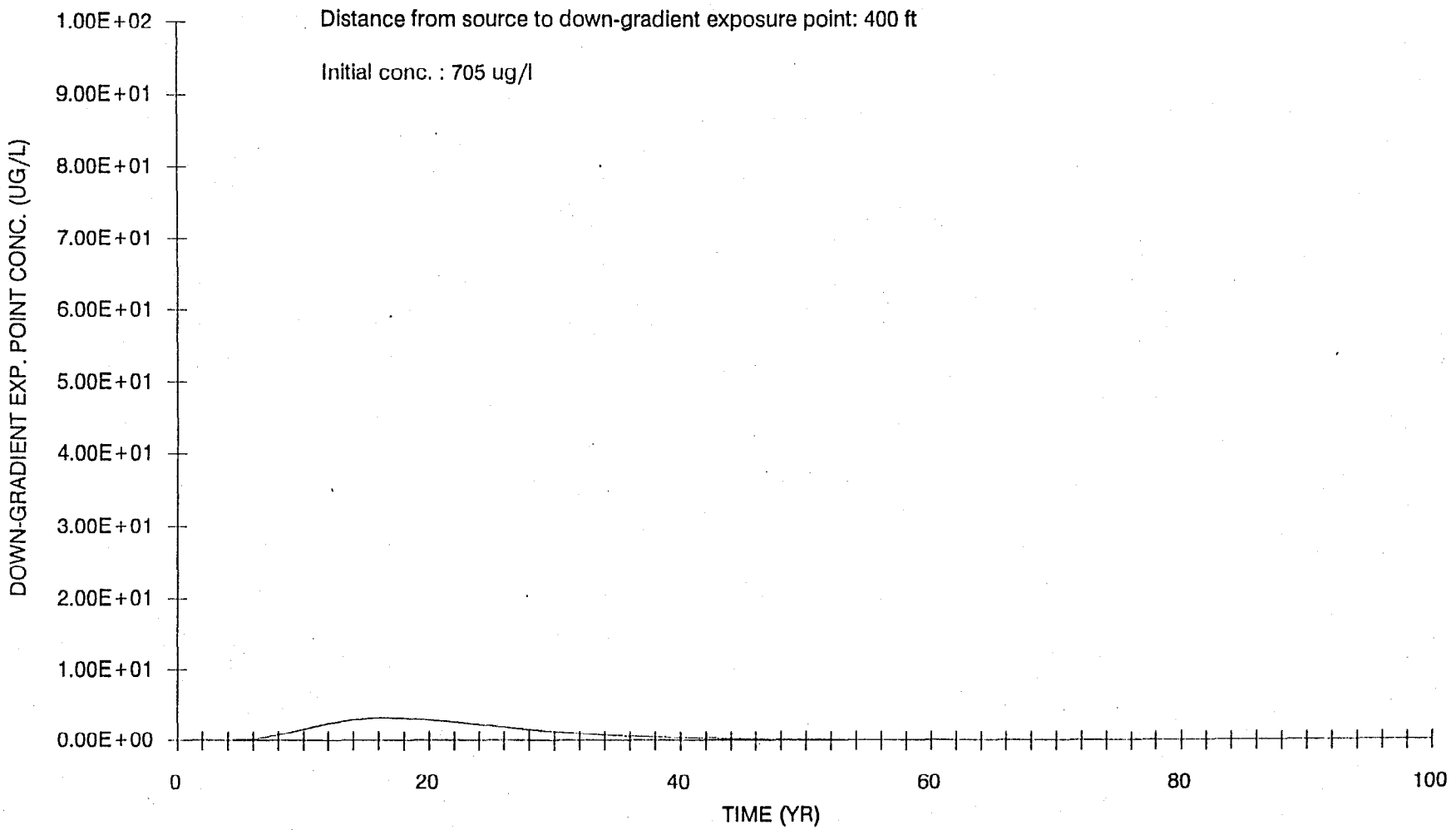
UNSAT. SOURCE	AREA:	LAYER 2		SATURATED AQUIFER		AQUIFER CHARACTERISTICS			
INFILT (FT/YR):	3					B (FT):	15	Vzo (FT/YR):	0.8
LENGTH (FT):	10					GW Q3 (L/DAY):	9.12E+01		
WIDTH (FT):	10	Kd (L/KG):	1.66E-01	Kd (L/KG):	1.66E-01	GW V. (FT/YR):	23.36	Kd (L/KG):	0.166
POROSITY 2:	0.25	SATURATION:	0.13	SATURATION:	1.00	H (FT):	15.0000	RETARDATION:	2.18192
POROSITY GMA:	0.25	THICKNESS (FT):	0.00	THICKNESS (FT):	15.00	EFF. POROSITY:	0.25	q (FT/YR) :	0
DENSITY 2 (G/CM3):	1.78	DECAY (1/DAY):	4.22E-04	DECAY (1/DAY):	4.22E-04	DISPERSIVITY:		DECAY (1/YR):	1.5E-01
DENSITY GMA (G/CM3):	1.78	CAo (PPB)	0.00E+00	CBo (PPB):	0.00E+00	Az (FT):	0.35		
				CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY):	2.33E+01	Q2 (L/DAY):	6.80E+01	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	350

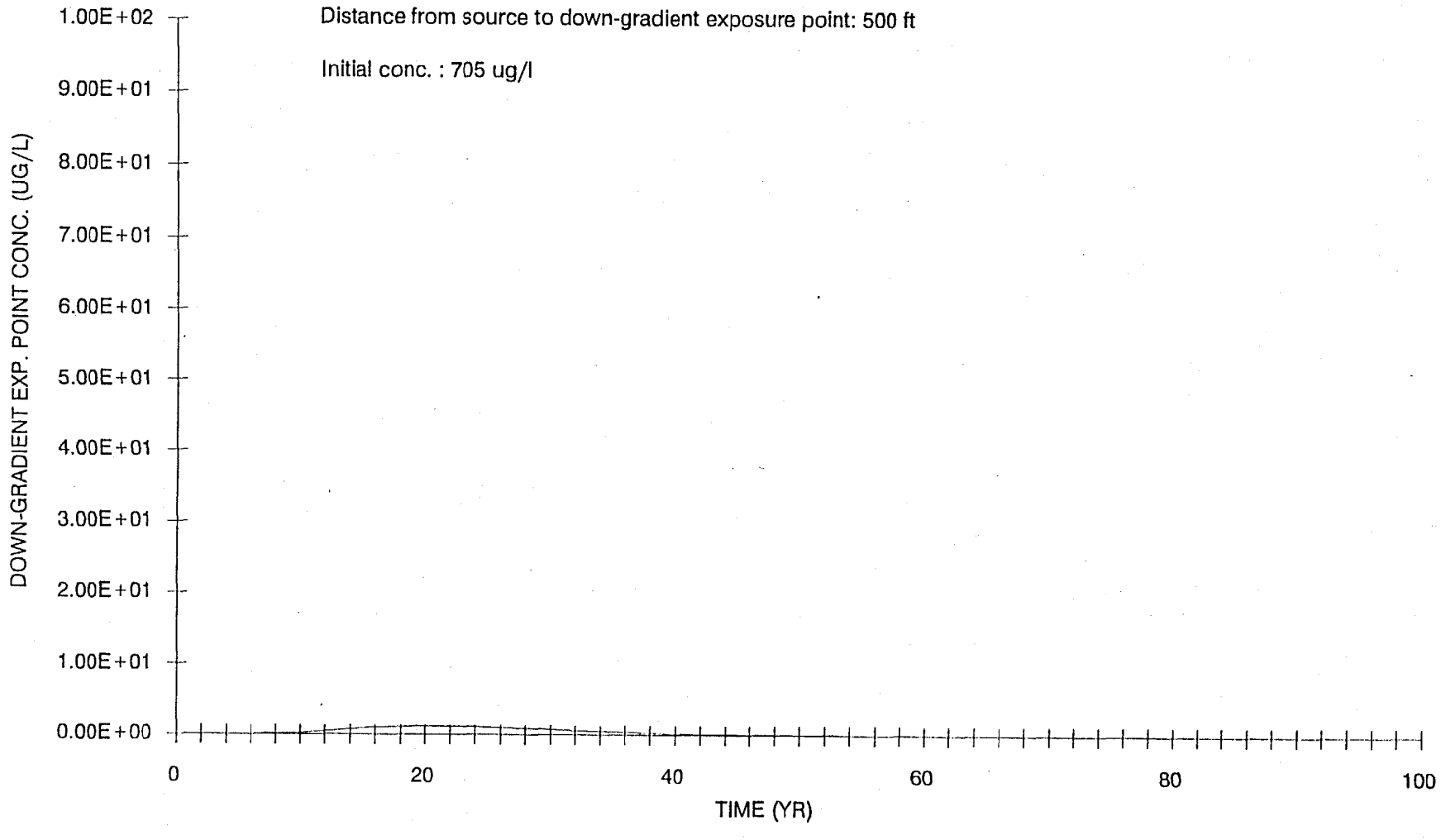
TIME INTERVAL (YRS)	2.5	LAYER 2 LEACHATE CONC.	SOURCE AREA CONC.(LEACH TANK))	CURRENT HOT SPOT
ELAPSED TIME - YRS	LAYER 1(PPB)	(UG/L)	(UG/L)	(UG/L)
0	3.50E+07	3.50E+07	0.00E+00	0.00E+00
2.5	3.50E+07	3.50E+07	7.91E+06	0.00E+00
5	3.50E+07	3.50E+07	8.06E+06	7.97E-01
7.5	0.00E+00	0.00E+00	1.51E+05	2.62E+02
10	0.00E+00	0.00E+00	2.82E+03	1.67E+03
12.5	0.00E+00	0.00E+00	5.27E+01	3.70E+03
15	0.00E+00	0.00E+00	9.84E-01	4.63E+03
17.5	0.00E+00	0.00E+00	1.84E-02	4.30E+03
20	0.00E+00	0.00E+00	3.44E-04	3.42E+03
22.5	0.00E+00	0.00E+00	6.43E-06	2.51E+03
25	0.00E+00	0.00E+00	1.20E-07	1.75E+03
27.5	0.00E+00	0.00E+00	2.25E-09	1.19E+03
30	0.00E+00	0.00E+00	4.20E-11	7.86E+02
32.5	0.00E+00	0.00E+00	7.85E-13	5.15E+02
35	0.00E+00	0.00E+00	1.47E-14	3.34E+02
37.5	0.00E+00	0.00E+00	2.74E-16	2.15E+02
40	0.00E+00	0.00E+00	5.13E-18	1.38E+02
42.5	0.00E+00	0.00E+00	9.59E-20	8.78E+01
45	0.00E+00	0.00E+00	1.79E-21	5.59E+01
47.5	0.00E+00	0.00E+00	3.35E-23	3.55E+01
50	0.00E+00	0.00E+00	6.26E-25	2.25E+01
52.5	0.00E+00	0.00E+00	1.17E-26	1.42E+01
55	0.00E+00	0.00E+00	2.19E-28	9.01E+00
57.5	0.00E+00	0.00E+00	4.09E-30	5.70E+00
60	0.00E+00	0.00E+00	7.65E-32	3.60E+00
62.5	0.00E+00	0.00E+00	1.43E-33	2.27E+00
65	0.00E+00	0.00E+00	2.67E-35	1.43E+00
67.5	0.00E+00	0.00E+00	5.00E-37	9.06E-01
70	0.00E+00	0.00E+00	9.34E-39	5.71E-01
72.5	0.00E+00	0.00E+00	1.75E-40	3.61E-01
75	0.00E+00	0.00E+00	3.26E-42	2.27E-01
77.5	0.00E+00	0.00E+00	6.10E-44	1.43E-01
80	0.00E+00	0.00E+00	1.14E-45	9.05E-02
82.5	0.00E+00	0.00E+00	2.13E-47	5.71E-02
85	0.00E+00	0.00E+00	3.99E-49	3.60E-02
87.5	0.00E+00	0.00E+00	7.45E-51	2.27E-02
90	0.00E+00	0.00E+00	1.39E-52	1.43E-02
92.5	0.00E+00	0.00E+00	2.60E-54	9.04E-03
95	0.00E+00	0.00E+00	4.87E-56	5.71E-03
97.5	0.00E+00	0.00E+00	9.10E-58	3.60E-03
100	0.00E+00	0.00E+00	1.70E-59	2.27E-03
102.5	0.00E+00	0.00E+00	3.18E-61	1.43E-03
105	0.00E+00	0.00E+00	5.94E-63	9.05E-04
107.5	0.00E+00	0.00E+00	1.11E-64	5.71E-04
110	0.00E+00	0.00E+00	2.08E-66	3.61E-04
112.5	0.00E+00	0.00E+00	3.88E-68	2.28E-04
115	0.00E+00	0.00E+00	7.26E-70	1.44E-04
117.5	0.00E+00	0.00E+00	1.36E-71	9.08E-05
120	0.00E+00	0.00E+00	2.54E-73	5.73E-05
122.5	0.00E+00	0.00E+00	4.74E-75	3.62E-05
125	0.00E+00	0.00E+00	8.86E-77	2.29E-05
MAXIMUM:	3.50E+07	3.50E+07	8.06E+06	4.63E+03

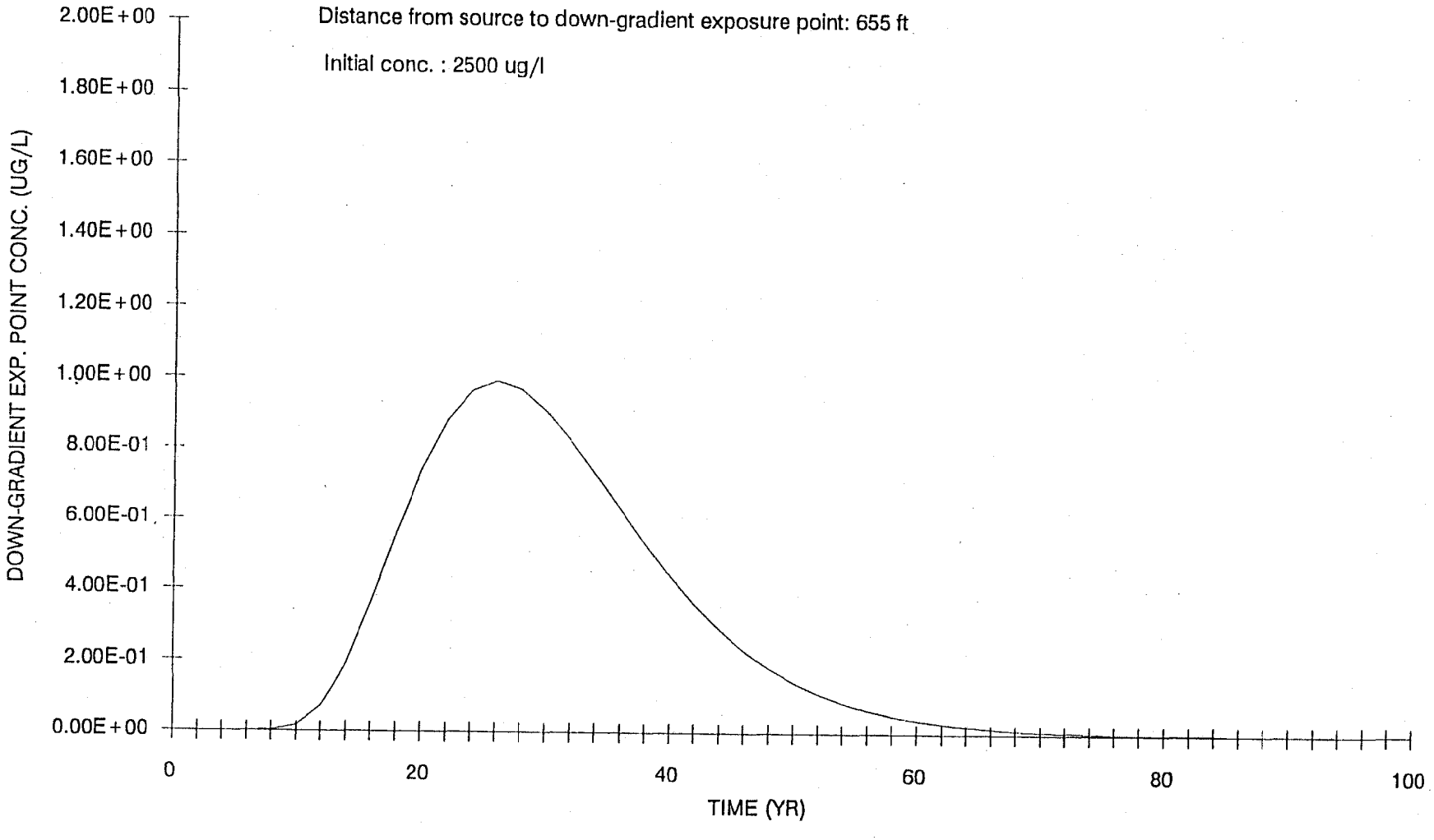

Distance from source to down-gradient exposure point: 100 ft
Initial conc. : 705 ug/l
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
1.00E+02
9.00E+01
8.00E+01
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
0
20
40
60
80
100
TIME (YR)

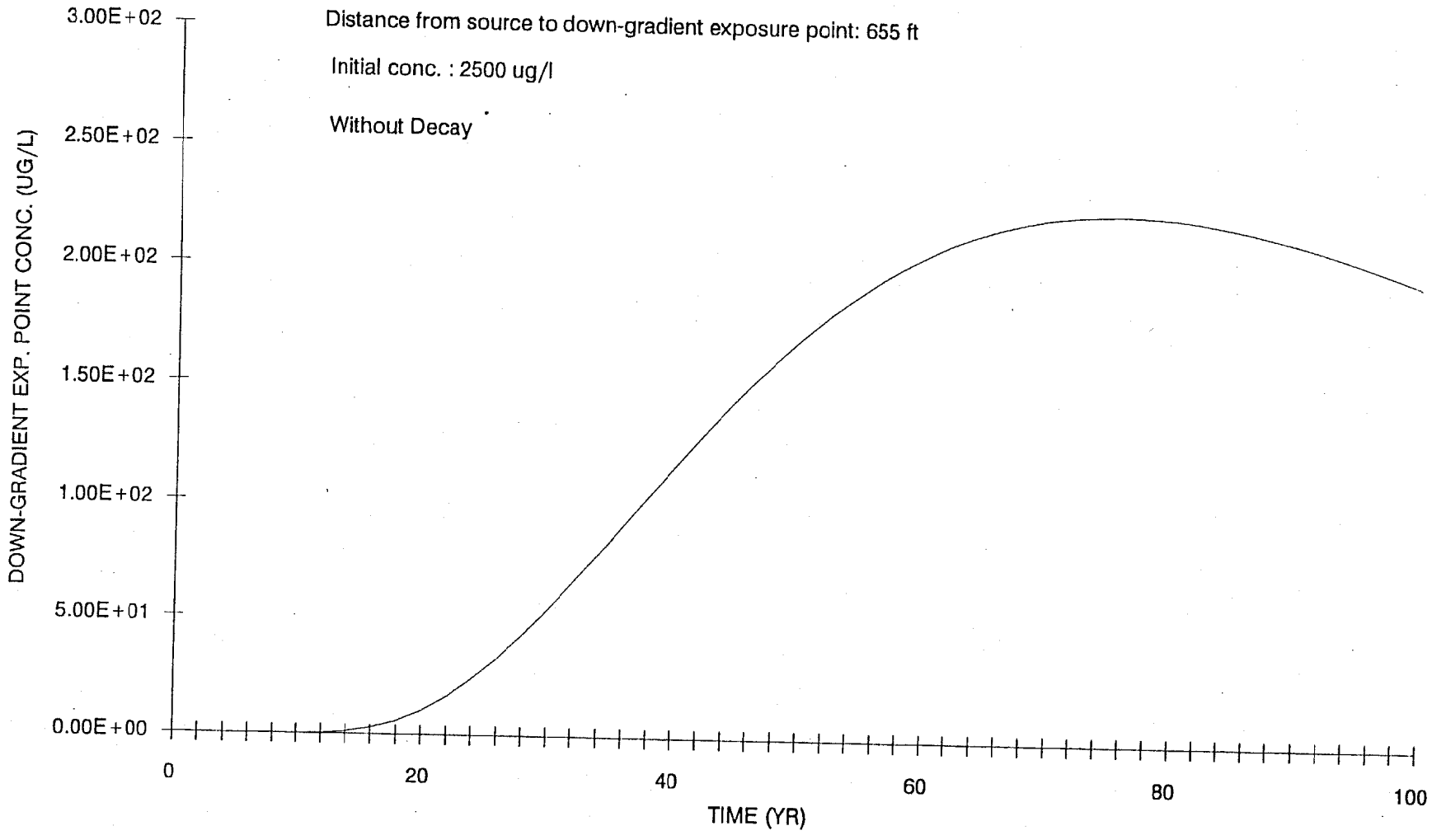

Distance from source to down-gradient exposure point: 200 ft
Initial conc. : 705 ug/l
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
1.00E+02
9.00E+01
8.00E+01
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
0
20
40
60
80
100
TIME (YR)


Distance from source to down-gradient exposure point: 300 ft
Initial conc. : 705 ug/l
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
1.00E+02
9.00E+01
8.00E+01
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
0
20
40
60
80
100
TIME (YR)


Distance from source to down-gradient exposure point: 400 ft
Initial conc. : 705 ug/l
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
1.00E+02
9.00E+01
8.00E+01
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
0
20
40
60
80
100
TIME (YR)


Distance from source to down-gradient exposure point: 500 ft
Initial conc. : 705 ug/l
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
1.00E+02
9.00E+01
8.00E+01
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
0
20
40
60
80
100
TIME (YR)


Distance from source to down-gradient exposure point: 655 ft
Initial conc. : 2500 ug/l
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
2.00E+00
1.80E+00
1.60E+00
1.40E+00
1.20E+00
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
0
20
40
60
80
100
TIME (YR)


Distance from source to down-gradient exposure point: 655 ft
Initial conc. : 2500 ug/l
Without Decay
DOWN-GRADIENT EXP. POINT CONC. (UG/L)
3.00E+02
2.50E+02
2.00E+02
1.50E+02
1.00E+02
5.00E+01
0.00E+00
0
20
40
60
80
100
TIME (YR)

SITE 4, 5, AND 19 GROUNDWATER MODELING

To: Liyang Chu/Wilmington **C.C.:** Diane McKenna/Wilmington

From: J.D. Chiou/Pittsburgh

Subject: ECTran modeling of TCE contaminant plume
NWS Earle Sites 4, 5, and 19
CTO 279, Job No. 7452.0201

Date: January 3, 1997

RECEIVED
Brown & Root Environmental
Wilmington, Massachusetts 01887

OBJECTIVES

In response to the regulatory comments on the previously submitted FS report, potential impacts of inorganic COCs identified in NWS Earle Sites 4, 5, and 19 through groundwater pathway need to be further evaluated. Quantitative estimates of the COC-specific maximum groundwater concentrations at the nearest potential groundwater exposure points associated with each of the three sites are required for this evaluation. An ECTran modeling task was conducted to provide the necessary estimations to support the evaluation. This memo summarizes the modeling approach used and important results obtained.

GENERAL APPROACH

The 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 - COCs were selected based on comparisons between the groundwater monitoring data in the impacted and background areas.

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

- Conceptualize 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. The potential groundwater exposure point is either an on-property surface water body where contaminated groundwater may discharge into or the

property line.

- Estimate the maximum groundwater concentrations 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.

- Estimate the maximum extent of groundwater plume - ECTran model simulations were conducted to determine the maximum extent of further plume migration before groundwater concentration become acceptable.

SITE-SPECIFIC ASSUMPTIONS

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

SITE 4:

• Source Area Plume Size	600 feet (L) x 600 feet (W)
• Exposure Point	surface water stream 400 feet downgradient (see Figure 1)
• Hydraulic Conductivity	4.48×10^{4} cm/s (1.27 feet/day)
• Hydraulic Gradient	0.008
• Effective Porosity	0.25
• Infiltration Rate	13 inches/year (before capping)
• Impacted Saturated Zone Thickness	30 feet (aquifer thickness)
• Initial COC Groundwater Concentrations	
Barium	580.96 ug/l
Iron	11849.29 ug/l
Manganese	165.10 ug/l
• Additional Source Loading	None (after capping)

SITE 5:

• Source Area Plume Size	375 feet (L) x 700 feet (W)
• Exposure Point	surface water stream 3500 feet downgradient (see Figure 2)

- Hydraulic Conductivity — 3.18×10^{-4} cm/s (0.90 feet/day)
- Hydraulic Gradient — 0.002
- Effective Porosity — 0.25
- Infiltration Rate — 13 inches/year (before capping)
- Impacted Saturated Zone Thickness — 30 feet (based on mixing zone calculation)
- Initial COC Groundwater Concentrations

Aluminum	17212.11 ug/l
Cadmium	4.51 ug/l
Iron	23714.18 ug/l
Nickel	47.82 ug/l
Manganese	302.00 ug/l

- Additional Source Loading — None (after capping)

SITE 19

- Source Area Plume Size — 200 feet (L) x 150 feet (W)
- Exposure Point — surface water stream 500 feet downgradient (see Figure 3)
- Hydraulic Conductivity — 6.91×10^{-4} cm/s (1.96 feet/day)
- Hydraulic Gradient — 0.01
- Effective Porosity — 0.25
- Infiltration Rate — 13 inches/year
- Impacted Saturated Zone Thickness — 30 feet (based on mixing zone calculation)
- Initial COC Groundwater Concentrations

Aluminum	9610.00 ug/l
Arsenic	27.40 ug/l
Cadmium	7.50 ug/l
Lead	17.20 ug/l
Thallium	28.90 ug/l
Manganese	185.00 ug/l

- Additional Source Loading (from 12 feet of residual contaminated soil)

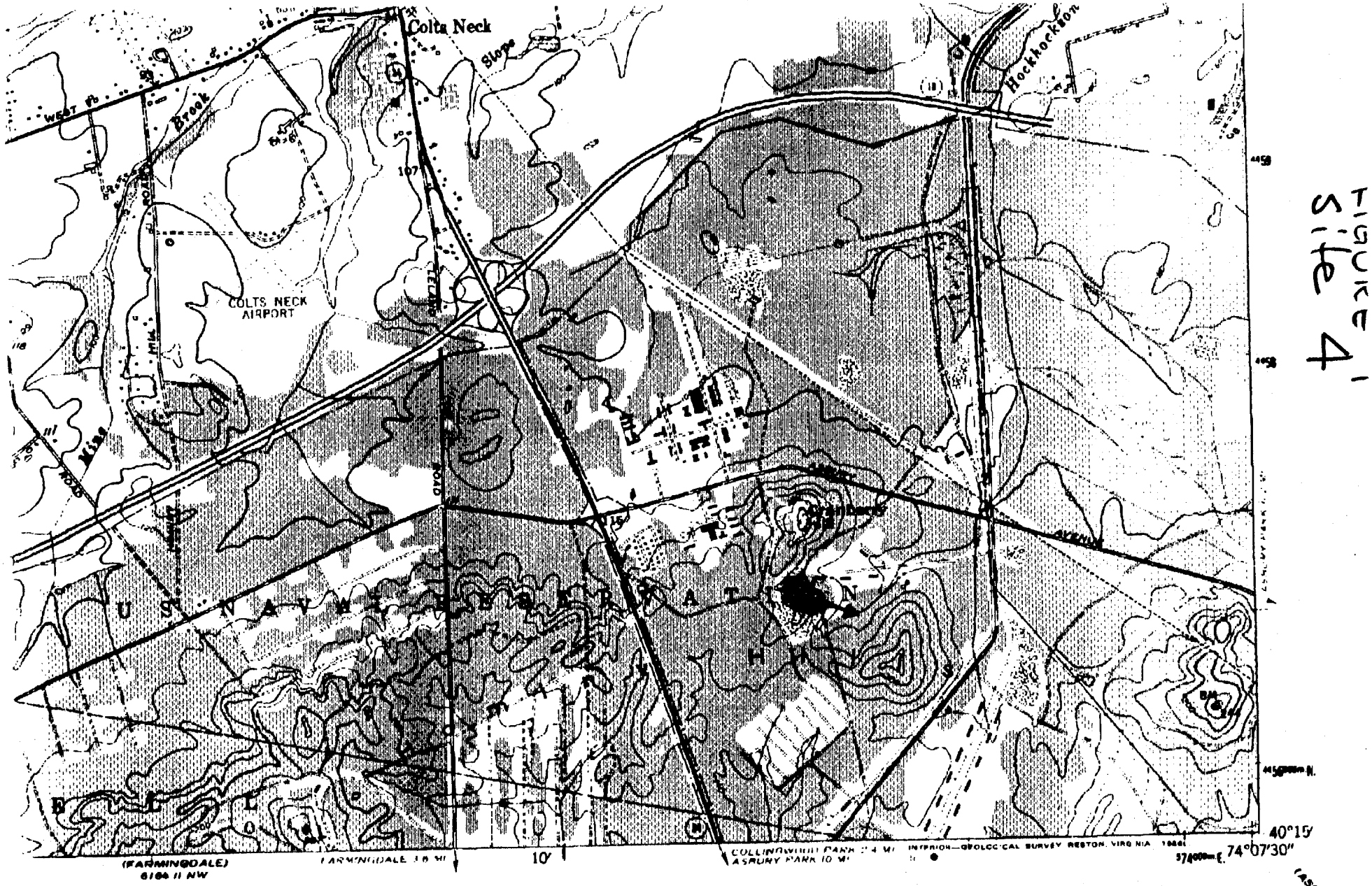
Aluminum	1658.00 mg/kg

Arsenic	1.60 mg/kg
Cadmium	0.09 mg/kg
Lead	1305.00 mg/kg
Thallium	3.00 mg/kg
Manganese	2.20 mg/kg

SUMMARY OF RESULTS

Table 1 lists the estimated COC-specific maximum groundwater concentration at the site-specific nearest exposure points within 1000 years. As shown in the table, all the estimated concentrations are much lower than the relevant groundwater criteria. The main reason for the low groundwater concentrations is the high K_d (and therefore low mobilities) associated with the inorganic constituents evaluated. Because no site-specific K_d value was available, the representative K_d values were selected from three commonly used references.

Table 2 summarizes the distances of further migration of each of the COCs from each site. The distance of further migration is defined as the maximum distance from the source area where future groundwater concentration may exceed the relevant criteria within 1000 years. As shown in Table 2, no significant further migration from any source area for any COC is expected. All the maximum extents of groundwater plumes are expected to remain in the base boundary and not to impact the major on-property surface water bodies.



SCALE 1:24 000

0 — 1 MILE

1000 2000 3000 4000 5000 6000 7000 FEET

5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

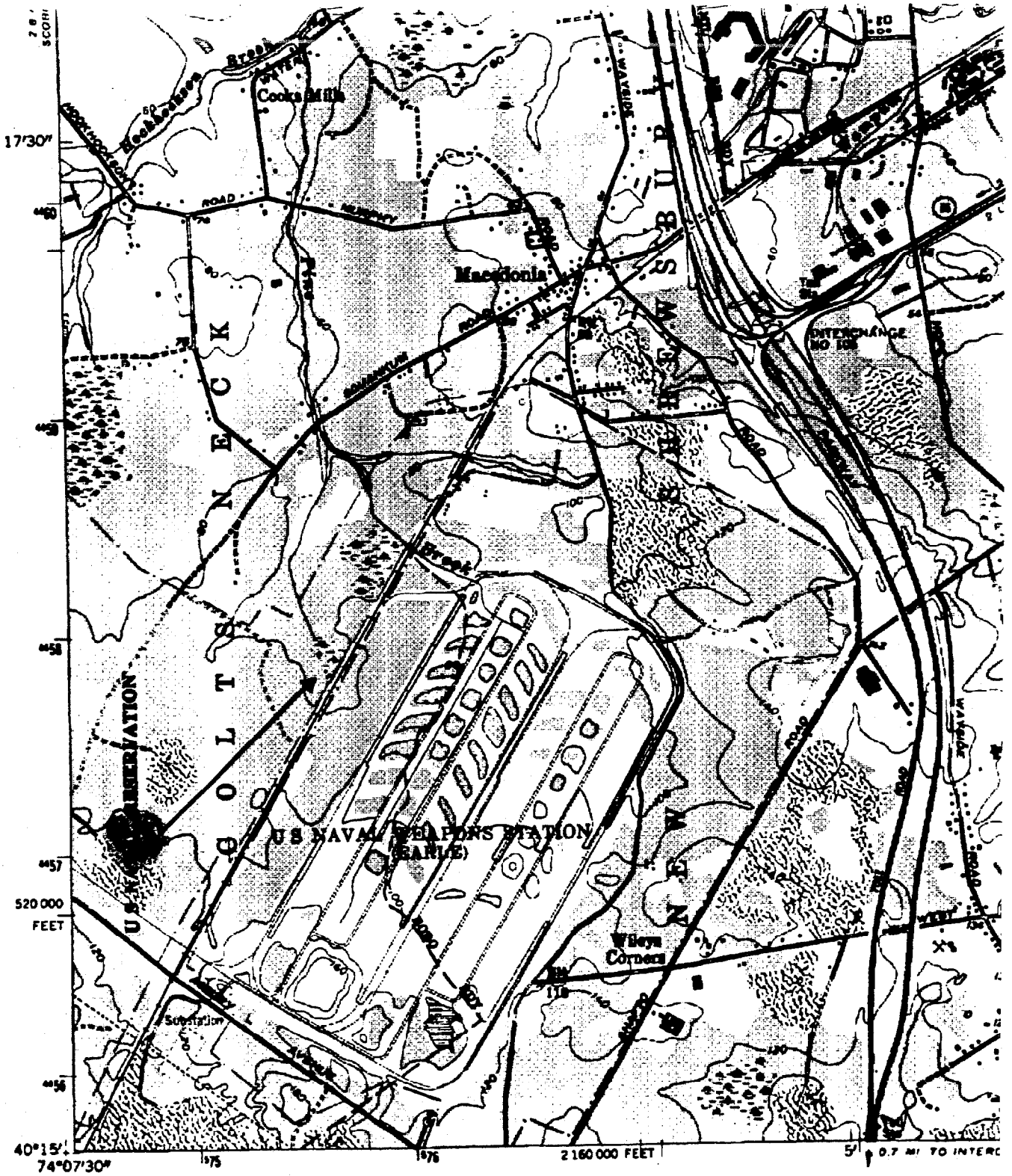
ROAD CLASSIFICATION

Heavy-duty
Medium duty
Light-duty
Unimproved dirt
U. S. Route
State Route

NEW JERSEY

FIGURE 4
Site

FIGURE 2
Site 5



(FARMINGDALE) 6168 II NW

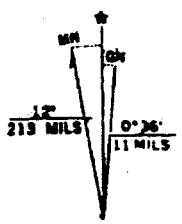
Mapped by the Defense Mapping Agency
Edited and published by the Geological Survey

Control by USGS, USCE, and New Jersey Geodetic Survey

Culture and drainage in part compiled from aerial photographs taken 1941. Topography by planetable surveys 1944. Culture revised by the Geological Survey 1954

Hydrography compiled from NOS chart 824 (1953)
This information is not intended for navigational purposes

Polyconic projection. 10,000-foot grid ticks based on New Jersey coordinate system. 1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue. 1927 North American Datum. To place on the predicted North American Datum 1983 move the projection lines 6 meters south and 35 meters west as shown by dashed corner ticks



UTM GRID AND 1981 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

FIGURE 3

Site 19

Table 1

Maximum Exposure Point Concentration

Site	Chemical	CAS No.	Partitioning Coef. Kd L/kg	Ref	GW Criteria From FS Report (ug/L)		Max. Conc. At Exp. Point (ug/L)		
							Site 4	Site 5	Site 19
5,19	Aluminum	7429-90-5	1500	(2)	7870	Background		0	0
19	Arsenic	7440-38-2	29	(1)	8	NJ GWQS			4.97E-02
4	Barium	7440-39-3	41	(1)	518	Background	2.60E-04		
5,19	Cadmium	7440-43-9	75	(1)	4	NJ GWQS		0	6.77E-08
4,5	Iron	7439-89-6	220	(3)	7690	Background	0	0	
19	Lead	7439-92-1	270	(3)	10	NJ GWQS			0
4,5,19	Manganese	7439-96-5	50	(3)	65	Background	1.83E-06	0	1.26E-03
5	Nickel	7440-02-0	65	(1)	100	NJ GWQS		0	
19	Thallium	7440-28-0	71	(1)	10	NJ GWQS			7.67E-07

(1) USEPA, Soil Screening Guidence, 1996
(2) Thibault 1990.
(3) Bases and Sharp, 1984.

Table 2

Distance of Further Migration

Site	Chemical	CAS No.	Partitioning Coef. Kd L/kg	Ref	GW Criteria From FS Report (ug/L)		Distance of Further Migration (4) (feet)		
							Site 4	Site 5	Site 19
5,19	Aluminum	7429-90-5	1500	(2)	7870	Background		0.4	2.2
19	Arsenic	7440-38-2	29	(1)	8	NJ GWQS			191.0
4	Barium	7440-39-3	41	(1)	518	Background	32.0		
5,19	Cadmium	7440-43-9	75	(1)	4	NJ GWQS		4.0	55.0
4,5	Iron	7439-89-6	220	(3)	7690	Background	10.0	3.0	
19	Lead	7439-92-1	270	(3)	10	NJ GWQS			30.0
4,5,19	Manganese	7439-96-5	50	(3)	65	Background	55.0	13.0	105.0
5	Nickel	7440-02-0	65	(1)	100	NJ GWQS		0.0	
19	Thallium	7440-28-0	71	(1)	10	NJ GWQS			79.0

(1) USEPA, Soil Screening Guidence, 1996
(2) Thibault 1990.
(3) Bases and Sharp, 1984.
(4) Distance of further migration is defined as the maximum distance from source area where the maximum concentration in 1000-year time frame may reach the value of growndwater criteria.

Table 1

Maximum Exposure Point Concentration

Site	Chemical	CAS No.	Partitioning Coef. Kd L/kg	Ref	GW Criteria From FS Report (ug/L)		Max. Conc. At Exp. Point (ug/L)		
							Site 4	Site 5	Site 19
5,19	Aluminum	7429-90-5	1500	(2)	7870	Background		0	0
19	Arsenic	7440-38-2	29	(1)	8	NJ GWQS			4.97E-02
4	Barium	7440-39-3	41	(1)	518	Background	2.60E-04		
5,19	Cadmium	7440-43-9	75	(1)	4	NJ GWQS		0	6.77E-08
4,5	Iron	7439-89-6	220	(3)	7690	Background	0	0	
19	Lead	7439-92-1	270	(3)	10	NJ GWQS			0
4,5,19	Manganese	7439-96-5	50	(3)	65	Background	1.83E-06	0	1.26E-03
5	Nickel	7440-02-0	65	(1)	100	NJ GWQS		0	
19	Thallium	7440-28-0	71	(1)	10	NJ GWQS			7.67E-07

(1) USEPA, Soil Screening Guidence, 1996
(2) Thibault 1990.
(3) Bases and Sharp, 1984.

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SITE: NAVAL WEAPONS STATION< EARLE NJ, S4 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT	Barium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
HALF-LIFE (YRS):	0.00E+00	WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
				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):	0.00E+00
Kl (L/KG):	4.10E+01		
CONSTANT SOURCE CONCENTRATION (UG/L)	0.00E+00	LENGTH (FT):	600
		WIDTH (FT):	600
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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:	0.2
POROSITY:	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	14.8	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	4.10E+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):	40.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	13.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L).	580.96	DISTANCE TO F.L.:	400

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	5.81E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	2.60E-04 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION< EARLE NJ, S4	CONTAMINANT:	Barium
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	5.81E+02

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	600			GW Q3 (L/DAY):	5.17E+03		
WIDTH (FT):	600	Kd (L/KG):	4.10E+01	GW V. (FT/YR):	14.80	Kd (L/KG):	41
POROSITY 2:	0.3	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	247
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):	5.81E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	40.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 5.17E+03	Ay (FT):	13.33	DISTANCE TO F.L. (FT):	400

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		5.81E+02	0.00E+00
20	0.00E+00		5.80E+02	0.00E+00
40	0.00E+00		5.79E+02	0.00E+00
60	0.00E+00		5.77E+02	0.00E+00
80	0.00E+00		5.76E+02	0.00E+00
100	0.00E+00		5.75E+02	0.00E+00
120	0.00E+00		5.74E+02	0.00E+00
140	0.00E+00		5.73E+02	0.00E+00
160	0.00E+00		5.72E+02	0.00E+00
180	0.00E+00		5.71E+02	0.00E+00
200	0.00E+00		5.69E+02	0.00E+00
220	0.00E+00		5.68E+02	0.00E+00
240	0.00E+00		5.67E+02	0.00E+00
260	0.00E+00		5.66E+02	0.00E+00
280	0.00E+00		5.65E+02	0.00E+00
300	0.00E+00		5.64E+02	0.00E+00
320	0.00E+00		5.63E+02	0.00E+00
340	0.00E+00		5.62E+02	0.00E+00
360	0.00E+00		5.60E+02	0.00E+00
380	0.00E+00		5.59E+02	0.00E+00
400	0.00E+00		5.58E+02	0.00E+00
420	0.00E+00		5.57E+02	0.00E+00
440	0.00E+00		5.56E+02	0.00E+00
460	0.00E+00		5.55E+02	0.00E+00
480	0.00E+00		5.54E+02	0.00E+00
500	0.00E+00		5.53E+02	0.00E+00
520	0.00E+00		5.52E+02	0.00E+00
540	0.00E+00		5.50E+02	0.00E+00
560	0.00E+00		5.49E+02	0.00E+00
580	0.00E+00		5.48E+02	1.25E-09
600	0.00E+00		5.47E+02	3.30E-09
620	0.00E+00		5.46E+02	8.19E-09
640	0.00E+00		5.45E+02	1.92E-08
660	0.00E+00		5.44E+02	4.27E-08
680	0.00E+00		5.43E+02	9.07E-08
700	0.00E+00		5.42E+02	1.84E-07
720	0.00E+00		5.41E+02	3.61E-07
740	0.00E+00		5.40E+02	6.81E-07
760	0.00E+00		5.38E+02	1.24E-06
780	0.00E+00		5.37E+02	2.20E-06
800	0.00E+00		5.36E+02	3.78E-06
820	0.00E+00		5.35E+02	6.33E-06
840	0.00E+00		5.34E+02	1.04E-05
860	0.00E+00		5.33E+02	1.65E-05
880	0.00E+00		5.32E+02	2.59E-05
900	0.00E+00		5.31E+02	3.97E-05
920	0.00E+00		5.30E+02	5.97E-05
940	0.00E+00		5.29E+02	8.83E-05
960	0.00E+00		5.28E+02	1.29E-04
980	0.00E+00		5.27E+02	1.84E-04
1000	0.00E+00		5.26E+02	2.60E-04
MAXIMUM:	0.00E+00		5.81E+02	2.60E-04

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SITE: NAVAL WEAPONS STATION< EARLE NJ, S4 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Iron	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	2.20E+02		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	600
		WIDTH (FT):	600
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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:	0.2
POROSITY:	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	14.8	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):	40.0	AGE (YRS).	0
LATERAL DISPERSIVITY, Ay (FT):	13.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	11849.29	DISTANCE TO F.L.:	400

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.18E+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, S4	CONTAMINANT:	Iron
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.18E+04

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	600			GW Q3 (L/DAY):	5.17E+03		
WIDTH (FT):	600	Kd (L/KG):	2.20E+02	GW V. (FT/YR):	14.80	Kd (L/KG):	220
POROSITY 2:	0.3	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):	1.18E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	40.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 5.17E+03	Ay (FT):	13.33	DISTANCE TO F.L. (FT):	400

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	1.18E+04	0.00E+00
20	0.00E+00	1.18E+04	0.00E+00
40	0.00E+00	1.18E+04	0.00E+00
60	0.00E+00	1.18E+04	0.00E+00
80	0.00E+00	1.18E+04	0.00E+00
100	0.00E+00	1.18E+04	0.00E+00
120	0.00E+00	1.18E+04	0.00E+00
140	0.00E+00	1.18E+04	0.00E+00
160	0.00E+00	1.18E+04	0.00E+00
180	0.00E+00	1.18E+04	0.00E+00
200	0.00E+00	1.18E+04	0.00E+00
220	0.00E+00	1.18E+04	0.00E+00
240	0.00E+00	1.18E+04	0.00E+00
260	0.00E+00	1.18E+04	0.00E+00
280	0.00E+00	1.18E+04	0.00E+00
300	0.00E+00	1.18E+04	0.00E+00
320	0.00E+00	1.18E+04	0.00E+00
340	0.00E+00	1.18E+04	0.00E+00
360	0.00E+00	1.18E+04	0.00E+00
380	0.00E+00	1.18E+04	0.00E+00
400	0.00E+00	1.18E+04	0.00E+00
420	0.00E+00	1.18E+04	0.00E+00
440	0.00E+00	1.18E+04	0.00E+00
460	0.00E+00	1.17E+04	0.00E+00
480	0.00E+00	1.17E+04	0.00E+00
500	0.00E+00	1.17E+04	0.00E+00
520	0.00E+00	1.17E+04	0.00E+00
540	0.00E+00	1.17E+04	0.00E+00
560	0.00E+00	1.17E+04	0.00E+00
580	0.00E+00	1.17E+04	0.00E+00
600	0.00E+00	1.17E+04	0.00E+00
620	0.00E+00	1.17E+04	0.00E+00
640	0.00E+00	1.17E+04	0.00E+00
660	0.00E+00	1.17E+04	0.00E+00
680	0.00E+00	1.17E+04	0.00E+00
700	0.00E+00	1.17E+04	0.00E+00
720	0.00E+00	1.17E+04	0.00E+00
740	0.00E+00	1.17E+04	0.00E+00
760	0.00E+00	1.17E+04	0.00E+00
780	0.00E+00	1.17E+04	0.00E+00
800	0.00E+00	1.17E+04	0.00E+00
820	0.00E+00	1.17E+04	0.00E+00
840	0.00E+00	1.17E+04	0.00E+00
860	0.00E+00	1.17E+04	0.00E+00
880	0.00E+00	1.17E+04	0.00E+00
900	0.00E+00	1.17E+04	0.00E+00
920	0.00E+00	1.16E+04	0.00E+00
940	0.00E+00	1.16E+04	0.00E+00
960	0.00E+00	1.16E+04	0.00E+00
980	0.00E+00	1.16E+04	0.00E+00
1000	0.00E+00	1.16E+04	0.00E+00
MAXIMUM	0.00E+00	1.18E+04	0.00E+00

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SITE:	NAVAL WEAPONS STATION< EARLE NJ, S4	INVESTIGATOR:	WYU	DATE:	1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Manganese	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG)	5.00E-01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	600
		WIDTH (FT):	600
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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.	0.2
POROSITY	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	14.8	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	5.00E-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):	40.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	13.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	165.1	DISTANCE TO F.L.:	400

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.65E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	1.83E-06 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION< EARLE NJ, S4	CONTAMINANT:	Manganese
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.65E+02

SATURATED LAYER

INFILT (FT/YR):	0					B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	600					GW Q3 (L/DAY):	5.17E+03		
WIDTH (FT):	600			Kd (L/KG):	5.00E+01	GW V. (FT/YR):	14.80	Kd (L/KG):	50
POROSITY 2:	0.3			SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	301
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):	1.65E+02	Az (FT):	0.09		
				CU2 (PPB):	0.00E+00	Ax (FT):	40.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY):	0.00E+00	Q2 (L/DAY):	5.17E+03	Ay (FT):	13.33	DISTANCE TO F.L. (FT):	400

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	1.65E+02	0.00E+00
20	0.00E+00	1.65E+02	0.00E+00
40	0.00E+00	1.65E+02	0.00E+00
60	0.00E+00	1.64E+02	0.00E+00
80	0.00E+00	1.64E+02	0.00E+00
100	0.00E+00	1.64E+02	0.00E+00
120	0.00E+00	1.63E+02	0.00E+00
140	0.00E+00	1.63E+02	0.00E+00
160	0.00E+00	1.63E+02	0.00E+00
180	0.00E+00	1.63E+02	0.00E+00
200	0.00E+00	1.62E+02	0.00E+00
220	0.00E+00	1.62E+02	0.00E+00
240	0.00E+00	1.62E+02	0.00E+00
260	0.00E+00	1.62E+02	0.00E+00
280	0.00E+00	1.61E+02	0.00E+00
300	0.00E+00	1.61E+02	0.00E+00
320	0.00E+00	1.61E+02	0.00E+00
340	0.00E+00	1.61E+02	0.00E+00
360	0.00E+00	1.60E+02	0.00E+00
380	0.00E+00	1.60E+02	0.00E+00
400	0.00E+00	1.60E+02	0.00E+00
420	0.00E+00	1.60E+02	0.00E+00
440	0.00E+00	1.59E+02	0.00E+00
460	0.00E+00	1.59E+02	0.00E+00
480	0.00E+00	1.59E+02	0.00E+00
500	0.00E+00	1.58E+02	0.00E+00
520	0.00E+00	1.58E+02	0.00E+00
540	0.00E+00	1.58E+02	0.00E+00
560	0.00E+00	1.58E+02	0.00E+00
580	0.00E+00	1.57E+02	0.00E+00
600	0.00E+00	1.57E+02	0.00E+00
620	0.00E+00	1.57E+02	0.00E+00
640	0.00E+00	1.57E+02	0.00E+00
660	0.00E+00	1.56E+02	0.00E+00
680	0.00E+00	1.56E+02	0.00E+00
700	0.00E+00	1.56E+02	2.68E-10
720	0.00E+00	1.56E+02	6.06E-10
740	0.00E+00	1.55E+02	1.31E-09
760	0.00E+00	1.55E+02	2.73E-09
780	0.00E+00	1.55E+02	5.47E-09
800	0.00E+00	1.55E+02	1.06E-08
820	0.00E+00	1.54E+02	1.98E-08
840	0.00E+00	1.54E+02	3.60E-08
860	0.00E+00	1.54E+02	6.37E-08
880	0.00E+00	1.54E+02	1.10E-07
900	0.00E+00	1.53E+02	1.85E-07
920	0.00E+00	1.53E+02	3.04E-07
940	0.00E+00	1.53E+02	4.90E-07
960	0.00E+00	1.53E+02	7.74E-07
980	0.00E+00	1.52E+02	1.20E-06
1000	0.00E+00	1.52E+02	1.83E-06
MAXIMUM:	0.00E+00	1.65E+02	1.83E-06

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
		EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
CONTAMINANT:	Aluminum	UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	1.50E+03		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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:	0.2
POROSITY:	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	2.628	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	1.50E+03	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):	100.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	33.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC (ug/L):	17212.11	DISTANCE TO F.L.:	3500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION	1.72E+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:	Aluminum
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.72E+04

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	1.50E-03	GW V. (FT/YR):	2.63	Kd (L/KG):	1500
POROSITY 2:	0.3	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	9001
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):	1.72E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	3500

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	1.72E+04	0.00E+00
20	0.00E+00	1.72E+04	0.00E+00
40	0.00E+00	1.72E+04	0.00E+00
60	0.00E+00	1.72E+04	0.00E+00
80	0.00E+00	1.72E+04	0.00E+00
100	0.00E+00	1.72E+04	0.00E+00
120	0.00E+00	1.72E+04	0.00E+00
140	0.00E+00	1.72E+04	0.00E+00
160	0.00E+00	1.72E+04	0.00E+00
180	0.00E+00	1.72E+04	0.00E+00
200	0.00E+00	1.72E+04	0.00E+00
220	0.00E+00	1.72E+04	0.00E+00
240	0.00E+00	1.72E+04	0.00E+00
260	0.00E+00	1.72E+04	0.00E+00
280	0.00E+00	1.72E+04	0.00E+00
300	0.00E+00	1.72E+04	0.00E+00
320	0.00E+00	1.72E+04	0.00E+00
340	0.00E+00	1.72E+04	0.00E+00
360	0.00E+00	1.72E+04	0.00E+00
380	0.00E+00	1.72E+04	0.00E+00
400	0.00E+00	1.72E+04	0.00E+00
420	0.00E+00	1.72E+04	0.00E+00
440	0.00E+00	1.72E+04	0.00E+00
460	0.00E+00	1.72E+04	0.00E+00
480	0.00E+00	1.72E+04	0.00E+00
500	0.00E+00	1.72E+04	0.00E+00
520	0.00E+00	1.72E+04	0.00E+00
540	0.00E+00	1.72E+04	0.00E+00
560	0.00E+00	1.72E+04	0.00E+00
580	0.00E+00	1.72E+04	0.00E+00
600	0.00E+00	1.72E+04	0.00E+00
620	0.00E+00	1.72E+04	0.00E+00
640	0.00E+00	1.72E+04	0.00E+00
660	0.00E+00	1.72E+04	0.00E+00
680	0.00E+00	1.72E+04	0.00E+00
700	0.00E+00	1.72E+04	0.00E+00
720	0.00E+00	1.72E+04	0.00E+00
740	0.00E+00	1.72E+04	0.00E+00
760	0.00E+00	1.72E+04	0.00E+00
780	0.00E+00	1.72E+04	0.00E+00
800	0.00E+00	1.72E+04	0.00E+00
820	0.00E+00	1.72E+04	0.00E+00
840	0.00E+00	1.72E+04	0.00E+00
860	0.00E+00	1.72E+04	0.00E+00
880	0.00E+00	1.72E+04	0.00E+00
900	0.00E+00	1.72E+04	0.00E+00
920	0.00E+00	1.72E+04	0.00E+00
940	0.00E+00	1.72E+04	0.00E+00
960	0.00E+00	1.72E+04	0.00E+00
980	0.00E+00	1.72E+04	0.00E+00
1000	0.00E+00	1.72E+04	0.00E+00
MAXIMUM	0.00E+00	1.72E+04	0.00E+00

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Cadmium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	7.50E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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:	0.2
POROSITY:	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	2.628	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):	100.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	33.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L).	4.51	DISTANCE TO F.L.:	3500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	4.51E+00 (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: Cadmium

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

INITIAL CONC. (ug/L): 4.51E+00

INVESTIGATOR: WYU
DATE: 1/2/97

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	7.50E+01	GW V. (FT/YR):	2.63	Kd (L/KG):	75
POROSITY 2:	0.3	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):	4.51E+00	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	3500

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	4.51E+00	0.00E+00
20	0.00E+00	4.51E+00	0.00E+00
40	0.00E+00	4.51E+00	0.00E+00
60	0.00E+00	4.51E+00	0.00E+00
80	0.00E+00	4.50E+00	0.00E+00
100	0.00E+00	4.50E+00	0.00E+00
120	0.00E+00	4.50E+00	0.00E+00
140	0.00E+00	4.50E+00	0.00E+00
160	0.00E+00	4.50E+00	0.00E+00
180	0.00E+00	4.50E+00	0.00E+00
200	0.00E+00	4.50E+00	0.00E+00
220	0.00E+00	4.49E+00	0.00E+00
240	0.00E+00	4.49E+00	0.00E+00
260	0.00E+00	4.49E+00	0.00E+00
280	0.00E+00	4.49E+00	0.00E+00
300	0.00E+00	4.49E+00	0.00E+00
320	0.00E+00	4.49E+00	0.00E+00
340	0.00E+00	4.49E+00	0.00E+00
360	0.00E+00	4.48E+00	0.00E+00
380	0.00E+00	4.48E+00	0.00E+00
400	0.00E+00	4.48E+00	0.00E+00
420	0.00E+00	4.48E+00	0.00E+00
440	0.00E+00	4.48E+00	0.00E+00
460	0.00E+00	4.48E+00	0.00E+00
480	0.00E+00	4.48E+00	0.00E+00
500	0.00E+00	4.48E+00	0.00E+00
520	0.00E+00	4.47E+00	0.00E+00
540	0.00E+00	4.47E+00	0.00E+00
560	0.00E+00	4.47E+00	0.00E+00
580	0.00E+00	4.47E+00	0.00E+00
600	0.00E+00	4.47E+00	0.00E+00
620	0.00E+00	4.47E+00	0.00E+00
640	0.00E+00	4.47E+00	0.00E+00
660	0.00E+00	4.46E+00	0.00E+00
680	0.00E+00	4.46E+00	0.00E+00
700	0.00E+00	4.46E+00	0.00E+00
720	0.00E+00	4.46E+00	0.00E+00
740	0.00E+00	4.46E+00	0.00E+00
760	0.00E+00	4.46E+00	0.00E+00
780	0.00E+00	4.46E+00	0.00E+00
800	0.00E+00	4.45E+00	0.00E+00
820	0.00E+00	4.45E+00	0.00E+00
840	0.00E+00	4.45E+00	0.00E+00
860	0.00E+00	4.45E+00	0.00E+00
880	0.00E+00	4.45E+00	0.00E+00
900	0.00E+00	4.45E+00	0.00E+00
920	0.00E+00	4.45E+00	0.00E+00
940	0.00E+00	4.44E+00	0.00E+00
960	0.00E+00	4.44E+00	0.00E+00
980	0.00E+00	4.44E+00	0.00E+00
1000	0.00E+00	4.44E+00	0.00E+00
MAXIMUM	0.00E+00	4.51E+00	0.00E+00

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BROWN & ROOT ENVIRONMENTAL

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Iron	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	2.20E+02		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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:	0.2
POROSITY:	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	2.628	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):	100.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	33.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	23714.18	DISTANCE TO F.L.:	3500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.37E+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:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	2.37E+04

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	2.20E+02	GW V. (FT/YR):	2.63	Kd (L/KG):	220
POROSITY 2:	0.3	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):	2.37E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY):	1.07E+03	Ay (FT):	33.33	DISTANCE TO F.L. (FT): 3500

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	2.37E+04	0.00E+00
20	0.00E+00	2.37E+04	0.00E+00
40	0.00E+00	2.37E+04	0.00E+00
60	0.00E+00	2.37E+04	0.00E+00
80	0.00E+00	2.37E+04	0.00E+00
100	0.00E+00	2.37E+04	0.00E+00
120	0.00E+00	2.37E+04	0.00E+00
140	0.00E+00	2.37E+04	0.00E+00
160	0.00E+00	2.37E+04	0.00E+00
180	0.00E+00	2.37E+04	0.00E+00
200	0.00E+00	2.37E+04	0.00E+00
220	0.00E+00	2.37E+04	0.00E+00
240	0.00E+00	2.37E+04	0.00E+00
260	0.00E+00	2.37E+04	0.00E+00
280	0.00E+00	2.37E+04	0.00E+00
300	0.00E+00	2.37E+04	0.00E+00
320	0.00E+00	2.37E+04	0.00E+00
340	0.00E+00	2.37E+04	0.00E+00
360	0.00E+00	2.37E+04	0.00E+00
380	0.00E+00	2.37E+04	0.00E+00
400	0.00E+00	2.37E+04	0.00E+00
420	0.00E+00	2.37E+04	0.00E+00
440	0.00E+00	2.37E+04	0.00E+00
460	0.00E+00	2.37E+04	0.00E+00
480	0.00E+00	2.37E+04	0.00E+00
500	0.00E+00	2.37E+04	0.00E+00
520	0.00E+00	2.36E+04	0.00E+00
540	0.00E+00	2.36E+04	0.00E+00
560	0.00E+00	2.36E+04	0.00E+00
580	0.00E+00	2.36E+04	0.00E+00
600	0.00E+00	2.36E+04	0.00E+00
620	0.00E+00	2.36E+04	0.00E+00
640	0.00E+00	2.36E+04	0.00E+00
660	0.00E+00	2.36E+04	0.00E+00
680	0.00E+00	2.36E+04	0.00E+00
700	0.00E+00	2.36E+04	0.00E+00
720	0.00E+00	2.36E+04	0.00E+00
740	0.00E+00	2.36E+04	0.00E+00
760	0.00E+00	2.36E+04	0.00E+00
780	0.00E+00	2.36E+04	0.00E+00
800	0.00E+00	2.36E+04	0.00E+00
820	0.00E+00	2.36E+04	0.00E+00
840	0.00E+00	2.36E+04	0.00E+00
860	0.00E+00	2.36E+04	0.00E+00
880	0.00E+00	2.36E+04	0.00E+00
900	0.00E+00	2.36E+04	0.00E+00
920	0.00E+00	2.36E+04	0.00E+00
940	0.00E+00	2.36E+04	0.00E+00
960	0.00E+00	2.36E+04	0.00E+00
980	0.00E+00	2.36E+04	0.00E+00
1000	0.00E+00	2.36E+04	0.00E+00
MAXIMUM	0.00E+00	2.37E+04	0.00E+00

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Nickel	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	6.50E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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:	0.2
POROSITY:	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	2.628	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	6.50E+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):	100.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	33.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	47.82	DISTANCE TO F.L.:	3500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	4.78E+01 (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:	Nickel
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	4.78E+01

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	6.50E+01	GW V. (FT/YR):	2.63	Kd (L/KG):	65
POROSITY 2:	0.3	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	391
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):	4.78E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	3500

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	4.78E+01	0.00E+00
20	0.00E+00	4.78E+01	0.00E+00
40	0.00E+00	4.78E+01	0.00E+00
60	0.00E+00	4.78E+01	0.00E+00
80	0.00E+00	4.78E+01	0.00E+00
100	0.00E+00	4.77E+01	0.00E+00
120	0.00E+00	4.77E+01	0.00E+00
140	0.00E+00	4.77E+01	0.00E+00
160	0.00E+00	4.77E+01	0.00E+00
180	0.00E+00	4.77E+01	0.00E+00
200	0.00E+00	4.76E+01	0.00E+00
220	0.00E+00	4.76E+01	0.00E+00
240	0.00E+00	4.76E+01	0.00E+00
260	0.00E+00	4.76E+01	0.00E+00
280	0.00E+00	4.76E+01	0.00E+00
300	0.00E+00	4.76E+01	0.00E+00
320	0.00E+00	4.75E+01	0.00E+00
340	0.00E+00	4.75E+01	0.00E+00
360	0.00E+00	4.75E+01	0.00E+00
380	0.00E+00	4.75E+01	0.00E+00
400	0.00E+00	4.75E+01	0.00E+00
420	0.00E+00	4.75E+01	0.00E+00
440	0.00E+00	4.74E+01	0.00E+00
460	0.00E+00	4.74E+01	0.00E+00
480	0.00E+00	4.74E+01	0.00E+00
500	0.00E+00	4.74E+01	0.00E+00
520	0.00E+00	4.74E+01	0.00E+00
540	0.00E+00	4.74E+01	0.00E+00
560	0.00E+00	4.73E+01	0.00E+00
580	0.00E+00	4.73E+01	0.00E+00
600	0.00E+00	4.73E+01	0.00E+00
620	0.00E+00	4.73E+01	0.00E+00
640	0.00E+00	4.73E+01	0.00E+00
660	0.00E+00	4.73E+01	0.00E+00
680	0.00E+00	4.72E+01	0.00E+00
700	0.00E+00	4.72E+01	0.00E+00
720	0.00E+00	4.72E+01	0.00E+00
740	0.00E+00	4.72E+01	0.00E+00
760	0.00E+00	4.72E+01	0.00E+00
780	0.00E+00	4.72E+01	0.00E+00
800	0.00E+00	4.71E+01	0.00E+00
820	0.00E+00	4.71E+01	0.00E+00
840	0.00E+00	4.71E+01	0.00E+00
860	0.00E+00	4.71E+01	0.00E+00
880	0.00E+00	4.71E+01	0.00E+00
900	0.00E+00	4.71E+01	0.00E+00
920	0.00E+00	4.70E+01	0.00E+00
940	0.00E+00	4.70E+01	0.00E+00
960	0.00E+00	4.70E+01	0.00E+00
980	0.00E+00	4.70E+01	0.00E+00
1000	0.00E+00	4.70E+01	0.00E+00
MAXIMUM	0.00E+00	4.78E+01	0.00E+00

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	INVESTIGATOR:	WYU	DATE:	1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
		EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
CONTAMINANT:	Manganese	UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	5.00E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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:	0.2
POROSITY	0.28	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	2.628	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	5.00E+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):	100.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	33.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	302	DISTANCE TO F.L.:	3500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	3.02E+02 (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

CONTAMINANT: Manganese

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

INVESTIGATOR: WYU
DATE: 1/2/97

INITIAL CONC. (ug/L): 3.02E+02

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	5.00E+01	GW V. (FT/YR):	2.63	Kd (L/KG):	50
POROSITY 2:	0.3	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	301
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):	3.02E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	100.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	33.33	DISTANCE TO F.L. (FT):	3500

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	3.02E+02	0.00E+00
20	0.00E+00	3.02E+02	0.00E+00
40	0.00E+00	3.02E+02	0.00E+00
60	0.00E+00	3.02E+02	0.00E+00
80	0.00E+00	3.01E+02	0.00E+00
100	0.00E+00	3.01E+02	0.00E+00
120	0.00E+00	3.01E+02	0.00E+00
140	0.00E+00	3.01E+02	0.00E+00
160	0.00E+00	3.01E+02	0.00E+00
180	0.00E+00	3.01E+02	0.00E+00
200	0.00E+00	3.01E+02	0.00E+00
220	0.00E+00	3.00E+02	0.00E+00
240	0.00E+00	3.00E+02	0.00E+00
260	0.00E+00	3.00E+02	0.00E+00
280	0.00E+00	3.00E+02	0.00E+00
300	0.00E+00	3.00E+02	0.00E+00
320	0.00E+00	3.00E+02	0.00E+00
340	0.00E+00	3.00E+02	0.00E+00
360	0.00E+00	2.99E+02	0.00E+00
380	0.00E+00	2.99E+02	0.00E+00
400	0.00E+00	2.99E+02	0.00E+00
420	0.00E+00	2.99E+02	0.00E+00
440	0.00E+00	2.99E+02	0.00E+00
460	0.00E+00	2.99E+02	0.00E+00
480	0.00E+00	2.99E+02	0.00E+00
500	0.00E+00	2.99E+02	0.00E+00
520	0.00E+00	2.98E+02	0.00E+00
540	0.00E+00	2.98E+02	0.00E+00
560	0.00E+00	2.98E+02	0.00E+00
580	0.00E+00	2.98E+02	0.00E+00
600	0.00E+00	2.98E+02	0.00E+00
620	0.00E+00	2.98E+02	0.00E+00
640	0.00E+00	2.98E+02	0.00E+00
660	0.00E+00	2.97E+02	0.00E+00
680	0.00E+00	2.97E+02	0.00E+00
700	0.00E+00	2.97E+02	0.00E+00
720	0.00E+00	2.97E+02	0.00E+00
740	0.00E+00	2.97E+02	0.00E+00
760	0.00E+00	2.97E+02	0.00E+00
780	0.00E+00	2.97E+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	2.95E+02	0.00E+00
960	0.00E+00	2.95E+02	0.00E+00
980	0.00E+00	2.95E+02	0.00E+00
1000	0.00E+00	2.95E+02	0.00E+00
MAXIMUM:	0.00E+00	3.02E+02	0.00E+00

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Aluminum	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.658E+03
		WATER CRITERIA (UG/L):	1.00E+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):	1.08E+00
Kl (L/KG):	1.50E+03	LENGTH (FT):	200
		WIDTH (FT):	150
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):	1.66E+03	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	SATURATION RATE:	0.95
SATURATION RATE:	0.6	POROSITY:	0.2
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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	28.6	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	1.50E+03	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):	9610	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	9.61E+03 (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, S19	CONTAMINANT:	Aluminum
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	9.61E+03

SATURATED LAYER

INFILT (FT/YR):	1.0833333					B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200					GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150			Kd (L/KG):	1.50E+03	GW V. (FT/YR):	28.60	Kd (L/KG):	1500
POROSITY 2:	0.3			SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	9001
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):	9.61E+03	Az (FT):	0.09		
				CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY):	2.52E+03	Q2 (L/DAY):	2.50E+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	1.11E+03		9.61E+03	0.00E+00
20	1.10E+03		9.60E+03	0.00E+00
40	1.10E+03		9.60E+03	0.00E+00
60	1.10E+03		9.59E+03	0.00E+00
80	1.10E+03		9.59E+03	0.00E+00
100	1.10E+03		9.58E+03	0.00E+00
120	1.10E+03		9.58E+03	0.00E+00
140	1.10E+03		9.57E+03	0.00E+00
160	1.10E+03		9.56E+03	0.00E+00
180	1.10E+03		9.56E+03	0.00E+00
200	1.10E+03		9.55E+03	0.00E+00
220	1.10E+03		9.55E+03	0.00E+00
240	1.09E+03		9.54E+03	0.00E+00
260	1.09E+03		9.54E+03	0.00E+00
280	1.09E+03		9.53E+03	0.00E+00
300	1.09E+03		9.52E+03	0.00E+00
320	1.09E+03		9.52E+03	0.00E+00
340	1.09E+03		9.51E+03	0.00E+00
360	1.09E+03		9.51E+03	0.00E+00
380	1.09E+03		9.50E+03	0.00E+00
400	1.09E+03		9.49E+03	0.00E+00
420	1.09E+03		9.49E+03	0.00E+00
440	1.09E+03		9.48E+03	0.00E+00
460	1.09E+03		9.48E+03	0.00E+00
480	1.08E+03		9.47E+03	0.00E+00
500	1.08E+03		9.47E+03	0.00E+00
520	1.08E+03		9.46E+03	0.00E+00
540	1.08E+03		9.46E+03	0.00E+00
560	1.08E+03		9.45E+03	0.00E+00
580	1.08E+03		9.44E+03	0.00E+00
600	1.08E+03		9.44E+03	0.00E+00
620	1.08E+03		9.43E+03	0.00E+00
640	1.08E+03		9.43E+03	0.00E+00
660	1.08E+03		9.42E+03	0.00E+00
680	1.08E+03		9.42E+03	0.00E+00
700	1.07E+03		9.41E+03	0.00E+00
720	1.07E+03		9.40E+03	0.00E+00
740	1.07E+03		9.40E+03	0.00E+00
760	1.07E+03		9.39E+03	0.00E+00
780	1.07E+03		9.39E+03	0.00E+00
800	1.07E+03		9.38E+03	0.00E+00
820	1.07E+03		9.38E+03	0.00E+00
840	1.07E+03		9.37E+03	0.00E+00
860	1.07E+03		9.36E+03	0.00E+00
880	1.07E+03		9.36E+03	0.00E+00
900	1.07E+03		9.35E+03	0.00E+00
920	1.07E+03		9.35E+03	0.00E+00
940	1.06E+03		9.34E+03	0.00E+00
960	1.06E+03		9.34E+03	0.00E+00
980	1.06E+03		9.33E+03	0.00E+00
1000	1.06E+03		9.32E+03	0.00E+00
MAXIMUM	1.11E+03		9.61E+03	0.00E+00

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/2/97

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)	1.600E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	3.22E+01
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):	1.08E+00
Kl (L/KG):	2.90E+01	LENGTH (FT):	200
		WIDTH (FT):	150
DEPLETING SOURCE:		**IS THERE A CLAY LINER LAYER (YES,NO)?**	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.60E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	12	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.2
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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	28.6	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):	27.4	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.74E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	4.97E-02 (UG/L)	1000

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

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19

CONTAMINANT: Arsenic

HALF-LIFE (YRS):

LAYER 2: 0.00E+00

SATURATED LAYER 0.00E+00

DOWNGRADIENT 0.00E+00

INITIAL CONC. (ug/L): 2.74E+01

INVESTIGATOR: WYU

DATE: 1/2/97

SATURATED LAYER

INFILT (FT/YR).	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	2.90E+01	GW V. (FT/YR):	28.60	Kd (L/KG):	29
POROSITY 2:	0.3	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):	2.74E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+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	5.52E+01	2.74E+01	0.00E+00
20	5.29E+01	2.74E+01	0.00E+00
40	5.08E+01	2.73E+01	0.00E+00
60	4.87E+01	2.72E+01	0.00E+00
80	4.68E+01	2.71E+01	0.00E+00
100	4.49E+01	2.70E+01	0.00E+00
120	4.30E+01	2.68E+01	0.00E+00
140	4.13E+01	2.66E+01	0.00E+00
160	3.96E+01	2.64E+01	0.00E+00
180	3.80E+01	2.61E+01	0.00E+00
200	3.65E+01	2.59E+01	0.00E+00
220	3.50E+01	2.56E+01	0.00E+00
240	3.36E+01	2.53E+01	0.00E+00
260	3.22E+01	2.50E+01	1.36E-11
280	3.09E+01	2.47E+01	1.14E-10
300	2.97E+01	2.44E+01	7.19E-10
320	2.85E+01	2.41E+01	3.61E-09
340	2.73E+01	2.38E+01	1.50E-08
360	2.62E+01	2.34E+01	5.33E-08
380	2.51E+01	2.31E+01	1.66E-07
400	2.41E+01	2.27E+01	4.60E-07
420	2.31E+01	2.23E+01	1.16E-06
440	2.22E+01	2.20E+01	2.68E-06
460	2.13E+01	2.16E+01	5.77E-06
480	2.04E+01	2.13E+01	1.17E-05
500	1.96E+01	2.09E+01	2.23E-05
520	1.88E+01	2.05E+01	4.04E-05
540	1.80E+01	2.01E+01	7.02E-05
560	1.73E+01	1.98E+01	1.17E-04
580	1.66E+01	1.94E+01	1.89E-04
600	1.59E+01	1.90E+01	2.95E-04
620	1.53E+01	1.87E+01	4.48E-04
640	1.47E+01	1.83E+01	6.61E-04
660	1.41E+01	1.79E+01	9.54E-04
680	1.35E+01	1.76E+01	1.35E-03
700	1.30E+01	1.72E+01	1.86E-03
720	1.24E+01	1.69E+01	2.53E-03
740	1.19E+01	1.65E+01	3.38E-03
760	1.14E+01	1.62E+01	4.45E-03
780	1.10E+01	1.58E+01	5.77E-03
800	1.05E+01	1.55E+01	7.38E-03
820	1.01E+01	1.51E+01	9.32E-03
840	9.70E+00	1.48E+01	1.17E-02
860	9.31E+00	1.45E+01	1.44E-02
880	8.93E+00	1.42E+01	1.76E-02
900	8.57E+00	1.38E+01	2.14E-02
920	8.22E+00	1.35E+01	2.57E-02
940	7.89E+00	1.32E+01	3.07E-02
960	7.57E+00	1.29E+01	3.63E-02
980	7.26E+00	1.26E+01	4.26E-02
1000	6.97E+00	1.23E+01	4.97E-02
MAXIMUM:	5.52E+01	2.74E+01	4.97E-02

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/2/97

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)	9.000E-02
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	1.33E+06
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):	1.08E+00
Kl (L/KG):	7.50E+01	LENGTH (FT):	200
		WIDTH (FT):	150
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	9.00E-02	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	12	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.2
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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	28.6	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):	7.5	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	7.50E+00 (UG/L)	0
FENCE LINE CONCENTRATION:	6.77E-08 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S19	CONTAMINANT:	Cadmium
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	7.50E+00

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	7.50E+01	GW V. (FT/YR):	28.60	Kd (L/KG):	75
POROSITY 2:	0.3	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):	7.50E+00	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+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	1.20E+00	7.50E+00	0.00E+00
20	1.18E+00	7.41E+00	0.00E+00
40	1.16E+00	7.33E+00	0.00E+00
60	1.14E+00	7.24E+00	0.00E+00
80	1.13E+00	7.16E+00	0.00E+00
100	1.11E+00	7.07E+00	0.00E+00
120	1.09E+00	6.99E+00	0.00E+00
140	1.07E+00	6.91E+00	0.00E+00
160	1.06E+00	6.83E+00	0.00E+00
180	1.04E+00	6.75E+00	0.00E+00
200	1.02E+00	6.67E+00	0.00E+00
220	1.01E+00	6.59E+00	0.00E+00
240	9.90E-01	6.51E+00	0.00E+00
260	9.74E-01	6.44E+00	0.00E+00
280	9.59E-01	6.36E+00	0.00E+00
300	9.43E-01	6.29E+00	0.00E+00
320	9.28E-01	6.21E+00	0.00E+00
340	9.14E-01	6.14E+00	0.00E+00
360	8.99E-01	6.07E+00	0.00E+00
380	8.85E-01	6.00E+00	0.00E+00
400	8.71E-01	5.93E+00	0.00E+00
420	8.57E-01	5.86E+00	0.00E+00
440	8.43E-01	5.79E+00	0.00E+00
460	8.30E-01	5.72E+00	0.00E+00
480	8.17E-01	5.65E+00	0.00E+00
500	8.04E-01	5.59E+00	0.00E+00
520	7.91E-01	5.52E+00	0.00E+00
540	7.78E-01	5.45E+00	0.00E+00
560	7.66E-01	5.39E+00	0.00E+00
580	7.54E-01	5.33E+00	0.00E+00
600	7.42E-01	5.26E+00	0.00E+00
620	7.30E-01	5.20E+00	0.00E+00
640	7.18E-01	5.14E+00	0.00E+00
660	7.07E-01	5.08E+00	0.00E+00
680	6.96E-01	5.02E+00	5.74E-12
700	6.85E-01	4.96E+00	1.32E-11
720	6.74E-01	4.90E+00	2.90E-11
740	6.63E-01	4.84E+00	6.13E-11
760	6.52E-01	4.79E+00	1.25E-10
780	6.42E-01	4.73E+00	2.44E-10
800	6.32E-01	4.67E+00	4.63E-10
820	6.22E-01	4.62E+00	8.50E-10
840	6.12E-01	4.56E+00	1.52E-09
860	6.02E-01	4.51E+00	2.63E-09
880	5.93E-01	4.46E+00	4.46E-09
900	5.83E-01	4.40E+00	7.38E-09
920	5.74E-01	4.35E+00	1.20E-08
940	5.65E-01	4.30E+00	1.90E-08
960	5.56E-01	4.25E+00	2.95E-08
980	5.47E-01	4.20E+00	4.51E-08
1000	5.38E-01	4.15E+00	6.77E-08
MAXIMUM:	1.20E+00	7.50E+00	6.77E-08

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BROWN & ROOT ENVIRONMENTAL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S19	INVESTIGATOR:	WYU	DATE:	1/2/97

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)	1.305E+03
		WATER CRITERIA (UG/L):	1.00E+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):	1.08E+00
Kl (L/KG):	2.70E+02	LENGTH (FT):	200
		WIDTH (FT):	150
DEPLETING SOURCE.		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.31E+03	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	12	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.6	SATURATION RATE:	0.95
POROSITY:	0.25	POROSITY:	0.2
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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	28.6	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):	17.2	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	3.66E+02 (UG/L)	1000
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, S19

CONTAMINANT: Lead

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

INITIAL CONC. (ug/L): 1.72E+01

INVESTIGATOR: WYU
DATE: 1/2/97

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	2.70E+02	GW V. (FT/YR):	28.60	Kd (L/KG):	270
POROSITY 2:	0.3	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):	1.72E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+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	4.83E+03	1.72E+01	0.00E+00
20	4.81E+03	2.57E+01	0.00E+00
40	4.79E+03	3.41E+01	0.00E+00
60	4.77E+03	4.25E+01	0.00E+00
80	4.75E+03	5.08E+01	0.00E+00
100	4.73E+03	5.90E+01	0.00E+00
120	4.71E+03	6.72E+01	0.00E+00
140	4.68E+03	7.53E+01	0.00E+00
160	4.66E+03	8.33E+01	0.00E+00
180	4.64E+03	9.13E+01	0.00E+00
200	4.62E+03	9.92E+01	0.00E+00
220	4.60E+03	1.07E+02	0.00E+00
240	4.58E+03	1.15E+02	0.00E+00
260	4.56E+03	1.23E+02	0.00E+00
280	4.54E+03	1.30E+02	0.00E+00
300	4.52E+03	1.38E+02	0.00E+00
320	4.50E+03	1.45E+02	0.00E+00
340	4.48E+03	1.53E+02	0.00E+00
360	4.46E+03	1.60E+02	0.00E+00
380	4.44E+03	1.68E+02	0.00E+00
400	4.42E+03	1.75E+02	0.00E+00
420	4.40E+03	1.82E+02	0.00E+00
440	4.38E+03	1.89E+02	0.00E+00
460	4.36E+03	1.96E+02	0.00E+00
480	4.34E+03	2.03E+02	0.00E+00
500	4.32E+03	2.10E+02	0.00E+00
520	4.30E+03	2.17E+02	0.00E+00
540	4.29E+03	2.24E+02	0.00E+00
560	4.27E+03	2.31E+02	0.00E+00
580	4.25E+03	2.38E+02	0.00E+00
600	4.23E+03	2.44E+02	0.00E+00
620	4.21E+03	2.51E+02	0.00E+00
640	4.19E+03	2.57E+02	0.00E+00
660	4.17E+03	2.64E+02	0.00E+00
680	4.15E+03	2.70E+02	0.00E+00
700	4.13E+03	2.77E+02	0.00E+00
720	4.12E+03	2.83E+02	0.00E+00
740	4.10E+03	2.89E+02	0.00E+00
760	4.08E+03	2.96E+02	0.00E+00
780	4.06E+03	3.02E+02	0.00E+00
800	4.04E+03	3.08E+02	0.00E+00
820	4.03E+03	3.14E+02	0.00E+00
840	4.01E+03	3.20E+02	0.00E+00
860	3.99E+03	3.26E+02	0.00E+00
880	3.97E+03	3.32E+02	0.00E+00
900	3.95E+03	3.38E+02	0.00E+00
920	3.94E+03	3.44E+02	0.00E+00
940	3.92E+03	3.49E+02	0.00E+00
960	3.90E+03	3.55E+02	0.00E+00
980	3.88E+03	3.61E+02	0.00E+00
1000	3.87E+03	3.66E+02	0.00E+00
MAXIMUM:	4.83E+03	3.66E+02	0.00E+00

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/2/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Manganese	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.200E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	1.74E+03
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):	1.08E+00
Kl (L/KG):	5.00E+01	LENGTH (FT):	200
		WIDTH (FT):	150
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):	2.20E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	SATURATION RATE:	0.95
SATURATION RATE:	0.6	POROSITY:	0.2
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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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	0.2	POROSITY:	0.3
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):	28.6	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	5.00E+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):	185	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.85E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	1.26E-03 (UG/L)	1000

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BROWN & ROOT ENVIRONMENTAL

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

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19

CONTAMINANT: Manganese

HALF-LIFE (YRS):

LAYER 2: 0.00E+00

SATURATED LAYER 0.00E+00

DOWNGRADIENT 0.00E+00

INVESTIGATOR: WYU

DATE: 1/2/97

INITIAL CONC. (ug/L): 1.85E+02

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	5.00E+01	GW V. (FT/YR):	28.60	Kd (L/KG):	50
POROSITY 2:	0.3	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	301
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):	1.85E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+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	4.40E+01	1.85E+02	0.00E+00
20	4.30E+01	1.82E+02	0.00E+00
40	4.19E+01	1.79E+02	0.00E+00
60	4.09E+01	1.76E+02	0.00E+00
80	4.00E+01	1.73E+02	0.00E+00
100	3.90E+01	1.70E+02	0.00E+00
120	3.81E+01	1.67E+02	0.00E+00
140	3.72E+01	1.64E+02	0.00E+00
160	3.63E+01	1.62E+02	0.00E+00
180	3.54E+01	1.59E+02	0.00E+00
200	3.46E+01	1.56E+02	0.00E+00
220	3.38E+01	1.54E+02	0.00E+00
240	3.30E+01	1.51E+02	0.00E+00
260	3.22E+01	1.48E+02	0.00E+00
280	3.14E+01	1.46E+02	0.00E+00
300	3.07E+01	1.43E+02	0.00E+00
320	3.00E+01	1.41E+02	0.00E+00
340	2.92E+01	1.39E+02	0.00E+00
360	2.85E+01	1.36E+02	0.00E+00
380	2.79E+01	1.34E+02	0.00E+00
400	2.72E+01	1.32E+02	0.00E+00
420	2.66E+01	1.29E+02	0.00E+00
440	2.59E+01	1.27E+02	0.00E+00
460	2.53E+01	1.25E+02	2.10E-10
480	2.47E+01	1.23E+02	6.97E-10
500	2.41E+01	1.21E+02	2.11E-09
520	2.36E+01	1.19E+02	5.87E-09
540	2.30E+01	1.17E+02	1.51E-08
560	2.24E+01	1.15E+02	3.65E-08
580	2.19E+01	1.13E+02	8.29E-08
600	2.14E+01	1.11E+02	1.78E-07
620	2.09E+01	1.09E+02	3.65E-07
640	2.04E+01	1.07E+02	7.13E-07
660	1.99E+01	1.05E+02	1.34E-06
680	1.94E+01	1.03E+02	2.43E-06
700	1.90E+01	1.02E+02	4.24E-06
720	1.85E+01	9.99E+01	7.20E-06
740	1.81E+01	9.82E+01	1.19E-05
760	1.76E+01	9.65E+01	1.90E-05
780	1.72E+01	9.48E+01	2.98E-05
800	1.68E+01	9.32E+01	4.57E-05
820	1.64E+01	9.16E+01	6.85E-05
840	1.60E+01	9.00E+01	1.01E-04
860	1.57E+01	8.85E+01	1.46E-04
880	1.53E+01	8.69E+01	2.07E-04
900	1.49E+01	8.54E+01	2.89E-04
920	1.46E+01	8.39E+01	3.99E-04
940	1.42E+01	8.25E+01	5.42E-04
960	1.39E+01	8.11E+01	7.27E-04
980	1.35E+01	7.97E+01	9.64E-04
1000	1.32E+01	7.83E+01	1.26E-03
MAXIMUM	4.40E+01	1.85E+02	1.26E-03

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/2/97

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)	3.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	3.91E+06
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):	1.08E+00
Kl (L/KG):	7.10E+01	LENGTH (FT):	200
		WIDTH (FT):	150
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):	3.00E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	SATURATION RATE:	0.95
SATURATION RATE:	0.6	POROSITY:	0.2
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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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:	0.2	POROSITY:	0.3
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):	28.6	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):	28.9	DISTANCE TO F.L.:	500

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.89E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	7.67E-07 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S19	CONTAMINANT:	Thallium
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/2/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	2.89E+01

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	7.10E+01	GW V. (FT/YR):	28.60	Kd (L/KG):	71
POROSITY 2:	0.3	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):	2.89E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	50.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+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	4.23E+01	2.89E+01	0.00E+00
20	4.15E+01	2.88E+01	0.00E+00
40	4.08E+01	2.87E+01	0.00E+00
60	4.02E+01	2.86E+01	0.00E+00
80	3.95E+01	2.85E+01	0.00E+00
100	3.88E+01	2.83E+01	0.00E+00
120	3.82E+01	2.82E+01	0.00E+00
140	3.75E+01	2.81E+01	0.00E+00
160	3.69E+01	2.80E+01	0.00E+00
180	3.63E+01	2.78E+01	0.00E+00
200	3.57E+01	2.77E+01	0.00E+00
220	3.51E+01	2.76E+01	0.00E+00
240	3.45E+01	2.74E+01	0.00E+00
260	3.39E+01	2.73E+01	0.00E+00
280	3.33E+01	2.71E+01	0.00E+00
300	3.28E+01	2.70E+01	0.00E+00
320	3.22E+01	2.69E+01	0.00E+00
340	3.17E+01	2.67E+01	0.00E+00
360	3.11E+01	2.66E+01	0.00E+00
380	3.06E+01	2.64E+01	0.00E+00
400	3.01E+01	2.63E+01	0.00E+00
420	2.96E+01	2.61E+01	0.00E+00
440	2.91E+01	2.60E+01	0.00E+00
460	2.86E+01	2.58E+01	0.00E+00
480	2.81E+01	2.56E+01	0.00E+00
500	2.77E+01	2.55E+01	0.00E+00
520	2.72E+01	2.53E+01	0.00E+00
540	2.67E+01	2.52E+01	0.00E+00
560	2.63E+01	2.50E+01	0.00E+00
580	2.59E+01	2.48E+01	0.00E+00
600	2.54E+01	2.47E+01	0.00E+00
620	2.50E+01	2.45E+01	0.00E+00
640	2.46E+01	2.44E+01	1.86E-11
660	2.42E+01	2.42E+01	4.53E-11
680	2.38E+01	2.40E+01	1.05E-10
700	2.34E+01	2.39E+01	2.32E-10
720	2.30E+01	2.37E+01	4.91E-10
740	2.26E+01	2.35E+01	9.99E-10
760	2.22E+01	2.34E+01	1.96E-09
780	2.18E+01	2.32E+01	3.70E-09
800	2.15E+01	2.30E+01	6.78E-09
820	2.11E+01	2.29E+01	1.21E-08
840	2.07E+01	2.27E+01	2.09E-08
860	2.04E+01	2.25E+01	3.53E-08
880	2.01E+01	2.24E+01	5.81E-08
900	1.97E+01	2.22E+01	9.37E-08
920	1.94E+01	2.20E+01	1.48E-07
940	1.91E+01	2.19E+01	2.29E-07
960	1.87E+01	2.17E+01	3.49E-07
980	1.84E+01	2.15E+01	5.21E-07
1000	1.81E+01	2.14E+01	7.67E-07
MAXIMUM:	4.23E+01	2.89E+01	7.67E-07

Table 2

Distance of Further Migration

Site	Chemical	CAS No.	Partitioning Coef. Kd L/kg	Ref	GW Criteria From FS Report (ug/L)		Distance of Further Migration (4) (feet)		
							Site 4	Site 5	Site 19
5,19	Aluminum	7429-90-5	1500	(2)	7870	Background		0.4	2.2
19	Arsenic	7440-38-2	29	(1)	8	NJ GWQS			191.0
4	Barium	7440-39-3	41	(1)	518	Background	32.0		
5,19	Cadmium	7440-43-9	75	(1)	4	NJ GWQS		4.0	55.0
4,5	Iron	7439-89-6	220	(3)	7690	Background	10.0	3.0	
19	Lead	7439-92-1	270	(3)	10	NJ GWQS			30.0
4,5,19	Manganese	7439-96-5	50	(3)	65	Background	55.0	13.0	105.0
5	Nickel	7440-02-0	65	(1)	100	NJ GWQS		0.0	
19	Thallium	7440-28-0	71	(1)	10	NJ GWQS			79.0

(1) USEPA, Soil Screening Guidence, 1996
(2) Thibault 1990.
(3) Bases and Sharp, 1984.
(4) Distance of further migration is defined as the maximum distance from source area where the maximum concentration in 1000-year time frame may reach the value of growndwater criteria.

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION,EARLE NJ, S4 INVESTIGATOR: WYU DATE: 1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Barium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	5.18E+02	CONSTANT CONCENTRATION (YES,NO)?	YES
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	0.00E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	YES

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke	1.00	INFILT(FT/YR):	0.00E+00
Kl (L/KG):	4.10E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	600
		WIDTH (FT):	600
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	14.8	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	4.10E+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):	3.2	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	1.1	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	580.96	DISTANCE TO F.L.:	32

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	5.81E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	5.12E+02 (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

CONTAMINANT: Barium

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

INITIAL CONC. (ug/L): 5.81E+02

INVESTIGATOR: WYU
DATE: 1/3/97

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	600			GW Q3 (L/DAY):	5.17E+03		
WIDTH (FT):	600	Kd (L/KG):	4.10E+01	GW V. (FT/YR):	14.80	Kd (L/KG):	41
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	247
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):	5.81E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	3.20	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 5.17E+03	Ay (FT):	1.07	DISTANCE TO F.L. (FT):	32

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	5.81E+02	0.00E+00
20	0.00E+00	5.80E+02	0.00E+00
40	0.00E+00	5.79E+02	0.00E+00
60	0.00E+00	5.77E+02	9.29E-07
80	0.00E+00	5.76E+02	2.62E-04
100	0.00E+00	5.75E+02	7.76E-03
120	0.00E+00	5.74E+02	7.40E-02
140	0.00E+00	5.73E+02	3.69E-01
160	0.00E+00	5.72E+02	1.22E+00
180	0.00E+00	5.71E+02	3.10E+00
200	0.00E+00	5.69E+02	6.46E+00
220	0.00E+00	5.68E+02	1.17E+01
240	0.00E+00	5.67E+02	1.92E+01
260	0.00E+00	5.66E+02	2.90E+01
280	0.00E+00	5.65E+02	4.11E+01
300	0.00E+00	5.64E+02	5.53E+01
320	0.00E+00	5.63E+02	7.14E+01
340	0.00E+00	5.62E+02	8.91E+01
360	0.00E+00	5.60E+02	1.08E+02
380	0.00E+00	5.59E+02	1.28E+02
400	0.00E+00	5.58E+02	1.49E+02
420	0.00E+00	5.57E+02	1.70E+02
440	0.00E+00	5.56E+02	1.91E+02
460	0.00E+00	5.55E+02	2.12E+02
480	0.00E+00	5.54E+02	2.33E+02
500	0.00E+00	5.53E+02	2.53E+02
520	0.00E+00	5.52E+02	2.73E+02
540	0.00E+00	5.50E+02	2.92E+02
560	0.00E+00	5.49E+02	3.10E+02
580	0.00E+00	5.48E+02	3.28E+02
600	0.00E+00	5.47E+02	3.44E+02
620	0.00E+00	5.46E+02	3.60E+02
640	0.00E+00	5.45E+02	3.75E+02
660	0.00E+00	5.44E+02	3.88E+02
680	0.00E+00	5.43E+02	4.01E+02
700	0.00E+00	5.42E+02	4.13E+02
720	0.00E+00	5.41E+02	4.24E+02
740	0.00E+00	5.40E+02	4.35E+02
760	0.00E+00	5.38E+02	4.44E+02
780	0.00E+00	5.37E+02	4.53E+02
800	0.00E+00	5.36E+02	4.62E+02
820	0.00E+00	5.35E+02	4.69E+02
840	0.00E+00	5.34E+02	4.76E+02
860	0.00E+00	5.33E+02	4.82E+02
880	0.00E+00	5.32E+02	4.88E+02
900	0.00E+00	5.31E+02	4.93E+02
920	0.00E+00	5.30E+02	4.98E+02
940	0.00E+00	5.29E+02	5.02E+02
960	0.00E+00	5.28E+02	5.06E+02
980	0.00E+00	5.27E+02	5.09E+02
1000	0.00E+00	5.26E+02	5.12E+02
MAXIMUM	0.00E+00	5.81E+02	5.12E+02

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S4	INVESTIGATOR:	WYU	DATE:	1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Iron	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	7.69E+03	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	2.20E+02		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	600
		WIDTH (FT):	600
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	14.8	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):	1.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	0.3	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	11849.29	DISTANCE TO F.L.:	10

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.18E+04 (UG/L)	0
FENCE LINE CONCENTRATION:	7.08E+03 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S4	CONTAMINANT:	Iron
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/3/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.18E+04

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	600			GW Q3 (L/DAY):	5.17E+03		
WIDTH (FT):	600	Kd (L/KG):	2.20E+02	GW V. (FT/YR):	14.80	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):	1.18E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	1.00	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 5.17E+03	Ay (FT):	0.33	DISTANCE TO F.L. (FT):	10

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	1.18E+04	0.00E+00
20	0.00E+00	1.18E+04	0.00E+00
40	0.00E+00	1.18E+04	0.00E+00
60	0.00E+00	1.18E+04	0.00E+00
80	0.00E+00	1.18E+04	6.25E-08
100	0.00E+00	1.18E+04	1.78E-05
120	0.00E+00	1.18E+04	7.73E-04
140	0.00E+00	1.18E+04	1.15E-02
160	0.00E+00	1.18E+04	8.66E-02
180	0.00E+00	1.18E+04	4.17E-01
200	0.00E+00	1.18E+04	1.46E+00
220	0.00E+00	1.18E+04	4.08E+00
240	0.00E+00	1.18E+04	9.58E+00
260	0.00E+00	1.18E+04	1.97E+01
280	0.00E+00	1.18E+04	3.64E+01
300	0.00E+00	1.18E+04	6.19E+01
320	0.00E+00	1.18E+04	9.83E+01
340	0.00E+00	1.18E+04	1.47E+02
360	0.00E+00	1.18E+04	2.11E+02
380	0.00E+00	1.18E+04	2.90E+02
400	0.00E+00	1.18E+04	3.86E+02
420	0.00E+00	1.18E+04	4.99E+02
440	0.00E+00	1.18E+04	6.29E+02
460	0.00E+00	1.17E+04	7.76E+02
480	0.00E+00	1.17E+04	9.39E+02
500	0.00E+00	1.17E+04	1.12E+03
520	0.00E+00	1.17E+04	1.31E+03
540	0.00E+00	1.17E+04	1.52E+03
560	0.00E+00	1.17E+04	1.73E+03
580	0.00E+00	1.17E+04	1.96E+03
600	0.00E+00	1.17E+04	2.20E+03
620	0.00E+00	1.17E+04	2.44E+03
640	0.00E+00	1.17E+04	2.69E+03
660	0.00E+00	1.17E+04	2.94E+03
680	0.00E+00	1.17E+04	3.20E+03
700	0.00E+00	1.17E+04	3.46E+03
720	0.00E+00	1.17E+04	3.72E+03
740	0.00E+00	1.17E+04	3.98E+03
760	0.00E+00	1.17E+04	4.25E+03
780	0.00E+00	1.17E+04	4.50E+03
800	0.00E+00	1.17E+04	4.76E+03
820	0.00E+00	1.17E+04	5.01E+03
840	0.00E+00	1.17E+04	5.26E+03
860	0.00E+00	1.17E+04	5.51E+03
880	0.00E+00	1.17E+04	5.75E+03
900	0.00E+00	1.17E+04	5.99E+03
920	0.00E+00	1.16E+04	6.22E+03
940	0.00E+00	1.16E+04	6.44E+03
960	0.00E+00	1.16E+04	6.66E+03
980	0.00E+00	1.16E+04	6.87E+03
1000	0.00E+00	1.16E+04	7.08E+03
MAXIMUM:	0.00E+00	1.18E+04	7.08E+03

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S4	INVESTIGATOR:	WYU	DATE:	1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Manganese	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	6.50E+01	CONSTANT CONCENTRATION (YES,NO)?	YES
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	0.00E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	YES

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	0.00E+00
Kl (L/KG):	5.00E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	600
		WIDTH (FT):	600
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	14.8	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	5.00E-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):	5.5	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	1.8	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	165.1	DISTANCE TO F.L.:	55

PREDICTED IMPACTS:

		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.65E-02 (UG/L)	0
FENCE LINE CONCENTRATION:	6.49E-01 (UG/L)	1000

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

SITE: NAVAL WEAPONS STATION, EARLE NJ, S4

CONTAMINANT: Manganese

HALF-LIFE (YRS):

LAYER 2:	0.00E+00
SATURATED LAYER	0.00E+00
DOWNGRADIENT	0.00E+00

INITIAL CONC. (ug/L): 1.65E+02

INVESTIGATOR: WYU

DATE: 1/3/97

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	600			GW Q3 (L/DAY):	5.17E+03		
WIDTH (FT):	600	Kd (L/KG):	5.00E+01	GW V. (FT/YR):	14.80	Kd (L/KG):	50
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	301
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):	1.65E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	5.50	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 5.17E+03	Ay (FT):	1.83	DISTANCE TO F.L. (FT):	55

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	1.65E+02	0.00E+00
20	0.00E+00	1.65E+02	0.00E+00
40	0.00E+00	1.65E+02	0.00E+00
60	0.00E+00	1.64E+02	0.00E+00
80	0.00E+00	1.64E+02	0.00E+00
100	0.00E+00	1.64E+02	8.10E-10
120	0.00E+00	1.63E+02	9.09E-08
140	0.00E+00	1.63E+02	2.66E-06
160	0.00E+00	1.63E+02	3.35E-05
180	0.00E+00	1.63E+02	2.40E-04
200	0.00E+00	1.62E+02	1.16E-03
220	0.00E+00	1.62E+02	4.22E-03
240	0.00E+00	1.62E+02	1.23E-02
260	0.00E+00	1.62E+02	3.06E-02
280	0.00E+00	1.61E+02	6.65E-02
300	0.00E+00	1.61E+02	1.30E-01
320	0.00E+00	1.61E+02	2.34E-01
340	0.00E+00	1.61E+02	3.92E-01
360	0.00E+00	1.60E+02	6.19E-01
380	0.00E+00	1.60E+02	9.31E-01
400	0.00E+00	1.60E+02	1.34E+00
420	0.00E+00	1.60E+02	1.87E+00
440	0.00E+00	1.59E+02	2.51E+00
460	0.00E+00	1.59E+02	3.29E+00
480	0.00E+00	1.59E+02	4.22E+00
500	0.00E+00	1.58E+02	5.29E+00
520	0.00E+00	1.58E+02	6.51E+00
540	0.00E+00	1.58E+02	7.88E+00
560	0.00E+00	1.58E+02	9.40E+00
580	0.00E+00	1.57E+02	1.11E+01
600	0.00E+00	1.57E+02	1.29E+01
620	0.00E+00	1.57E+02	1.48E+01
640	0.00E+00	1.57E+02	1.69E+01
660	0.00E+00	1.56E+02	1.90E+01
680	0.00E+00	1.56E+02	2.13E+01
700	0.00E+00	1.56E+02	2.37E+01
720	0.00E+00	1.56E+02	2.62E+01
740	0.00E+00	1.55E+02	2.88E+01
760	0.00E+00	1.55E+02	3.14E+01
780	0.00E+00	1.55E+02	3.41E+01
800	0.00E+00	1.55E+02	3.68E+01
820	0.00E+00	1.54E+02	3.96E+01
840	0.00E+00	1.54E+02	4.24E+01
860	0.00E+00	1.54E+02	4.52E+01
880	0.00E+00	1.54E+02	4.80E+01
900	0.00E+00	1.53E+02	5.09E+01
920	0.00E+00	1.53E+02	5.37E+01
940	0.00E+00	1.53E+02	5.65E+01
960	0.00E+00	1.53E+02	5.94E+01
980	0.00E+00	1.52E+02	6.22E+01
1000	0.00E+00	1.52E+02	6.49E+01
MAXIMUM	0.00E+00	1.65E+02	6.49E+01

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Aluminum	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	7.87E+03	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG)	1.50E+03		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	2.628	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	1.50E+03	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):	0.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	0.0	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	17212.11	DISTANCE TO F.L.:	0.4

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.72E+04 (UG/L)	0
FENCE LINE CONCENTRATION:	4.13E+03 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	CONTAMINANT:	Aluminum
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/3/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.72E+04

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	1.50E+03	GW V. (FT/YR):	2.63	Kd (L/KG):	1500
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	9001
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):	1.72E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	0.04	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	0.01	DISTANCE TO F.L. (FT):	0.4

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	1.72E+04	0.00E+00
20	0.00E+00	1.72E+04	0.00E+00
40	0.00E+00	1.72E+04	0.00E+00
60	0.00E+00	1.72E+04	0.00E+00
80	0.00E+00	1.72E+04	0.00E+00
100	0.00E+00	1.72E+04	0.00E+00
120	0.00E+00	1.72E+04	4.71E-08
140	0.00E+00	1.72E+04	2.92E-06
160	0.00E+00	1.72E+04	6.49E-05
180	0.00E+00	1.72E+04	7.24E-04
200	0.00E+00	1.72E+04	4.99E-03
220	0.00E+00	1.72E+04	2.42E-02
240	0.00E+00	1.72E+04	9.05E-02
260	0.00E+00	1.72E+04	2.76E-01
280	0.00E+00	1.72E+04	7.15E-01
300	0.00E+00	1.72E+04	1.63E+00
320	0.00E+00	1.72E+04	3.37E+00
340	0.00E+00	1.72E+04	6.36E+00
360	0.00E+00	1.72E+04	1.12E+01
380	0.00E+00	1.72E+04	1.85E+01
400	0.00E+00	1.72E+04	2.92E+01
420	0.00E+00	1.72E+04	4.39E+01
440	0.00E+00	1.72E+04	6.36E+01
460	0.00E+00	1.72E+04	8.92E+01
480	0.00E+00	1.72E+04	1.22E+02
500	0.00E+00	1.72E+04	1.61E+02
520	0.00E+00	1.72E+04	2.09E+02
540	0.00E+00	1.72E+04	2.66E+02
560	0.00E+00	1.72E+04	3.33E+02
580	0.00E+00	1.72E+04	4.09E+02
600	0.00E+00	1.72E+04	4.95E+02
620	0.00E+00	1.72E+04	5.92E+02
640	0.00E+00	1.72E+04	7.00E+02
660	0.00E+00	1.72E+04	8.17E+02
680	0.00E+00	1.72E+04	9.46E+02
700	0.00E+00	1.72E+04	1.08E+03
720	0.00E+00	1.72E+04	1.23E+03
740	0.00E+00	1.72E+04	1.39E+03
760	0.00E+00	1.72E+04	1.56E+03
780	0.00E+00	1.72E+04	1.74E+03
800	0.00E+00	1.72E+04	1.92E+03
820	0.00E+00	1.72E+04	2.12E+03
840	0.00E+00	1.72E+04	2.32E+03
860	0.00E+00	1.72E+04	2.52E+03
880	0.00E+00	1.72E+04	2.74E+03
900	0.00E+00	1.72E+04	2.96E+03
920	0.00E+00	1.72E+04	3.18E+03
940	0.00E+00	1.72E+04	3.41E+03
960	0.00E+00	1.72E+04	3.65E+03
980	0.00E+00	1.72E+04	3.89E+03
1000	0.00E+00	1.72E+04	4.13E+03
MAXIMUM:	0.00E+00	1.72E+04	4.13E+03

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	**INVESTIGATOR:**	WYU	**DATE:**	1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Cadmium	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	4.00E+00	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	7.50E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	2.628	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):	0.4	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	0.1	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC (ug/L):	4.51	DISTANCE TO F.L.:	4

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	4.51E+00 (UG/L)	0
FENCE LINE CONCENTRATION:	3.59E+00 (UG/L)	1000

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

SITE: NAVAL WEAPONS STATION, EARLE NJ, S5

CONTAMINANT: Cadmium

HALF-LIFE (YRS):

LAYER 2:	0.00E+00
SATURATED LAYER	0.00E+00
DOWNGRADIENT	0.00E+00

INITIAL CONC. (ug/L): 4.51E+00

INVESTIGATOR: WYU

DATE: 1/3/97

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	7.50E+01	GW V. (FT/YR):	2.63	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):	4.51E+00	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	0.40	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	0.13	DISTANCE TO F.L. (FT):	-1

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	4.51E+00	0.00E+00
20	0.00E+00	4.51E+00	0.00E+00
40	0.00E+00	4.51E+00	0.00E+00
60	0.00E+00	4.51E+00	1.16E-11
80	0.00E+00	4.50E+00	1.62E-08
100	0.00E+00	4.50E+00	1.26E-06
120	0.00E+00	4.50E+00	2.30E-05
140	0.00E+00	4.50E+00	1.83E-04
160	0.00E+00	4.50E+00	8.62E-04
180	0.00E+00	4.50E+00	2.87E-03
200	0.00E+00	4.50E+00	7.50E-03
220	0.00E+00	4.49E+00	1.64E-02
240	0.00E+00	4.49E+00	3.14E-02
260	0.00E+00	4.49E+00	5.41E-02
280	0.00E+00	4.49E+00	8.60E-02
300	0.00E+00	4.49E+00	1.28E-01
320	0.00E+00	4.49E+00	1.81E-01
340	0.00E+00	4.49E+00	2.45E-01
360	0.00E+00	4.48E+00	3.20E-01
380	0.00E+00	4.48E+00	4.05E-01
400	0.00E+00	4.48E+00	4.99E-01
420	0.00E+00	4.48E+00	6.02E-01
440	0.00E+00	4.48E+00	7.12E-01
460	0.00E+00	4.48E+00	8.28E-01
480	0.00E+00	4.48E+00	9.49E-01
500	0.00E+00	4.48E+00	1.07E+00
520	0.00E+00	4.47E+00	1.20E+00
540	0.00E+00	4.47E+00	1.33E+00
560	0.00E+00	4.47E+00	1.46E+00
580	0.00E+00	4.47E+00	1.59E+00
600	0.00E+00	4.47E+00	1.72E+00
620	0.00E+00	4.47E+00	1.84E+00
640	0.00E+00	4.47E+00	1.97E+00
660	0.00E+00	4.46E+00	2.09E+00
680	0.00E+00	4.46E+00	2.21E+00
700	0.00E+00	4.46E+00	2.33E+00
720	0.00E+00	4.46E+00	2.44E+00
740	0.00E+00	4.46E+00	2.55E+00
760	0.00E+00	4.46E+00	2.65E+00
780	0.00E+00	4.46E+00	2.75E+00
800	0.00E+00	4.45E+00	2.85E+00
820	0.00E+00	4.45E+00	2.94E+00
840	0.00E+00	4.45E+00	3.03E+00
860	0.00E+00	4.45E+00	3.11E+00
880	0.00E+00	4.45E+00	3.19E+00
900	0.00E+00	4.45E+00	3.27E+00
920	0.00E+00	4.45E+00	3.34E+00
940	0.00E+00	4.44E+00	3.41E+00
960	0.00E+00	4.44E+00	3.47E+00
980	0.00E+00	4.44E+00	3.54E+00
1000	0.00E+00	4.44E+00	3.59E+00
MAXIMUM:	0.00E+00	4.51E+00	3.59E+00

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SITE:	NAVAL WEAPONS STATION, EARLE NJ, S5	**INVESTIGATOR:**	WYU	**DATE:**	1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Iron	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
HALF-LIFE (YRS):	0.00E+00	WATER CRITERIA (UG/L):	7.69E+03	CONSTANT CONCENTRATION (YES,NO)?	YES
				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):	0.00E+00
Kl (L/KG):	2.20E+02		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		**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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	2.628	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):	0.3	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	0.1	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	23714.18	DISTANCE TO F.L.:	3

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.37E+04 (UG/L)	0
FENCE LINE CONCENTRATION:	4.20E+03 (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
SATURATED LAYER 0.00E+00
DOWNGRADIENT 0.00E+00

INITIAL CONC. (ug/L): 2.37E+04

INVESTIGATOR: WYU
DATE: 1/3/97

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	2.20E+02	GW V. (FT/YR):	2.63	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):	2.37E+04	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	0.30	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	0.10	DISTANCE TO F.L. (FT):	3

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	2.37E+04	0.00E+00
20	0.00E+00	2.37E+04	0.00E+00
40	0.00E+00	2.37E+04	0.00E+00
60	0.00E+00	2.37E+04	0.00E+00
80	0.00E+00	2.37E+04	0.00E+00
100	0.00E+00	2.37E+04	0.00E+00
120	0.00E+00	2.37E+04	0.00E+00
140	0.00E+00	2.37E+04	3.32E-07
160	0.00E+00	2.37E+04	1.00E-05
180	0.00E+00	2.37E+04	1.43E-04
200	0.00E+00	2.37E+04	1.20E-03
220	0.00E+00	2.37E+04	6.80E-03
240	0.00E+00	2.37E+04	2.90E-02
260	0.00E+00	2.37E+04	9.88E-02
280	0.00E+00	2.37E+04	2.83E-01
300	0.00E+00	2.37E+04	7.02E-01
320	0.00E+00	2.37E+04	1.56E+00
340	0.00E+00	2.37E+04	3.14E+00
360	0.00E+00	2.37E+04	5.86E+00
380	0.00E+00	2.37E+04	1.02E+01
400	0.00E+00	2.37E+04	1.69E+01
420	0.00E+00	2.37E+04	2.65E+01
440	0.00E+00	2.37E+04	4.00E+01
460	0.00E+00	2.37E+04	5.81E+01
480	0.00E+00	2.37E+04	8.18E+01
500	0.00E+00	2.37E+04	1.12E+02
520	0.00E+00	2.36E+04	1.49E+02
540	0.00E+00	2.36E+04	1.95E+02
560	0.00E+00	2.36E+04	2.50E+02
580	0.00E+00	2.36E+04	3.14E+02
600	0.00E+00	2.36E+04	3.89E+02
620	0.00E+00	2.36E+04	4.74E+02
640	0.00E+00	2.36E+04	5.71E+02
660	0.00E+00	2.36E+04	6.80E+02
680	0.00E+00	2.36E+04	8.00E+02
700	0.00E+00	2.36E+04	9.32E+02
720	0.00E+00	2.36E+04	1.08E+03
740	0.00E+00	2.36E+04	1.23E+03
760	0.00E+00	2.36E+04	1.40E+03
780	0.00E+00	2.36E+04	1.58E+03
800	0.00E+00	2.36E+04	1.77E+03
820	0.00E+00	2.36E+04	1.97E+03
840	0.00E+00	2.36E+04	2.19E+03
860	0.00E+00	2.36E+04	2.41E+03
880	0.00E+00	2.36E+04	2.64E+03
900	0.00E+00	2.36E+04	2.88E+03
920	0.00E+00	2.36E+04	3.13E+03
940	0.00E+00	2.36E+04	3.39E+03
960	0.00E+00	2.36E+04	3.65E+03
980	0.00E+00	2.36E+04	3.93E+03
1000	0.00E+00	2.36E+04	4.20E+03
MAXIMUM:	0.00E+00	2.37E+04	4.20E+03

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S5 INVESTIGATOR: WYU DATE: 1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Manganese	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	YES
		UNDERS: Under source, FL: Fenceline		INPUT LEACHATE CONCENTRATION (UG/L)	0.000E+00
		WATER CRITERIA (UG/L):	6.50E+01	CONSTANT CONCENTRATION (YES,NO)?	YES
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):	0.00E+00
Kl (L/KG):	5.00E+01		
CONSTANT SOURCE CONCENTRATION (UG/L):	0.00E+00	LENGTH (FT):	375
		WIDTH (FT):	700
THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION		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):		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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	2.628	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG)	5.00E+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):	1.3	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	0.4	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	302	DISTANCE TO F.L.:	13

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION	3.02E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	5.57E+01 (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

CONTAMINANT: Manganese

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

INVESTIGATOR: WYU
DATE: 1/3/97

INITIAL CONC. (ug/L): 3.02E+02

SATURATED LAYER

INFILT (FT/YR):	0			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	375			GW Q3 (L/DAY):	1.07E+03		
WIDTH (FT):	700	Kd (L/KG):	5.00E+01	GW V. (FT/YR):	2.63	Kd (L/KG):	50
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	301
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):	3.02E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	1.30	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 0.00E+00	Q2 (L/DAY): 1.07E+03	Ay (FT):	0.43	DISTANCE TO F.L. (FT):	13

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	3.02E+02	0.00E+00
20	0.00E+00	3.02E+02	0.00E+00
40	0.00E+00	3.02E+02	0.00E+00
60	0.00E+00	3.02E+02	0.00E+00
80	0.00E+00	3.01E+02	0.00E+00
100	0.00E+00	3.01E+02	0.00E+00
120	0.00E+00	3.01E+02	0.00E+00
140	0.00E+00	3.01E+02	5.97E-09
160	0.00E+00	3.01E+02	1.73E-07
180	0.00E+00	3.01E+02	2.38E-06
200	0.00E+00	3.01E+02	1.94E-05
220	0.00E+00	3.00E+02	1.08E-04
240	0.00E+00	3.00E+02	4.51E-04
260	0.00E+00	3.00E+02	1.51E-03
280	0.00E+00	3.00E+02	4.27E-03
300	0.00E+00	3.00E+02	1.05E-02
320	0.00E+00	3.00E+02	2.30E-02
340	0.00E+00	3.00E+02	4.61E-02
360	0.00E+00	2.99E+02	8.52E-02
380	0.00E+00	2.99E+02	1.48E-01
400	0.00E+00	2.99E+02	2.42E-01
420	0.00E+00	2.99E+02	3.78E-01
440	0.00E+00	2.99E+02	5.67E-01
460	0.00E+00	2.99E+02	8.20E-01
480	0.00E+00	2.99E+02	1.15E+00
500	0.00E+00	2.99E+02	1.57E+00
520	0.00E+00	2.98E+02	2.08E+00
540	0.00E+00	2.98E+02	2.71E+00
560	0.00E+00	2.98E+02	3.46E+00
580	0.00E+00	2.98E+02	4.33E+00
600	0.00E+00	2.98E+02	5.35E+00
620	0.00E+00	2.98E+02	6.50E+00
640	0.00E+00	2.98E+02	7.81E+00
660	0.00E+00	2.97E+02	9.27E+00
680	0.00E+00	2.97E+02	1.09E+01
700	0.00E+00	2.97E+02	1.27E+01
720	0.00E+00	2.97E+02	1.46E+01
740	0.00E+00	2.97E+02	1.67E+01
760	0.00E+00	2.97E+02	1.89E+01
780	0.00E+00	2.97E+02	2.13E+01
800	0.00E+00	2.96E+02	2.38E+01
820	0.00E+00	2.96E+02	2.65E+01
840	0.00E+00	2.96E+02	2.93E+01
860	0.00E+00	2.96E+02	3.22E+01
880	0.00E+00	2.96E+02	3.52E+01
900	0.00E+00	2.96E+02	3.84E+01
920	0.00E+00	2.96E+02	4.17E+01
940	0.00E+00	2.95E+02	4.50E+01
960	0.00E+00	2.95E+02	4.85E+01
980	0.00E+00	2.95E+02	5.20E+01
1000	0.00E+00	2.95E+02	5.57E+01
MAXIMUM:	0.00E+00	3.02E+02	5.57E+01

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Aluminum	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.658E+03
		WATER CRITERIA (UG/L):	7.87E+03	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	1.73E+03
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):	1.08E+00
Kl (L/KG):	1.50E+03	LENGTH (FT):	200
		WIDTH (FT):	150
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):	1.66E+03	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	28.6	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	1.50E+03	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):	0.2	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	0.1	CONC. IN UPGRADIENT GROUNDWATER.CU2 (UG/L)	0
INITIAL CONC. (ug/L):	9610	DISTANCE TO F.L.:	2.2

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	9.61E+03 (UG/L)	0
FENCE LINE CONCENTRATION:	7.56E+03 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S19	CONTAMINANT:	Aluminum
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/3/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	9.61E+03

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	1.50E+03	GW V. (FT/YR):	28.60	Kd (L/KG):	1500
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	9001
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):	9.61E+03	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	0.22	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+03	Ay (FT):	0.07	DISTANCE TO F.L. (FT):	2.2

TIME INTERVAL (YRS)	20	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	1.11E+03	9.61E+03	0.00E+00
20	1.10E+03	9.60E+03	0.00E+00
40	1.10E+03	9.60E+03	0.00E+00
60	1.10E+03	9.59E+03	1.93E-08
80	1.10E+03	9.59E+03	2.87E-05
100	1.10E+03	9.58E+03	2.31E-03
120	1.10E+03	9.58E+03	4.32E-02
140	1.10E+03	9.57E+03	3.49E-01
160	1.10E+03	9.56E+03	1.67E+00
180	1.10E+03	9.56E+03	5.03E+00
200	1.10E+03	9.55E+03	1.48E+01
220	1.10E+03	9.55E+03	3.27E+01
240	1.09E+03	9.54E+03	6.28E+01
260	1.09E+03	9.54E+03	1.09E+02
280	1.09E+03	9.53E+03	1.74E+02
300	1.09E+03	9.52E+03	2.60E+02
320	1.09E+03	9.52E+03	3.69E+02
340	1.09E+03	9.51E+03	5.01E+02
360	1.09E+03	9.51E+03	6.55E+02
380	1.09E+03	9.50E+03	8.31E+02
400	1.09E+03	9.49E+03	1.03E+03
420	1.09E+03	9.49E+03	1.24E+03
440	1.09E+03	9.48E+03	1.47E+03
460	1.09E+03	9.48E+03	1.71E+03
480	1.08E+03	9.47E+03	1.97E+03
500	1.08E+03	9.47E+03	2.23E+03
520	1.08E+03	9.46E+03	2.49E+03
540	1.08E+03	9.46E+03	2.77E+03
560	1.08E+03	9.45E+03	3.04E+03
580	1.08E+03	9.44E+03	3.31E+03
600	1.08E+03	9.44E+03	3.58E+03
620	1.08E+03	9.43E+03	3.85E+03
640	1.08E+03	9.43E+03	4.11E+03
660	1.08E+03	9.42E+03	4.37E+03
680	1.08E+03	9.42E+03	4.63E+03
700	1.07E+03	9.41E+03	4.87E+03
720	1.07E+03	9.40E+03	5.11E+03
740	1.07E+03	9.40E+03	5.34E+03
760	1.07E+03	9.39E+03	5.56E+03
780	1.07E+03	9.39E+03	5.78E+03
800	1.07E+03	9.38E+03	5.98E+03
820	1.07E+03	9.38E+03	6.18E+03
840	1.07E+03	9.37E+03	6.36E+03
860	1.07E+03	9.36E+03	6.54E+03
880	1.07E+03	9.36E+03	6.71E+03
900	1.07E+03	9.35E+03	6.87E+03
920	1.07E+03	9.35E+03	7.03E+03
940	1.06E+03	9.34E+03	7.17E+03
960	1.06E+03	9.34E+03	7.31E+03
980	1.06E+03	9.33E+03	7.44E+03
1000	1.06E+03	9.32E+03	7.56E+03
MAXIMUM	1.11E+03	9.61E+03	7.56E+03

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/3/97

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)	1.600E+00
		WATER CRITERIA (UG/L):	8.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	1.61E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	YES

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.08E+00
Kl (L/KG):	2.90E+01	LENGTH (FT):	200
		WIDTH (FT):	150
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.60E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	12	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	28.6	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):	19.1	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	6.4	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC (ug/L):	27.4	DISTANCE TO F.L.:	191

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.74E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	7.95E+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, S19	CONTAMINANT:	Arsenic
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/3/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	2.74E+01

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	2.90E+01	GW V. (FT/YR):	28.60	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):	2.74E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	19.10	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E-03	Q2 (L/DAY): 2.50E+03	Ay (FT):	6.37	DISTANCE TO F.L. (FT):	191

TIME INTERVAL (YRS) 20

ELAPSED TIME - YRS	LAYER 2(PPB)	SOURCE AREA CONC.(GMA) (UG/L)	FENCE LINE CONC. (UG/L)
0	5.52E+01	2.74E+01	0.00E+00
20	5.29E+01	2.74E+01	0.00E+00
40	5.08E+01	2.73E+01	0.00E+00
60	4.87E+01	2.72E+01	0.00E+00
80	4.68E+01	2.71E+01	0.00E+00
100	4.49E+01	2.70E+01	3.30E-11
120	4.30E+01	2.68E+01	4.57E-09
140	4.13E+01	2.66E+01	1.55E-07
160	3.96E+01	2.64E+01	2.19E-06
180	3.80E+01	2.61E+01	1.71E-05
200	3.65E+01	2.59E+01	8.91E-05
220	3.50E+01	2.56E+01	3.43E-04
240	3.36E+01	2.53E+01	1.05E-03
260	3.22E+01	2.50E+01	2.72E-03
280	3.09E+01	2.47E+01	6.12E-03
300	2.97E+01	2.44E+01	1.24E-02
320	2.85E+01	2.41E+01	2.28E-02
340	2.73E+01	2.38E+01	3.92E-02
360	2.62E+01	2.34E+01	6.32E-02
380	2.51E+01	2.31E+01	9.68E-02
400	2.41E+01	2.27E+01	1.42E-01
420	2.31E+01	2.23E+01	2.00E-01
440	2.22E+01	2.20E+01	2.74E-01
460	2.13E+01	2.16E+01	3.64E-01
480	2.04E+01	2.13E+01	4.71E-01
500	1.96E+01	2.09E+01	5.97E-01
520	1.88E+01	2.05E+01	7.42E-01
540	1.80E+01	2.01E+01	9.06E-01
560	1.73E+01	1.98E+01	1.09E+00
580	1.66E+01	1.94E+01	1.29E+00
600	1.59E+01	1.90E+01	1.51E+00
620	1.53E+01	1.87E+01	1.75E+00
640	1.47E+01	1.83E+01	2.01E+00
660	1.41E+01	1.79E+01	2.28E+00
680	1.35E+01	1.76E+01	2.56E+00
700	1.30E+01	1.72E+01	2.86E+00
720	1.24E+01	1.69E+01	3.17E+00
740	1.19E+01	1.65E+01	3.49E+00
760	1.14E+01	1.62E+01	3.82E+00
780	1.10E+01	1.58E+01	4.16E+00
800	1.05E+01	1.55E+01	4.50E+00
820	1.01E+01	1.51E+01	4.85E+00
840	9.70E+00	1.48E+01	5.20E+00
860	9.31E+00	1.45E+01	5.55E+00
880	8.93E+00	1.42E+01	5.90E+00
900	8.57E+00	1.38E+01	6.25E+00
920	8.22E+00	1.35E+01	6.60E+00
940	7.89E+00	1.32E+01	6.94E+00
960	7.57E+00	1.29E+01	7.28E+00
980	7.26E+00	1.26E+01	7.62E+00
1000	6.97E+00	1.23E+01	7.95E+00
MAXIMUM:	5.52E+01	2.74E+01	7.95E+00

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/3/97

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)	9.000E-02
		WATER CRITERIA (UG/L):	4.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	9.11E-02
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	YES

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.08E-00
Kl (L/KG):	7.50E+01	LENGTH (FT):	200
		WIDTH (FT):	150
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):	9.00E-02	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	28.6	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):	5.5	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	1.8	CONC IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	7.5	DISTANCE TO F.L.:	55

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	7.50E+00 (UG/L)	0
FENCE LINE CONCENTRATION:	3.95E-00 (UG/L)	1000

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

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19

INVESTIGATOR: WYU

DATE: 1/3/97

CONTAMINANT: Cadmium

HALF-LIFE (YRS):

LAYER 2:	0.00E+00
SATURATED LAYER	0.00E+00
DOWNGRADIENT	0.00E+00

INITIAL CONC. (ug/L): 7.50E+00

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	7.50E+01	GW V. (FT/YR):	28.60	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):	7.50E+00	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	5.50	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+03	Ay (FT):	1.83	DISTANCE TO F.L. (FT):	55

TIME INTERVAL (YRS) 20

ELAPSED TIME - YRS	LAYER 2(PPB)	SOURCE AREA CONC.(GMA) (UG/L)	FENCE LINE CONC. (UG/L)
0	1.20E+00	7.50E+00	0.00E+00
20	1.18E+00	7.41E+00	0.00E+00
40	1.16E+00	7.33E+00	0.00E+00
60	1.14E+00	7.24E+00	0.00E+00
80	1.13E+00	7.16E+00	8.80E-11
100	1.11E+00	7.07E+00	2.14E-08
120	1.09E+00	6.99E+00	8.35E-07
140	1.07E+00	6.91E+00	1.15E-05
160	1.06E+00	6.83E+00	8.16E-05
180	1.04E+00	6.75E+00	3.75E-04
200	1.02E+00	6.67E+00	1.27E-03
220	1.01E+00	6.59E+00	3.43E-03
240	9.90E-01	6.51E+00	7.85E-03
260	9.74E-01	6.44E+00	1.58E-02
280	9.59E-01	6.36E+00	2.85E-02
300	9.43E-01	6.29E+00	4.77E-02
320	9.28E-01	6.21E+00	7.44E-02
340	9.14E-01	6.14E+00	1.10E-01
360	8.99E-01	6.07E+00	1.55E-01
380	8.85E-01	6.00E+00	2.11E-01
400	8.71E-01	5.93E+00	2.78E-01
420	8.57E-01	5.86E+00	3.55E-01
440	8.43E-01	5.79E+00	4.42E-01
460	8.30E-01	5.72E+00	5.40E-01
480	8.17E-01	5.65E+00	6.47E-01
500	8.04E-01	5.59E+00	7.62E-01
520	7.91E-01	5.52E+00	8.85E-01
540	7.78E-01	5.45E+00	1.01E+00
560	7.66E-01	5.39E+00	1.15E+00
580	7.54E-01	5.33E+00	1.29E+00
600	7.42E-01	5.26E+00	1.43E+00
620	7.30E-01	5.20E+00	1.58E+00
640	7.18E-01	5.14E+00	1.73E+00
660	7.07E-01	5.08E+00	1.88E+00
680	6.96E-01	5.02E+00	2.02E+00
700	6.85E-01	4.96E+00	2.17E+00
720	6.74E-01	4.90E+00	2.32E+00
740	6.63E-01	4.84E+00	2.46E+00
760	6.52E-01	4.79E+00	2.60E+00
780	6.42E-01	4.73E+00	2.74E+00
800	6.32E-01	4.67E+00	2.87E+00
820	6.22E-01	4.62E+00	3.00E+00
840	6.12E-01	4.56E+00	3.13E+00
860	6.02E-01	4.51E+00	3.25E+00
880	5.93E-01	4.46E+00	3.36E+00
900	5.83E-01	4.40E+00	3.48E+00
920	5.74E-01	4.35E+00	3.58E+00
940	5.65E-01	4.30E+00	3.68E+00
960	5.56E-01	4.25E+00	3.78E+00
980	5.47E-01	4.20E+00	3.87E+00
1000	5.38E-01	4.15E+00	3.95E+00
MAXIMUM	1.20E+00	7.50E+00	3.95E+00

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BROWN & ROOT ENVIRONMENTAL

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/3/97

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)	1.305E+03
		WATER CRITERIA (UG/L):	1.00E+01	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	1.36E+03
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):	1.08E+00
Kl (L/KG):	2.70E+02		
		LENGTH (FT):	200
		WIDTH (FT):	150
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):	1.31E+03	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	28.6	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):	3.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	1.0	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	17.2	DISTANCE TO F.L.:	30

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	3.66E+02 (UG/L)	1000
FENCE LINE CONCENTRATION:	9.59E+00 (UG/L)	1000

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

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S19	CONTAMINANT:	Lead
		HALF-LIFE (YRS):	
		LAYER 2:	0.00E+00
INVESTIGATOR:	WYU	SATURATED LAYER	0.00E+00
DATE:	1/3/97	DOWNGRADIENT	0.00E+00
		INITIAL CONC. (ug/L):	1.72E+01

SATURATED LAYER

INFILT (FT/YR):	1.0833333				B (FT):	30	Vzo (FT/YR): 0.343
LENGTH (FT):	200				GW Q3 (L/DAY):	5.02E+03	
WIDTH (FT):	150		Kd (L/KG):	2.70E+02	GW V. (FT/YR):	28.60	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):	1.72E+01	Az (FT):	0.09	
			CU2 (PPB):	0.00E+00	Ax (FT):	3.00	P&T (YEARS): 0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY):	2.50E+03	Ay (FT):	1.00	DISTANCE TO F.L. (FT): 30

TIME INTERVAL (YRS)	20	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	4.83E+03	1.72E+01	0.00E+00
20	4.81E+03	2.57E+01	0.00E+00
40	4.79E+03	3.41E+01	0.00E+00
60	4.77E+03	4.25E+01	0.00E+00
80	4.75E+03	5.08E+01	0.00E+00
100	4.73E+03	5.90E+01	0.00E+00
120	4.71E+03	6.72E+01	0.00E+00
140	4.68E+03	7.53E+01	0.00E+00
160	4.66E+03	8.33E+01	3.47E-10
180	4.64E+03	9.13E+01	7.07E-09
200	4.62E+03	9.92E+01	7.92E-08
220	4.60E+03	1.07E+02	5.78E-07
240	4.58E+03	1.15E+02	3.06E-06
260	4.56E+03	1.23E+02	1.26E-05
280	4.54E+03	1.30E+02	4.29E-05
300	4.52E+03	1.38E+02	1.25E-04
320	4.50E+03	1.45E+02	3.20E-04
340	4.48E+03	1.53E+02	7.39E-04
360	4.46E+03	1.60E+02	1.56E-03
380	4.44E+03	1.68E+02	3.06E-03
400	4.42E+03	1.75E+02	5.65E-03
420	4.40E+03	1.82E+02	9.85E-03
440	4.38E+03	1.89E+02	1.64E-02
460	4.36E+03	1.96E+02	2.62E-02
480	4.34E+03	2.03E+02	4.04E-02
500	4.32E+03	2.10E+02	6.02E-02
520	4.30E+03	2.17E+02	8.73E-02
540	4.29E+03	2.24E+02	1.24E-01
560	4.27E+03	2.31E+02	1.71E-01
580	4.25E+03	2.38E+02	2.31E-01
600	4.23E+03	2.44E+02	3.07E-01
620	4.21E+03	2.51E+02	4.01E-01
640	4.19E+03	2.57E+02	5.16E-01
660	4.17E+03	2.64E+02	6.55E-01
680	4.15E+03	2.70E+02	8.21E-01
700	4.13E+03	2.77E+02	1.02E+00
720	4.12E+03	2.83E+02	1.24E+00
740	4.10E+03	2.89E+02	1.51E+00
760	4.08E+03	2.96E+02	1.81E+00
780	4.06E+03	3.02E+02	2.16E+00
800	4.04E+03	3.08E+02	2.55E+00
820	4.03E+03	3.14E+02	2.99E+00
840	4.01E+03	3.20E+02	3.48E+00
860	3.99E+03	3.26E+02	4.03E+00
880	3.97E+03	3.32E+02	4.63E+00
900	3.95E+03	3.38E+02	5.29E+00
920	3.94E+03	3.44E+02	6.02E+00
940	3.92E+03	3.49E+02	6.81E+00
960	3.90E+03	3.55E+02	7.67E+00
980	3.88E+03	3.61E+02	8.59E+00
1000	3.87E+03	3.66E+02	9.59E+00
MAXIMUM:	4.83E+03	3.66E+02	9.59E+00

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SITE: NAVAL WEAPONS STATION, EARLE NJ, S19 INVESTIGATOR: WYU DATE: 1/3/97

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX			
CONTAMINANT:	Manganese	EXPOSURE POINT: (UNDERS, FL)	FL	LEACHATE CONCENTRATION (YES,NO) ?	NO
		UNDERS: Under source, FL: Fenceline		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.200E+00
		WATER CRITERIA (UG/L):	6.50E+01	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	2.30E-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):	1.08E-00
Kl (L/KG):	5.00E+01	LENGTH (FT):	200
		WIDTH (FT):	150
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):	2.20E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	12	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	28.6	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0
Kd (L/KG):	5.00E+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):	10.5	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	3.5	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	185	DISTANCE TO F.L.:	105

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	1.85E+02 (UG/L)	0
FENCE LINE CONCENTRATION:	6.23E+01 (UG/L)	1000

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

SITE: NAVAL WEAPONS STATION, EARLE NJ, S19

CONTAMINANT: Manganese

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

INVESTIGATOR: WYU
DATE: 1/3/97

INITIAL CONC. (ug/L): 1.85E+02

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	5.00E+01	GW V. (FT/YR):	28.60	Kd (L/KG):	50
POROSITY 2:	0.25	SATURATION:	1.00	H (FT):	30.0000	RETARDATION:	301
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):	1.85E+02	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	10.50	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+03	Ay (FT):	3.50	DISTANCE TO F.L. (FT):	105

TIME INTERVAL (YRS)	20	SOURCE AREA CONC.(GMA)	FENCE LINE CONC.
ELAPSED TIME - YRS	LAYER 2(PPB)	(UG/L)	(UG/L)
0	4.40E+01	1.85E+02	0.00E+00
20	4.30E+01	1.82E+02	0.00E+00
40	4.19E+01	1.79E+02	0.00E+00
60	4.09E+01	1.76E+02	0.00E+00
80	4.00E+01	1.73E+02	0.00E+00
100	3.90E+01	1.70E+02	1.27E-09
120	3.81E+01	1.67E+02	1.35E-07
140	3.72E+01	1.64E+02	3.78E-06
160	3.63E+01	1.62E+02	4.62E-05
180	3.54E+01	1.59E+02	3.23E-04
200	3.46E+01	1.56E+02	1.53E-03
220	3.38E+01	1.54E+02	5.47E-03
240	3.30E+01	1.51E+02	1.58E-02
260	3.22E+01	1.48E+02	3.85E-02
280	3.14E+01	1.46E+02	8.28E-02
300	3.07E+01	1.43E+02	1.60E-01
320	3.00E+01	1.41E+02	2.85E-01
340	2.92E+01	1.39E+02	4.74E-01
360	2.85E+01	1.36E+02	7.42E-01
380	2.79E+01	1.34E+02	1.11E+00
400	2.72E+01	1.32E+02	1.58E+00
420	2.66E+01	1.29E+02	2.18E+00
440	2.59E+01	1.27E+02	2.92E+00
460	2.53E+01	1.25E+02	3.80E+00
480	2.47E+01	1.23E+02	4.83E+00
500	2.41E+01	1.21E+02	6.02E+00
520	2.36E+01	1.19E+02	7.35E+00
540	2.30E+01	1.17E+02	8.84E+00
560	2.24E+01	1.15E+02	1.05E+01
580	2.19E+01	1.13E+02	1.23E+01
600	2.14E+01	1.11E+02	1.42E+01
620	2.09E+01	1.09E+02	1.62E+01
640	2.04E+01	1.07E+02	1.83E+01
660	1.99E+01	1.05E+02	2.06E+01
680	1.94E+01	1.03E+02	2.29E+01
700	1.90E+01	1.02E+02	2.53E+01
720	1.85E+01	9.99E+01	2.77E+01
740	1.81E+01	9.82E+01	3.02E+01
760	1.76E+01	9.65E+01	3.28E+01
780	1.72E+01	9.48E+01	3.53E+01
800	1.68E+01	9.32E+01	3.79E+01
820	1.64E+01	9.16E+01	4.05E+01
840	1.60E+01	9.00E+01	4.31E+01
860	1.57E+01	8.85E+01	4.56E+01
880	1.53E+01	8.69E+01	4.81E+01
900	1.49E+01	8.54E+01	5.06E+01
920	1.46E+01	8.39E+01	5.31E+01
940	1.42E+01	8.25E+01	5.54E+01
960	1.39E+01	8.11E+01	5.78E+01
980	1.35E+01	7.97E+01	6.01E+01
1000	1.32E+01	7.83E+01	6.23E+01
MAXIMUM:	4.40E+01	1.85E+02	6.23E+01

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BROWN & ROOT ENVIRONMENTAL

SITE:	NAVAL WEAPONS STATION, EARLE NJ, S19	**INVESTIGATOR:**	WYU	**DATE:**	1/3/97

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)	3.000E+00
		WATER CRITERIA (UG/L):	1.00E+00	CONSTANT CONCENTRATION (YES,NO)?	NO
HALF-LIFE (YRS):	0.00E+00			TRY NEW GOAL:	3.07E-01
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS):	1000	ACCEPTABLE!	DECREASE

SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.08E+00
Kl (L/KG):	7.10E+01	LENGTH (FT):	200
		WIDTH (FT):	150
DEPLETING SOURCE:		**IS THERE A CLAY LINER LAYER (YES,NO)?**	no
WASTE CHARACTERISTICS:			
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	3.00E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	12	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)?	6	HOW MANY SUBLAYERS (1 - 10)?	5
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):	28.6	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):	7.9	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	2.6	CONC. IN UPGRADIENT GROUNDWATER,CU2 (UG/L)	0
INITIAL CONC. (ug/L):	28.9	DISTANCE TO F.L.:	79

PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.89E+01 (UG/L)	0
FENCE LINE CONCENTRATION:	9.76E+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, S19

CONTAMINANT: Thallium

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

INITIAL CONC. (ug/L): 2.89E+01

INVESTIGATOR: WYU
DATE: 1/3/97

SATURATED LAYER

INFILT (FT/YR):	1.0833333			B (FT):	30	Vzo (FT/YR):	0.343
LENGTH (FT):	200			GW Q3 (L/DAY):	5.02E+03		
WIDTH (FT):	150	Kd (L/KG):	7.10E+01	GW V. (FT/YR):	28.60	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):	2.89E+01	Az (FT):	0.09		
		CU2 (PPB):	0.00E+00	Ax (FT):	7.90	P&T (YEARS):	0
AGE (YEARS):	0	Q1 (L/DAY): 2.52E+03	Q2 (L/DAY): 2.50E+03	Ay (FT):	2.63	DISTANCE TO F.L. (FT):	79

TIME INTERVAL (YRS) 20

ELAPSED TIME - YRS	LAYER 2(PPB)	SOURCE AREA CONC.(GMA) (UG/L)	FENCE LINE CONC. (UG/L)
0	4.23E+01	2.89E+01	0.00E+00
20	4.15E+01	2.88E+01	0.00E+00
40	4.08E+01	2.87E+01	0.00E+00
60	4.02E+01	2.86E+01	0.00E+00
80	3.95E+01	2.85E+01	0.00E+00
100	3.88E+01	2.83E+01	3.04E-11
120	3.82E+01	2.82E+01	4.40E-09
140	3.75E+01	2.81E+01	1.54E-07
160	3.69E+01	2.80E+01	2.23E-06
180	3.63E+01	2.78E+01	1.78E-05
200	3.57E+01	2.77E+01	9.39E-05
220	3.51E+01	2.76E+01	3.66E-04
240	3.45E+01	2.74E+01	1.14E-03
260	3.39E+01	2.73E+01	2.96E-03
280	3.33E+01	2.71E+01	6.71E-03
300	3.28E+01	2.70E+01	1.36E-02
320	3.22E+01	2.69E+01	2.53E-02
340	3.17E+01	2.67E+01	4.36E-02
360	3.11E+01	2.66E+01	7.08E-02
380	3.06E+01	2.64E+01	1.09E-01
400	3.01E+01	2.63E+01	1.60E-01
420	2.96E+01	2.61E+01	2.27E-01
440	2.91E+01	2.60E+01	3.11E-01
460	2.86E+01	2.58E+01	4.14E-01
480	2.81E+01	2.56E+01	5.38E-01
500	2.77E+01	2.55E+01	6.84E-01
520	2.72E+01	2.53E+01	8.52E-01
540	2.67E+01	2.52E+01	1.04E+00
560	2.63E+01	2.50E+01	1.26E+00
580	2.59E+01	2.48E+01	1.49E+00
600	2.54E+01	2.47E+01	1.75E+00
620	2.50E+01	2.45E+01	2.04E+00
640	2.46E+01	2.44E+01	2.34E+00
660	2.42E+01	2.42E+01	2.66E+00
680	2.38E+01	2.40E+01	3.00E+00
700	2.34E+01	2.39E+01	3.36E+00
720	2.30E+01	2.37E+01	3.73E+00
740	2.26E+01	2.35E+01	4.12E+00
760	2.22E+01	2.34E+01	4.52E+00
780	2.18E+01	2.32E+01	4.93E+00
800	2.15E+01	2.30E+01	5.35E+00
820	2.11E+01	2.29E+01	5.78E+00
840	2.07E+01	2.27E+01	6.22E+00
860	2.04E+01	2.25E+01	6.66E+00
880	2.01E+01	2.24E+01	7.10E+00
900	1.97E+01	2.22E+01	7.55E+00
920	1.94E+01	2.20E+01	7.99E+00
940	1.91E+01	2.19E+01	8.44E+00
960	1.87E+01	2.17E+01	8.88E+00
980	1.84E+01	2.15E+01	9.33E+00
1000	1.81E+01	2.14E+01	9.76E+00
MAXIMUM:	4.23E+01	2.89E+01	9.76E+00

PRELIMINARY REMEDIATION GOALS

APPENDIX A, TABLE 1
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF
FUTURE RESIDENT - EXPOSURE TO GROUNDWATER - SITE 04
CONCENTRATION IN UG/L ASSOCIATED WITH ESTIMATED CANCER RISK OR HAZARD INDEX
NWS EARLE, COLTS NECK, NEW JERSEY

	CARCINOGENIC CLEANUP LEVELS*			NONCARCINOGENIC CLEANUP LEVELS**		
	CANCER RISK LEVEL			HAZARD INDEX		
COC	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
1,2-DICHLOROETHENE (TOTAL)	-	-	-	13.3	133	400
CHLOROFORM	0.791	7.91	79.1	14.8	148	444
TRICHLOROETHENE	3.65	36.5	365	8.45	84.5	253
VINYL CHLORIDE	0.028	0.284	2.84	-	-	-
BARIUM	-	-	-	104	1040	3130
IRON	-	-	-	452	4520	13600

* - Carcinogenic cleanup levels are based on aggregate lifetime exposure, assuming 6 years as child and 24 years as adult.

** - Noncarcinogenic cleanup levels are based on exposure to a residential child, ages zero to six.

APPENDIX A, TABLE 2
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF
FUTURE RESIDENT - EXPOSURE TO GROUNDWATER - SITE 05
CONCENTRATION IN UG/L ASSOCIATED WITH ESTIMATED CANCER RISK OR HAZARD INDEX
NWS EARLE, COLTS NECK, NEW JERSEY

COC	CARCINOGENIC CLEANUP LEVELS*			NONCARCINOGENIC CLEANUP LEVELS**		
	CANCER RISK LEVEL			HAZARD INDEX		
	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
1,2-DICHLOROETHENE (TOTAL)	-	-	-	13.3	133	400
CHLOROFORM	0.791	7.91	79.1	14.8	148	444
VINYL CHLORIDE	0.028	0.284	2.84	-	-	-
ARSENIC	0.045	0.447	4.47	0.468	4.68	14
IRON	-	-	-	452	4520	13600

* - Carcinogenic cleanup levels are based on aggregate lifetime exposure, assuming 6 years as child and 24 years as adult.

** - Noncarcinogenic cleanup levels are based on exposure to a residential child, ages zero to six.

APPENDIX A, TABLE 3
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF
FUTURE RESIDENT - EXPOSURE TO GROUNDWATER - SITE 19
CONCENTRATION IN UG/L ASSOCIATED WITH ESTIMATED CANCER RISK OR HAZARD INDEX
NWS EARLE, COLTS NECK, NEW JERSEY

COC	CARCINOGENIC CLEANUP LEVELS*			NONCARCINOGENIC CLEANUP LEVELS**		
	CANCER RISK LEVEL			HAZARD INDEX		
	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
ANTIMONY	-	-	-	0.602	6.02	18.1
ARSENIC	0.045	0.447	4.47	0.468	4.68	14
CADMIUM	-	-	-	0.767	7.67	23
CHROMIUM VI	-	-	-	7.13	71.3	214
SELENIUM	-	-	-	7.8	78	234
THALLIUM	-	-	-	0.12	1.2	3.61

* - Carcinogenic cleanup levels are based on aggregate lifetime exposure, assuming 6 years as child and 24 years as adult.
** - Noncarcinogenic cleanup levels are based on exposure to a residential child, ages zero to six.

APPENDIX A, TABLE 4
PRELIMINARY REMEDIATION GOALS DEVELOPED FOR PROTECTION OF
FUTURE INDUSTRIAL WORKER - EXPOSURE TO GROUNDWATER - SITE 19
CONCENTRATION IN UG/L ASSOCIATED WITH ESTIMATED CANCER RISK OR HAZARD INDEX
NWS EARLE, COLTS NECK, NEW JERSEY

COC	CARCINOGENIC CLEANUP LEVELS*			NONCARCINOGENIC CLEANUP LEVELS**		
	CANCER RISK LEVEL			HAZARD INDEX		
	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
ARSENIC	0.191	1.91	19.1	3.06	30.6	91.9
CADMIUM	-	-	-	5.09	50.9	153
CHROMIUM VI	-	-	-	50.1	501	1500
THALLIUM	-	-	-	0.811	8.11	24.3

* - Carcinogenic cleanup levels are based on a 25-year exposure duration for an industrial worker.

** - Noncarcinogenic cleanup levels are based on exposure to an industrial worker.

APPENDIX B

COSTS

NWS Earle Site FS
Site 4 - Alternative 1 - No Action
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW4ALT1.WK4]30 JUL 97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	0			0.00
1	0.935		21.62		20.21
2	0.873		21.62		18.88
3	0.816		21.62		17.65
4	0.763		21.62		16.49
5	0.713		21.62	15.5	26.47
6	0.666		21.62		14.41
7	0.623		21.62		13.46
8	0.582		21.62		12.58
9	0.544		21.62		11.76
10	0.508		21.62	15.5	18.87
11	0.475		21.62		10.27
12	0.444		21.62		9.60
13	0.415		21.62		8.97
14	0.388		21.62		8.38
15	0.362		21.62	15.5	13.45
16	0.339		21.62		7.32
17	0.317		21.62		6.84
18	0.296		21.62		6.40
19	0.277		21.62		5.98
20	0.258		21.62	15.5	9.59
21	0.242		21.62		5.22
22	0.226		21.62		4.88
23	0.211		21.62		4.56
24	0.197		21.62		4.26
25	0.184		21.62	15.5	6.84
26	0.172		21.62		3.72
27	0.161		21.62		3.48
28	0.150		21.62		3.25
29	0.141		21.62		3.04
30	0.131		21.62	15.5	4.88
			TOTAL PRESENT WORTH =		$301,730

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Brown & Root Environmental		Calc. Sheet
Client: Navy CLEAN File No.	By: LC	Date:
Subject: Site 4, Alt. 1 - Assumptions and Cost Basis, NWS Earle FS, CTO 279	Checked by: MJW 7/31/97	Date:

[C:\CLEAN\CTO279\DRFS\COST\4-ALT1.DOC]

Site 4 Alternative 1: No Action

ASSUMPTIONS:

1. Long-term annual groundwater, surface water, and sediment monitoring:

   - From 6 existing monitoring wells, 3 QC samples. Total 9 samples annually.

   - From 3 surface water locations, 3 QC samples. Total 6 samples annually.

   - From 3 sediment locations (same as surface water) . 3 QC samples. Total 6 samples annually.

   Sampling and analysis for site-specific contaminants: VOCs and metals.

   Labor: 1 event/year.

   - GW/SW/SED sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
   - Sampling ≈ 52 hours @ $60/hr (w/overhead & profit) = $3120
   - Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
   - Annual: add $300 M&IE; ODCs & supplies @ $200; & shipping @ $200.

   Total ≈ $5420 annually

   Estimated analytical costs:

   - VOCs (EPA Method 624) $324/sample @ 21 samples/yr = $6804
   - metals (EPA 6010/7000s) @ $254/sample @ 21 samples/yr = $5334

   Total = $ 12138 = $12200

2. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

3. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 4 -- Alternative 3 - Capping, Natural Atten., Long-term Monitoring
Colts Neck New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW4ALT3.WK4] 15 OCT 96

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,983			1983.40
1	0.935		29.62		27.68
2	0.873		29.62		25.87
3	0.816		29.62		24.18
4	0.763		29.62		22.60
5	0.713		29.62	15.5	32.17
6	0.666		29.62		19.74
7	0.623		29.62		18.45
8	0.582		29.62		17.24
9	0.544		29.62		16.11
10	0.508		29.62	15.5	22.94
11	0.475		29.62		14.07
12	0.444		29.62		13.15
13	0.415		29.62		12.29
14	0.388		29.62		11.49
15	0.362		29.62	15.5	16.35
16	0.339		29.62		10.03
17	0.317		29.62		9.38
18	0.296		29.62		8.76
19	0.277		29.62		8.19
20	0.258		29.62	15.5	11.66
21	0.242		29.62		7.15
22	0.226		29.62		6.69
23	0.211		29.62		6.25
24	0.197		29.62		5.84
25	0.184		29.62	15.5	8.31
26	0.172		29.62		5.10
27	0.161		29.62		4.77
28	0.150		29.62		4.45
29	0.141		29.62		4.16
30	0.131		29.62	15.5	5.93
		TOTAL PRESENT WORTH =			$2,384,402

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 4 ALT. 3 - CAPPING, INST. CONTROLS, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\4-ALT3.WK4] 15 OCT 96

Sheet 1 of 3

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip	Total Cost ($) Sub.	Mat	Labor	Equip	Total Direct Cost ($)	Comments
PRE-DESIGN INVESTIGATION												
1) Topographic survey	5	AC	1,775.00	0.00	0.00	0.00	8,875	0	0	0	8,875	[013 306 0100]
2) Soil gas assessment	1	LS	18,500.00	0.00	0.00	0.00	18,500	0	0	0	18,500	
3) Additional soils boring and analyses	1	LS	20,500.00	1,000.00	3,000.00	0.00	20,500	1,000	3,000	0	24,500	
4) Geotechnical evaluation	1	LS	0.00	500.00	2,000.00	0.00	0	500	2,000	0	2,500	
5) Engineering design (see page 3)												
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1 ea)	7	MO	400.00	0.00	0.00	0.00	2,800	0	0	0	2,800	Historical data
2) Storage Trailer (1 ea)	7	MO	400.00	0.00	0.00	0.00	2,800	0	0	0	2,800	Historical data
3) Portable Communication Equipment	4	SETS	400.00	0.00	0.00	0.00	1,600	0	0	0	1,600	
4) Equipment Mobilization/Demobilization	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	
5) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
6) Site Utilities	7	MO	4,000.00	0.00	0.00	0.00	28,000	0	0	0	28,000	
7) 1 Pick-up Truck (rental)	7	MO	500.00	100.00	0.00	0.00	3,500	700	0	0	4,200	Historical data
PERSONNEL AND EQUIP. DECON FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	7	MO	1,000.00	0.00	100.00	0.00	7,000	0	700	0	7,700	Historical data
2) Decon Water (1000 gal/mon)	7	GAL	0.20	0.00	0.00	0.00	1	0	0	0	1	
3) Clean Water Storage Tank	1	EA	0.00	3,000.00	300.00	0.00	0	3,000	300	0	3,300	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	5,000.00	400.00	0.00	0	5,000	400	0	5,400	5000 Gallon
5) Personnel Decon. Trailer	7	MO	2,500.00	0.00	200.00	0.00	17,500	0	1,400	0	18,900	Vendor catalog
6) PPE rolloff cont.	7	MO	700.00	0.00	0.00	0.00	4,900	0	0	0	4,900	Historical data
SITE MANAGEMENT STAFFING												
1) Site manager	1,260	HR	0.00	0.00	35.86	0.00	0	0	45,184	0	45,184	
2) Site supervisor/foreman	1,260	HR	0.00	0.00	30.00	0.00	0	0	37,800	0	37,800	
3) Site safety officer	1,260	HR	0.00	0.00	25.00	0.00	0	0	31,500	0	31,500	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	140	HR	0.00	0.00	45.00	0.00	0	0	6,300	0	6,300	
2) Project administrator	150	HR	0.00	0.00	30.00	0.00	0	0	4,500	0	4,500	
3) Health and Safety director	44	HR	0.00	0.00	35.00	0.00	0	0	1,540	0	1,540	
4) Procurement/subcontracting	200	HR	0.00	0.00	30.00	0.00	0	0	6,000	0	6,000	
4) Clerical support	630	HR	0.00	0.00	12.36	0.00	0	0	7,787	0	7,787	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 4 ALT. 3 - CAPPING, INST. CONTROLS, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\4-ALT3.WK4] 15 OCT 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
SITE PREPARATION												
1) clear & grub Site 4	5	AC	0.00	0.00	595.00	1,775.00	0	0	0	0	0	[021 108 0550]
2) cut & chip medium trees	5	AC	0.00	0.00	1425.00	1575.00	0	0	7,125	7,875	15,000	[021 104 0200]
3) Site grading	24,200	SY	0.00	0.00	0.16	0.27	0	0	3,872	6,534	10,406	[17 03 0103]
4) Erosion control, silt fences	600	LF	0.00	0.37	0.33	0.00	0	222	198	0	420	[022 704 1100]
4) Erosion control, hay bales	3	ton	0.00	45.00	157.00	54.00	0	135	471	162	768	[022 704 1200]
5) Security fencing (to be installed, as needed)	1,600	LF	0.00	10.15	2.72	1.81	0	16,240	4,352	2,896	23,488	6 ft high
6) Gate	1	EA	0.00	2450.00	340.00	226.00	0	2,450	340	226	3,016	
7) Fugitive dusts control (water tank)	1	EA	0.00	5000.00	0.00	0.00	0	5,000	0	0	5,000	10,000 gal
7a) Spray from tank truck	7	MO	0.00	0.00	1160.00	1292.80	0	0	8,120	9,050	17,170	[18 05 0413]
CONSOLIDATION												
1) Site 19 soils/sediments, spread/grade (possible)	260	CY	0.00	0.00	0.10	0.19	0.00	0.00	26	49	75	[17 03 0501]
GRADING & COMPACTION												
1) Spread and grade (2 passes)	48,400	SY	0.00	0.00	0.16	0.27	0.00	0.00	7,744	13,068	20,812	[17 03 0103]
2) Compact Site 4	24,200	SY	0.00	0.00	0.25	0.15	0.00	0.00	6,050	3,630	9,680	[17 03 0510]
COVER SYSTEM PLACEMENT												
1) Subgrade - sand & gravel, place & comp.	8,070	CY	0.00	11.44	1.72	1.56	0	92,321	13,880	12,589	118,790	[17 03 0430]
2) FML 30 mil L/HDPE (barrier layer)	24,200	SY	4.68	0.00	0.00	0.00	113,256	0	0	0	113,256	vendor data
3) Geosynthetic drainage layer	24,200	SY	5.67	0.00	0.00	0.00	137,214	0	0	0	137,214	vendor data
4) Top layer - 24" total, inc. place, spread, & compact												
4a) top soil - 6"	2,690	CY	0.00	17.31	2.60	1.65	0	46,564	6,994	4,439	57,996	[18 05 0301]
4b) soil - 18"	5,380	CY	0.00	5.00	2.60	1.65	0	26,900	13,988	8,877	49,765	
5) Perimeter drain, trenching, 1600' x 3' x 4'	711	CY	0.00	0.00	2.38	1.37	0	0	1,692	974	2,667	[022 254 0050]
5a) pipe bedding w/sand; backfill gravel	711	CY	0.00	11.44	1.72	1.56	0	8,134	1,223	0.00	9,357	[17 03 0430]
5b) 8" perf. PVC pipe	1,600	LF	0.00	2.38	1.58	0.00	0	3,808	2,528	0	6,336	[027 168 2080]
EROSION CONTROL												
15) Revegetation, hydroseed w/fertilizer & mulch	218	MSF	0.00	25.50	6.50	7.15	0	5,554	1,416	1,557	8,527	[029 300 5400]
STORM WATER RETENTION BASIN												
1) Excavate	926	CY	0.00	0.00	0.84	0.85	0	0	778	787	1,565	[022 108 2420]
2) Grade & compact	185	SY	0.00	0.00	0.25	0.15	0	0	46	28	74	[17 03 0510]
3) Install riprap on sidewalls for erosion control	200	SY	0.00	12.50	22.00	9.55	0	2,500	4,400	1,910	8,810	[022 [illegible] 0400]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 4 ALT. 3 - CAPPING, INST. CONTROLS, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
PAGE 2 TOTAL	379,446	221,027	234,211	74,927	909,612	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	11,711	3,746	15,457	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	7,026	2,248	9,274	
Subtotal Direct Costs	379,446	221,027	245,922	78,673	934,343	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	168,732	0	168,732	
Field Construction Labor Overhead @ 60%	0	0	56,161	0	56,161	
Subcontract Overhead @ 5%	18,972	0	0	0	18,972	
Tax on Materials @ 5%	0	11,051	0	0	11,051	
G & A @ 10% (on labor, equip., & matl's.)	0	22,103	24,592	7,867	54,562	
Subtotal Direct and Indirect Costs	398,419	254,182	495,407	86,541	1,243,822	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	15,937	10,167	19,816	3,462	49,382	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					261,203	
Adjusted Direct and Indirect Costs	414,355	264,349	515,223	90,002	1,554,407	
Engineering @ 6 % of total direct and indirect					93,264	
Prime Contractor Fee @ 10% of Total Adjusted Cost					155,441	
Total Costs					1,803,112	
Contingency @ 10% of Total Cost					180,311	
TOTAL ESTIMATED COST					1,983,423	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA
3) Historical data based on competitive bids submitted by subcontractors at this or other sites.

NWS Earle Site FS
Site 4 - Alternative 3 - Capping, Natural Attentuation. Long-term monitoring
Colts Neck New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM4ALT3.WK4] 15 OCT 96

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Cap maintenance	$8,000		Quarterly inspections, fencing repairs, mowi cover, reseeding, fertilizer applic., cap repairs
2. Groundwater, surface water, & sediment monitoring	$17,620		collect 9 GW (6 + 3 QC), 6 SW (3 + 3QC), and 6 SED (3 + 3QC) samples annually, plus travel, living & s
3. Reporting	$4,000		50 LOE hours for annual reports plus other direct costs
4. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

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Site 4 Alternative 3: Capping, Institutional Controls, Natural Attentuation, & Long-term Monitoring

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Site 4 footprint of approx. 5 acres. No current topographic map available.

iii. Cost estimating sources:

- ECHOS Environmental Restoration, Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.
- Means Heavy Construction Cost Data, 9th edition, R.S. Means Company, Inc., 1995.
- Means Site Work & Landscape Cost Data, 14th edition, R.S. Means Company, Inc., 1995.

iv. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

CAPITAL COST ITEMS:

1. <u>Pre-design investigations</u>

- Would require topographic survey, 5 acres. Surveying may best be accomplished after site has been cleared of trees and vegetation.

- Would require additional soil boring to delineate extent of landfill materials, obtain soil stratigraphy. Estimate/assume need of a drill rig for 2 weeks to properly catalog landfill extent. Subcontract drill rig @ $500 mob. + $2000/day (inc. crew, supplies, etc.) Total = $20500. Add geologist oversight of driller, to log soil boring and stratigraphy: 2 weeks @ 10 hr/day, + $1000 M&IE.

- Would need soil gas survey to assess need for gas vent layer in cover system. Estimate 1 field crew for 1 week plus equipment and supplies. Use subcontractor: 4 @ 10 hour/day @ 5 days @ $60/hr = $12000. Equip + supplies + M&IE = $2000 + $500 + $2000. Add $2000 for report. Total = $18500.

- Would require geotechnical evaluations. Use borings and performance of compaction tests to assess settlement potentials. Engineering report would be prepared. Assume 1 week field engineer at 10 hours @ 10 days @ $30/hr (w/o O&P), 2 weeks data evaluation and report prep. 8 hr @ 10 days @ $30/hr = $2400, add add $2000 ODCs

- Engineering design as 6% of direct labor.

2. Mobilization/Demobilization Require office trailer, storage trailer, portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines), site security, decon trailer. Will require drinking and wash water, and sanitary facilities.

3. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

4. Site Preparation:

Tree removal - Remove medium sized trees from 5 acres.

Clearing and grubbing - Clear brush, shrubs, etc. Grub stumps and roots, etc.

Site grading - Grade 5 acres to design specifications. Assume 2 passes required. 5 acres = 217800 SF = 24200 SY. [17 03 0103]

Access road - Existing access roads appear to be adequate to sustain heavy equipment. Assume no further improvements needed.

Erosion controls - will need to establish temporary silt fences and hay bales to protect adjacent wetlands. Polypropylene [022 704 1100]. Total linear ft silt fence = 600 LF. Add approx. 3 tons hay bales.

Security Fencing - Will require ~ 1600 LF to encompass site: 8 ft high, 3 strand barbed wire; 10 ft post spacing [028 308 0600]. 1 sliding gate (45 ft) to accommodate truck/heavy equipment traffic [028 308 0900]. Can be installed after construction completed or in phases

Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down 2 acres per day, 20 days per month [18 05 0413].

5. Consolidation - may need to consolidate Site 19 soils/sediments @ 260 CY.

- Assume 1 scraper, 14 CY, 3000 ft haul, to move stockpiled materials to desired areas [022 246 1350]. Once materials consolidated back onto plateau, ready for grading and compaction.

6. Grading and Compaction - Grade [025 122 3310] and compaction [17 03 0514]. Use 5 acres = 24200 SY.

7. Cover System Placement

- place/grade subgrade sand/gravel
- install FML (30 mil HDPE)
- install synthetic drainage layer
- place min. 18 in. of compacted soil layer
- place 6 in. min top soil

- Subgrade - Approximately 1 ft of well graded sand/gravel as surcharge over landfill materials to provide smooth working surface prior to FML placement. Compact subgrade. Allow consolidation, assume 6 - 8 weeks to reach low/target rate of settlement.

- AREA: = 24200 SY
- VOLUME: 24200 SY x 1 ft = 8070 CY

- Perimeter drain - for perimeter of covered area = 1600 LF. Would be ditch or trench to 4 ft deep, 3ft wide with perforated 8" dia. PVC pipe, with gravel pack.

8. Erosion Control

- Revegetate to stabilize top cover after completion of cover. Approximately 5 acres. Revegetate with utility mix ground cover.

9. Storm Water Retention Basin

- Will require detention pond to temporarily store Q (flow) from 24-hour, 25-year storm. Actual location and size to be selected during the design.

Use Q = CIA (rational formula) [Handbook of Civil Engineering, Sec 21]
C = 0.2 for lawn, 2-7% slope, poorly drained soils
I = intensity = K/(t+b) (Steel formula)
t = 24 hour = 1440 min
K = 260, b = 32 for New Jersey
A = 5 acres

Q = (0.2) [260/(1440 + 32)] (5)
= 0.18 cfs

Assume 0.18 cfs for 24 hour duration.

V of retension basin = (0.18 cfs) (24 hr) (60 min) (60 sec)
= 15552 CF

For basin of 50 FT x 100 FT, need depth of 3.1 FT. Add 2 ft freeboard, or ~5 ft.
Or V = 50 x 100 x 5 = 25000 cf = 926 CY

- Will need to excavate, grade & compact, and install erosion control on faces of basin.

LONG-TERM O & M COST ITEMS:

1. Quarterly inspections and repairs of the cap, fence, etc.
   - estimate 1 person @ 1 day inspection: 10 @ $15 /hr = $150 + $50 ODCs = $200
   - estimate mowing of 5 acres @ $0.54/MSF = $118, + $50 mob fee = $170
   - estimate repair of soil cover, re-eseeding, and fertilizing @ 2 people @ 2 days @ 10 hours @ 15/hr, + $1000 ODCs = $1600

- Total = $1,970/quarter = $2000

2. Long-term monitoring. Would be same as for no action. For FS to be consistent with NCP requirements, will need to cost out for 30-year duration. It is possible after one of the 5-year reviews that long-term monitoring would be discontinued once groundwater quality meets the NJ GWQS na surface water quality meets SWQS.

a. Long-term annual post-closure groundwater, surface water, and sediment monitoring:

- From 6 existing monitoring wells, 3 QC samples. Total 9 samples annually.
- From 3 surface water locations, 3 QC samples. Total 6 samples annually.
- From 3 sediment locations (same as surface water), 3 QC samples. Total 6 samples annually.

Sampling and analysis for site-specific contaminants: VOCs and metals.

Labor: 1 event/year.

- GW/SW/SED sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
- Sampling » 52 hours @ $60/hr (w/overhead & profit) = $3120
- Proj. mgmt/coord. » 20 hours/year @ $80/hr (w/O&P) = $1600
- Annual: add $300 M&IE, ODCs & supplies @ $200; & shipping @ $200.

Total ≈ $5420 annually

Estimated analytical costs:

- VOCs (EPA Method 624) $324/sample @ 21 samples/yr = $6804
- metals (EPA 6010/7000s) @ $254/sample @ 21 samples/yr = $5334

Total = $ 12138 = $12200

b. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

c. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 5 - Alternative 1 - No Action
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW5ALT1.WK4]30 JUL 97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	0			0.00
1	0.935		15.82		14.79
2	0.873		15.82		13.82
3	0.816		15.82		12.91
4	0.763		15.82		12.07
5	0.713		15.82	15.5	22.33
6	0.666		15.82		10.54
7	0.623		15.82		9.85
8	0.582		15.82		9.21
9	0.544		15.82		8.61
10	0.508		15.82	15.5	15.92
11	0.475		15.82		7.52
12	0.444		15.82		7.02
13	0.415		15.82		6.56
14	0.388		15.82		6.14
15	0.362		15.82	15.5	11.35
16	0.339		15.82		5.36
17	0.317		15.82		5.01
18	0.296		15.82		4.68
19	0.277		15.82		4.37
20	0.258		15.82	15.5	8.09
21	0.242		15.82		3.82
22	0.226		15.82		3.57
23	0.211		15.82		3.34
24	0.197		15.82		3.12
25	0.184		15.82	15.5	5.77
26	0.172		15.82		2.72
27	0.161		15.82		2.55
28	0.150		15.82		2.38
29	0.141		15.82		2.22
30	0.131		15.82	15.5	4.11
			TOTAL PRESENT WORTH =		$229,757

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Brown & Root Environmental		Calculation Sheet
Client: Navy CLEAN File No.	**By:** LC	
Subject: Site 5, Alt. 1 - Assumptions and Cost Basis, NWS Earle FS, CTO 279	**Checked by:** MJW 7/31/97	**Date:** 09 Oct 96

[C:\CLEAN\CTO279\DRFS\COST\5-ALT1.DOC]

Site 5 Alternative 1: No Action

ASSUMPTIONS:

1. Long-term annual groundwater monitoring:

   - From 8 existing monitoring wells. 3 QC samples. Total 11 samples annually.

   Sampling and analysis for site-specific contaminants: VOCs and metals.

   Labor: 1 event/year.

   - GW sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
   - Sampling ≈ 52 hours @ $60/hr (w/overhead & profit) = $ 3120
   - Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
   - Annual: add $300 M&IE, ODCs & supplies @ $200; & shipping @ $200.

   Total ≈ $5420 annually

   Estimated analytical costs:

   - VOCs (EPA Method 624) $324/sample @ 11 samples/yr = $ 3564
   - metals (EPA 6010/7000s) @ $254/sample @ 11 samples/yr = $ 2794

   Total = $ 6358 ≈ 6400

2. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

3. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 5 - Alternative 3 - Capping, Natural Atten., Long-term Monitoring
Colts Neck New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW5ALT3.WK4] 15 OCT 96

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	588			587.50
1	0.935		18.62		17.40
2	0.873		18.62		16.26
3	0.816		18.62		15.20
4	0.763		18.62		14.21
5	0.713		18.62	15.5	24.33
6	0.666		18.62		12.41
7	0.623		18.62		11.60
8	0.582		18.62		10.84
9	0.544		18.62		10.13
10	0.508		18.62	15.5	17.34
11	0.475		18.62		8.85
12	0.444		18.62		8.27
13	0.415		18.62		7.73
14	0.388		18.62		7.22
15	0.362		18.62	15.5	12.37
16	0.339		18.62		6.31
17	0.317		18.62		5.89
18	0.296		18.62		5.51
19	0.277		18.62		5.15
20	0.258		18.62	15.5	8.82
21	0.242		18.62		4.50
22	0.226		18.62		4.20
23	0.211		18.62		3.93
24	0.197		18.62		3.67
25	0.184		18.62	15.5	6.29
26	0.172		18.62		3.21
27	0.161		18.62		3.00
28	0.150		18.62		2.80
29	0.141		18.62		2.62
30	0.131		18.62	15.5	4.48
		TOTAL PRESENT WORTH =			$852,003

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 5 ALT. 3 - CAPPING, INST. CONTROLS, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\5-ALT3.WK4] 15 OCT 96

Sheet 1 of 3

Item	Qty	Unit	Unit Cost ($) Sub.	Mat	Labor	Equip	Total Cost ($) Sub.	Mat	Labor	Equip	Total Direct Cost ($)	Comments
PRE-DESIGN INVESTIGATION												
1) Topographic survey	1	AC	1,775.00	0.00	0.00	0.00	1,775	0	0	0	1,775	[013 306 0100]
2) Soil gas assessment	1	LS	7,400.00	0.00	0.00	0.00	7,400	0	0	0	7,400	
3) Additional soils boring and analyses	1	LS	6,500.00	400.00	600.00	0.00	6,500	400	600	0	7,500	
4) Geotechnical evaluation	1	LS	0.00	2,400.00	3,300.00	0.00	0	2,400	3,300	0	5,700	
5) Engineering design (see page 3)												
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1 ea)	2	MO	400.00	0.00	0.00	0.00	800	0	0	0	800	Historical data
2) Storage Trailer (1 ea)	2	MO	400.00	0.00	0.00	0.00	800	0	0	0	800	Historical data
3) Portable Communication Equipment	4	SETS	400.00	0.00	0.00	0.00	1,600	0	0	0	1,600	
4) Equipment Mobilization/Demobilization	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	
5) Site Utility Hook ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
6) Site Utilities	2	MO	4,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
7) 1 Pick-up Truck (rental)	2	MO	500.00	100.00	0.00	0.00	1,000	200	0	0	1,200	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000.00	0.00	100.00	0.00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	2,000	GAL	0.20	0.00	0.00	0.00	400	0	0	0	400	
3) Clean Water Storage Tank	1	EA	0.00	3,000.00	300.00	0.00	0	3,000	300	0	3,300	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	5,000.00	400.00	0.00	0	5,000	400	0	5,400	5000 Gallon
5) Personnel Decon. Trailer	2	MO	2,500.00	0.00	200.00	0.00	5,000	0	400	0	5,400	Vendor catalog
6) PPE rolloff cont.	2	MO	700.00	0.00	0.00	0.00	1,400	0	0	0	1,400	Historical data
SITE MANAGEMENT STAFFING												
1) Site manager	360	HR	0.00	0.00	35.86	0.00	0	0	12,910	0	12,910	
2) Site supervisor/foreman	360	HR	0.00	0.00	30.00	0.00	0	0	10,800	0	10,800	
3) Site safety officer	360	HR	0.00	0.00	25.00	0.00	0	0	9,000	0	9,000	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	40	HR	0.00	0.00	45.00	0.00	0	0	1,800	0	1,800	
2) Project administrator	40	HR	0.00	0.00	30.00	0.00	0	0	1,200	0	1,200	
3) Health and Safety director	8	HR	0.00	0.00	35.00	0.00	0	0	280	0	280	
4) Procurement/subcontracting	150	HR	0.00	0.00	30.00	0.00	0	0	4,500	0	4,500	
4) Clerical support	180	HR	0.00	0.00	12.36	0.00	0	0	2,225	0	2,225	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 5 ALT. 3 - CAPPING, INST. CONTROLS, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\5-ALT3.WK4] 15 OCT 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip	Sub	Mat.	Labor	Equip	Cost ($)	Comments
SITE PREPARATION												
1) clear & grub Site 5	1	AC	0.00	0.00	595.00	1,775.00	0	0	0	0	0	[021 108 0550]
2) Site grading	4,840	SY	0.00	0.00	0.16	0.27	0	0	774	1,307	2,081	[17 03 0103]
3) Fugitive dusts control (water tank)	1	EA	0.00	5000.00	0.00	0.00	0	5,000	0	0	5,000	10,000 gal
4) Spray from tank truck	2	MO	0.00	0.00	1160.00	1292.80	0	0	2,320	2,586	4,906	[18 05 0413]
GRADING & COMPACTION												
1) Grade (2 passes)	9,680	SY	0.00	0.00	0.16	0.27	0.00	0.00	1,549	2,614	4,162	[17 03 0103]
2) Compact Site 5	4,840	SY	0.00	0.00	0.25	0.15	0.00	0.00	1,210	726	1,936	[17 03 0510]
COVER SYSTEM PLACEMENT												
1) Subgrade - sand & gravel, place & comp.	1,613	CY	0.00	11.44	1.72	1.56	0	18,457	2,775	2,517	23,748	[17 03 0430]
2) FML 30 mil L/HDPE (barrier layer)	4,840	SY	4.68	0.00	0.00	0.00	22,651	0	0	0	22,651	vendor data
3) Geosynthetic drainage layer	4,840	SY	5.67	0.00	0.00	0.00	27,443	0	0	0	27,443	vendor data
4) Top layer - 24" total, inc. place, spread, & compact												
4a) top soil - 6"	807	CY	0.00	17.31	2.60	1.65	0	13,963	2,097	1,331	17,392	[18 05 0301]
4b) soil - 18"	2,420	CY	0.00	5.00	2.60	1.65	0	12,100	6,292	3,993	22,385	
5) Perimeter drain, trenching, 1600' x 3' x 4'	711	CY	0.00	0.00	2.38	1.37	0	0	1,692	974	2,667	[022 254 0050]
5a) pipe bedding w/sand; backfill gravel	711	CY	0.00	11.44	1.72	1.56	0	8,134	1,223	0.00	9,357	[17 03 0430]
5b) 8" perf. PVC pipe	1,600	LF	0.00	2.38	1.58	0.00	0	3,808	2,528	0	6,336	[027 168 2080]
EROSION CONTROL												
15) Revegetation, hydroseed w/fertilizer & mulch	44	MSF	0.00	25.50	6.50	7.15	0	1,111	283	311	1,705	[029 308 5400]
STORM WATER RETENTION BASIN												
1) Excavate	204	CY	0.00	0.00	0.84	0.85	0	0	171	173	345	[022 208 2420]
2) Grade & compact	111	SY	0.00	0.00	0.25	0.15	0	0	28	17	44	[17 03 0510]
3) Install erosion control material on sidewalls	75	SY	0.00	12.50	22.00	9.55	0	938	1,650	716	3,304	[022 712 0400]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 5 ALT. 3 - CAPPING, INST. CONTROLS, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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		Total Cost ($) Sub.	Mat.	Labor	Equip	Total Direct Cost ($)	Comments
	PAGE 2 TOTAL	99,769	75,510	73,065	17,541	265,885	
Direct Cost Adjustment Factors							
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)		0	0	3,653	877	4,530	
Safety Level C Multiplier (25% of labor and equipment, as listed)		0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)		0	0	2,192	526	2,718	
	Subtotal Direct Costs	99,769	75,510	76,718	18,418	273,133	
Indirect Cost Adjustment Factors							
Labor Overhead @ 120% (for field mgmt. & home office, only)		0	0	51,257	0	51,257	
Field Construction Labor Overhead @ 60%		0	0	18,210	0	18,210	
Subcontract Overhead @ 5%		4,988	0	0	0	4,988	
Tax on Materials @ 5%		0	3,776	0	0	3,776	
G & A @ 10% (on labor, equip., & matl's.)		0	7,551	7,672	1,842	17,065	
	Subtotal Direct and Indirect Costs	104,757	86,837	153,857	20,260	368,429	
Cost Adjustment Factors							
1995 to 1996 Cost Correction Factor @ 4%		4,190	3,473	6,154	810	14,628	
City/Location Cost Adjustment Factor @ 21% (ref. 2)						[illegible],370	
	Adjusted Direct and Indirect Costs	108,948	90,310	160,012	21,070	460,428	
Engineering @ 6 % of total direct and indirect						27,626	
Prime Contractor Fee @ 10% of Total Adjusted Cost						46,043	
	Total Costs					534,096	
Contingency @ 10% of Total Cost						53,410	
	TOTAL ESTIMATED COST					587,506	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA
3) Historical data based on competitive bids submitted by subcontractors at this or other sites.

NWS Earle Site FS
Site 5 - Alternative 3 - Capping, Natural Attentuation, Long-term monitoring
Colts Neck New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM5ALT3.WK4] 15 OCT 96

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Cap maintenance	$2,800		Quarterly inspections, fencing repairs, mowi cover, reseeding, fertilizer applic. repairs
1. Groundwater monitoring	$11,820		collect 11 GW (8 + 3 QC) annually, plus travel, living & shipping
2. Reporting	$4,000		50 LOE hours for annual reports plus other direct costs
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

BROWN & ROOT ENVIRONMENTAL		COST ESTIMATE ASSUMPTIONS	
CLIENT: Navy CLEAN	FILE NO.:	BY: LC	PAGE: 1 of 4
SUBJECT: Site 5, Alt. 3 Assumptions and Cost Basis, NWS Earle FS, CTO 279		REVIEWED BY: MJW 7/31/97	15 OCT 96

[C:\CLEAN\CTO279\DRFS\COST\5-ALT3.WP]

Site 5 Alternative 3: Capping, Institutional Controls, Natural Attentuation, & Long-term Monitoring

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Site 5 footprint of area to be addressed approx. 1 acre. No current topographic map available.

iii. Cost estimating sources:

- ECHOS Environmental Restoration, Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.
- Means Heavy Construction Cost Data, 9th edition, R.S. Means Company, Inc., 1995.
- Means Site Work & Landscape Cost Data, 14th edition, R.S. Means Company, Inc., 1995.

iv. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

CAPITAL COST ITEMS:

1. <u>Pre-design investigations</u>

- Would require topographic survey, 1 acres. Surveying may best be accomplished after site has been cleared of trees and vegetation.

- Would require additional soil boring to delineate extent of landfill materials, obtain soil stratigraphy. Estimate/assume need of a drill rig for 3 days to properly catalog landfill extent. Subcontract drill rig @ $500 mob. + $2000/day (inc. crew, supplies, etc.) Total = $6500.

Add geologist oversight of driller, to log soil boring and stratigraphy: 3 days @ 10 hr/day @ $20/hr, + $300 M&IE + $100 supplies= $1000.

- Would need soil gas survey to assess need for gas vent layer in cover system. Estimate 1 field crew for 2 day plus equipment and supplies. Use subcontractor: 4 @ 10 hour/day @ 2 days @ $60/hr = $4800. Equip + supplies + M&IE = $1000 + $200 + $400. Add $1000 for report. Total = $.

- Would require geotechnical evaluations. Use borings and performance of compaction tests to assess settlement potentials. Engineering report would be prepared. Assume field engineer at 10 hours @ 3 days @ $30/hr (w/o O&P) = $900 + $300 ODCs + $100 supplies = $1300, 2 weeks data evaluation and report prep. 8 hr @ 10 days @ $30/hr = $2400, add add $2000 ODCs

- Engineering design as 6% of direct labor.

2. Mobilization/Demobilization Require office trailer, storage trailer, portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines), site security, decon trailer. Will require drinking and wash water, and sanitary facilities.

3. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

4. Site Preparation:

Tree removal - Remove medium sized trees from 1 acre.

Clearing and grubbing - Clear brush, shrubs, etc. Grub stumps and roots, etc.

Site grading - Grade 1 acre to design specifications. Assume 2 passes required.
1 acre = 4840 SY. [17 03 0103]

Access road - Existing access roads appear to be adequate to sustain heavy equipment. Assume no further improvements needed.

No erosion controls needed. No adja[illegible]t wetlands.

Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down 2 acres per day, 20 days per month [18 05 0413].

5. Grading and Compaction - Grade [025 122 3310] and compaction [17 03 0514]. Use 1 acre = 4840 SY.

7. Cover System Placement

- place/grade subgrade sand/gravel
- install FML (30 mil HDPE)
- install synthetic drainage layer
- place min. 18 in. of compacted soil layer
- place 6 in. min top soil

- Subgrade - Approximately 1 ft of well graded sand/gravel as surcharge over landfill materials to provide smooth working surface prior to FML placement. Compact subgrade. Allow consolidation, assume 6 - 8 weeks to reach low/target rate of settlement.

- AREA = 4840 SY
- VOLUME = 4840 SY x 1 FT = 4840 CY

- Perimeter drain - for a portion of perimeter of covered area = 500 LF. Would be ditch or trench to 4 ft deep, 3ft wide with perforated 8" dia. PVC pipe, with gravel pack.

8. Erosion Control

- Revegetate to stabilize top cover after completion of cover. Approximately 1 acre. Revegetate with utility mix ground cover.

9. Storm Water Retention Basin

- Will require detention pond to temporarily store Q (flow) from 24-hour, 25-year storm. Actual location and size to be selected during the design.

Use Q = CIA (rational formula) [Handbook of Civil Engineering, Sec 21]
C = 0.2 for lawn, 2-7% slope, poorly drained soils
I = intensity = K/(t+b) (Steel formula)
t = 24 hour = 1440 min
K = 260, b = 32 for New Jersey
A = 1 acres

Q = (0.2) [260/(1440 + 32)] (1)
= 0.04 cfs

Assume 0.18 cfs for 24 hour duration.

V of retension basin = (0.04 cfs) (24 hr) (60 min) (60 sec)
= 3456 CF

For basin of 20 FT x 50 FT, need depth of 3.5 FT. Add 2 ft freeboard, or ~5.5 ft.
Or V = 20 x 50 x 5.5 = 5500 CF = 204 CY

- Will need to excavate, grade & compact, and install erosion control on faces of basin.

LONG-TERM O & M COST ITEMS:

1. Quarterly inspections and repairs of the cap, fence, etc.
   - estimate 1 person @ 1 day inspection: 10 @ $15 /hr = $150 + $50 ODCs = $200
   - estimate mowing of 1 acres @ $0.54/MSF = $45, + $50 mob fee = $170
   - estimate repair of soil cover, re-seeding, and fertilizing @ 2 people @ 1 day @ 10 hours @ $15/hr, + $400 ODCs = $700

   - Total = $700/quarter

2. Long-term monitoring. Would be same as for no action. For FS to be consistent with NCP requirements, will need to cost out for 30-year duration. It is possible after one of the 5-year reviews that long-term mionitroing would be discontinued once groundwater quality meets the NJ GWQS na surface water quality meets SWQS.

   a. Long-term annual post-closure groundwater monitoring:

   - From 8 existing monitoring wells, 3 QC samples. Total 11 samples annually.

   Sampling and analysis for site-specific contaminants: VOCs and metals.

Labor: 1 event/year.

- GW/SW/SED sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
- Sampling » 52 hours @ $60/hr (w/overhead & profit) = $3120
- Proj. mgmt/coord. » 20 hours/year @ $80/hr (w/O&P) = $1600
- Annual: add $300 M&IE, ODCs & supplies @ $200; & shipping @ $200.

Total ≈ $5420 annually

Estimated analytical costs:

- VOCs (EPA Method 624) $324/sample @ 11 samples/yr = $3564
- metals (EPA 6010/7000s) @ $254/sample @ 11 samples/yr = $2794

Total = $ 6358 ≈ $6400

b. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

c. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 19 - Alternative 1 - No Action
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW19ALT1.WK4]30 JUL 97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	0			0.00
1	0.935		21.62		20.21
2	0.873		21.62		18.88
3	0.816		21.62		17.65
4	0.763		21.62		16.49
5	0.713		21.62	15.5	26.47
6	0.666		21.62		14.41
7	0.623		21.62		13.46
8	0.582		21.62		12.58
9	0.544		21.62		11.76
10	0.508		21.62	15.5	18.87
11	0.475		21.62		10.27
12	0.444		21.62		9.60
13	0.415		21.62		8.97
14	0.388		21.62		8.38
15	0.362		21.62	15.5	13.45
16	0.339		21.62		7.32
17	0.317		21.62		6.84
18	0.296		21.62		6.40
19	0.277		21.62		5.98
20	0.258		21.62	15.5	9.59
21	0.242		21.62		5.22
22	0.226		21.62		4.88
23	0.211		21.62		4.56
24	0.197		21.62		4.26
25	0.184		21.62	15.5	6.84
26	0.172		21.62		3.72
27	0.161		21.62		3.48
28	0.150		21.62		3.25
29	0.141		21.62		3.04
30	0.131		21.62	15.5	4.88
		TOTAL PRESENT WORTH =			$301,730

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Brown & Root Environmental		Calculation Sheet
Client: Navy CLEAN | File No.	By: LC	Page 1
Subject: Site 19, Alt. 1 - Assumptions and Cost Basis, NWS Earle FS, CTO 279	Checked by: MJW 7/31/97	Date: 08 Oct 96

[C:\CLEAN\CTO279\DRFS\COST\19-ALT1.DOC]

Site 19 Alternative 1: No Action

ASSUMPTIONS:

1. Long-term annual groundwater, surface water, and sediment monitoring:

   - From 6 existing monitoring wells. 3 QC samples. Total 9 samples annually.

   - From 3 surface water locations. 3 QC samples. Total 6 samples annually.

   - From 3 sediment locations (same as surface water), 3 QC samples. Total 6 samples annually.

   Sampling and analysis for site-specific contaminants: VOCs and metals.

   Labor: 1 event/year.

   - GW/SW/SED sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
   - Sampling ≈ 52 hours @ $60/hr (w/overhead & profit) = $3120
   - Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
   - Annual: add $300 M&IE; ODCs & supplies @ $200; & shipping @ $200.

   Total ≈ $5420 annually

   Estimated analytical costs:

   - VOCs (EPA Method 624) $324/sample @ 21 samples/yr = $6804
   - metals (EPA 6010/7000s) @ $254/sample @ 21 samples/yr = $5334

   Total = $ 12138 = $12200

2. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

3. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 19 - Alternative 4 - Excavation, On-Site Solidification, Natural At...
Colts Neck New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW19ALT4.WK4] 15 OCT 96

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	491			491.20
1	0.935		21.60		20.19
2	0.873		21.60		18.87
3	0.816		21.60		17.63
4	0.763		21.60		16.48
5	0.713		21.60	15.5	26.45
6	0.666		21.60		14.39
7	0.623		21.60		13.45
8	0.582		21.60		12.57
9	0.544		21.60		11.75
10	0.508		21.60	15.5	18.86
11	0.475		21.60		10.26
12	0.444		21.60		9.59
13	0.415		21.60		8.96
14	0.388		21.60		8.38
15	0.362		21.60	15.5	13.45
16	0.339		21.60		7.32
17	0.317		21.60		6.84
18	0.296		21.60		6.39
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21	0.242		21.60		5.22
22	0.226		21.60		4.88
23	0.211		21.60		4.56
24	0.197		21.60		4.26
25	0.184		21.60	15.5	6.84
26	0.172		21.60		3.72
27	0.161		21.60		3.48
28	0.150		21.60		3.25
29	0.141		21.60		3.04
30	0.131		21.60	15.5	4.87
		TOTAL PRESENT WORTH =			$792,681

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 4 - ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT4.WK4] 15 OCT 96

Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat	Labor	Equip	Total Cost ($) Sub.	Mat	Labor	Equip	Total Direct Cost ($)	Comments
INITIAL ACTIVITIES												
1) Field delineation of soils	1	LS	0.00	1,200.00	2,000.00	400.00	0	1,200	2,000	400	3,600	[013 306 0100]
3) Engineering design (see page 3)												
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	2	MO	4,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
5) 1 Pick-up Truck (rental)	2	MO	500.00	100.00	0.00	0.00	1,000	200	0	0	1,200	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000.00	0.00	100.00	0.00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	2,000	GAL	0.20	0.00	0.00	0.00	400	0	0	0	400	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	2	MO	2,500.00	0.00	200.00	0.00	5,000	0	400	0	5,400	Vendor catalog
6) PPE rolloff cont.	2	MO	700.00	0.00	0.00	0.00	1,400	0	0	0	1,400	Historical data
SITE MANAGEMENT STAFFING												
1) Site manager	630	HR	0.00	0.00	35.86	0.00	0	0	22,592	0	22,592	
2) Site supervisor/foreman	630	HR	0.00	0.00	30.00	0.00	0	0	18,900	0	18,900	
3) Site safety officer	200	HR	0.00	0.00	25.00	0.00	0	0	5,000	0	5,000	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	40	HR	0.00	0.00	45.00	0.00	0	0	1,800	0	1,800	
2) Project administrator	40	HR	0.00	0.00	30.00	0.00	0	0	1,200	0	1,200	
3) Health and Safety director	8	HR	0.00	0.00	35.00	0.00	0	0	280	0	280	
4) Procurement/subcontracting	150	HR	0.00	0.00	30.00	0.00	0	0	4,500	0	4,500	
4) Clerical support	300	HR	0.00	0.00	12.36	0.00	0	0	3,708	0	3,708	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 4 - ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT4.WK4] 15 OCT 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip	Sub	Mat	Labor	Equip	Cost ($)	Comments
SITE PREPARATION												
1) clear & grub Site 19	0.5	AC	0.00	0.00	595.00	1,775.00	0	0	0	0	0	[021 108 0550]
2) cut & chip medium trees	0.5	AC	0.00	0.00	1425.00	1575.00	0	0	713	788	1,500	[021 104 0200]
4) Erosion control, silt fences	100	LF	0.00	0.37	0.33	0.00	0	37	33	0	70	[022 704 1100]
4) Erosion control, hay bales	0.5	ton	0.00	45.00	157.00	54.00	0	23	79	27	128	[022 704 1200]
7) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
7a) Spray from tank truck	2	MO	0.00	0.00	1160.00	1292.80	0	0	2,320	2,586	4,906	[18 05 0413]
EXCAVATION												
1)Excavate Site 19 soils/sediments	260	CY	0.00	0.00	1.06	1.24	0.00	0.00	276	322	598	[022 238 0360]
2) Haul 300 ft to treatment area	260	CY	0.00	0.00	0.51	0.51	0.00	0.00	133	133	265	[022 208 2200]
SOLIDIFICATION												
1) Equipment mob/demob.	1	EA	17513.00	0.00	0.00	0.00	17,513	0	0	0	17,513	[33 15 0436]
2) Vibrating screen	1	EA	2765.00	0.00	0.00	0.00	2,765	0	0	0	2,765	[33 18 8601]
3) Conveyor belts	1	EA	3000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	[33 18 8401]
4) 50 CY/HR batch plant	1	EA	10000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	[33 15 0429]
5) Water system for mixer	1	EA	1000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	[33 15 0426]
6) Water pump	1	EA	1300.00	0.00	0.00	0.00	1,300	0	0	0	1,300	[33 15 0431]
7) Dust collection system	1	EA	1300.00	0.00	0.00	0.00	3,500	0	0	0	3,500	[33 15 0430]
8) Ancillary equipment	1	EA	3500.00	0.00	0.00	0.00	3,500	0	0	0	3,500	[33 15 0435]
9) Maintenance	1	YR	500.00	0.00	7652.00	0.00	500	0	7,652	0	8,152	[33 15 0437]
10) Pressure washer	1	EA	2000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	[33 17 0816]
11) Portland cement	65	TON	0.00	68.02	0.00	0.00	0	4,421	0	0	4,421	[33 15 0405]
12) Truck scale	1	MO	1484.00	0.00	0.00	0.00	742	0	0	0	742	[33 01 0462]
13) Labor	320	HR	0.00	0.00	30.00	0.00	0	0	9,600	0	9,600	
14) Load materials to screen	260	CY	0.42	0.00	0.51	0.00	109	0	133	0	242	[022 216 4050]
15) Leaching test (TCLP metals); 1 per 10	10	EA	125.00	0.00	0.00	0.00	1,250	0	0	0	1,250	[33 02 1755]
BACKFILL TOPO. DEPRESSION												
1) Backfill treated mat'ls. into topo. depression	325	CY	0.00	0.00	0.51	0.51	0.00	0.00	166	166	332	[022 208 2200]
2) Compact treated mat'l, 6" lifts in depression	325	CY	0.00	0.00	0.21	0.42	0.00	0.00	68	137	205	[022 [illegible] 5600]
3) Backfill with some barricade materials	94	CY	0.00	0.00	0.51	0.51	0.00	0.00	48	48	96	[0[illegible] 2200]
4) Compact barricade mat'l, 6" lifts in depression	94	CY	0.00	0.00	0.21	0.42	0.00	0.00	20	39	59	[0[illegible] 5600]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 4 - ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT4.WK4] 15 OCT 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip	Sub.	Mat.	Labor	Equip	Cost ($)	Comments
BARRICADE DEMOLITION												
1) Remove 1280 CY soils	1,186	CY	0.00	0.00	0.51	0.51	0.00	0.00	605	605	1,210	[022 208 2200]
2) Haul to stockpile area (1000 ft)	1,186	CY	0.00	0.00	0.21	0.42	0.00	0.00	249	498	747	[022 226 5600]
3) Disassemble/demolish wood structure (B-2 crew)	10	days	0.00	0.00	792.00	100.00	0.00	0.00	7,920	1,000	8,920	B-4 daily rate
4) Haul to stockpile area	2,295	CY	0.00	0.00	0.21	0.42	0.00	0.00	482	964	1,446	[022 226 5600]
Pave Depression												
1) 3" asphalt binder	335	SY	0.00	3.94	0.38	0.34	0.00	0.00	127	114	241	[025 104 0160]
2) 3" asphalt wearing course	335	SY	0.00	4.32	0.42	0.39	0.00	0.00	141	131	271	[025 104 0460]
Fill Cement Pipe												
1) Block buried cement pipe	2	CY	0.00	54.00	0.00	0.00	0.00	108	0.00	0.00	108	[025 104 0460]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 4 - ON-SITE SOLIDIFICATION, ON-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT4.WK4] 15 OCT 96

	Total Cost ($) Sub.	Mat	Labor	Equip	Total Direct Cost ($)	Comments
PAGE 3 TOTAL	78,779	13,489	92,599	8,232	193,100	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	4,630	412	5,042	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	2,778	247	3,025	
Subtotal Direct Costs	78,779	13,489	97,229	8,644	201,166	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt & home office, only)	0	0	69,576	0	69,576	
Field Construction Labor Overhead @ 60%	0	0	20,772	0	20,772	
Subcontract Overhead @ 5%	3,939	0	0	0	3,939	
Tax on Materials @ 5%	0	674	0	0	674	
G & A @ 10% (on labor, equip., & matl's.)	0	1,349	9,723	864	11,936	
Subtotal Direct and Indirect Costs	82,718	15,512	197,300	9,508	308,063	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	3,309	620	7,892	380	12,202	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					64,693	
Adjusted Direct and Indirect Costs	86,027	16,133	205,192	9,889	384,958	
Engineering @ 6 % of total direct and indirect					23,097	
Prime Contractor Fee @ 10% of Total Adjusted Cost					38,496	
Total Costs					446,551	
Contingency @ 10% of Total Cost					44,655	
TOTAL ESTIMATED COST					491,206	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA
3) Historical data based on competitive bids submitted by subcontractors at this or other sites.

NWS Earle Site FS
Site 19 - Alternative 4 - Excavation, On-site solidification, Natural Attentuation, Long-term monitoring
Colts Neck New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM19ALT4.WK4] 15 OCT 96

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater, surface water, & sediment monitoring	$17,620		collect 9 GW (6 + 3 QC), 5 SW (3 + 3QC), and 6 SED (3 + 3QC) samples annually, plus travel, living & shipping
2. Reporting	$4,000		50 LOE hours for annual reports plus other direct costs
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

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Site 19 Alternative 4: Excavation. On-Site Solidification, On-Site Disposal, Nat. Atte[illegible] [illegible]ng-term Monitoring

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.0-20, June 25, 1993.

ii. Cost estimating sources:

- ECHOS Environmental Restoration. Unit Cost Book and Assemblies Cost Book, Delta Technologies Group. Inc. and Marshall & Swift. 1995.
- Means Heavy Construction Cost Data, 9th edition. R.S. Means Company, Inc., 1995.
- Means Site Work & Landscape Cost Data. 14th edition. R.S. Means Company, Inc., 1995.

iii. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

CAPITAL COST ITEMS:

1. Initial Activities

   - Field delineation of contaminated soils 2 people @ 10 hours @ @ 5 days @ $20/hr + $1000 M&IE + $400 equip + $200 supplies = $3600.

2. Mobilization/Demobilization Require portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines), decon. trailer Will require drinking and wash water, and sanitary facilities.

3. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

4. Site Preparation:

   Clearing and grubbing 0.5 acres - Clear brush, shrubs, etc.

   Access road - Existing access roads appear to be adequate to sustain heavy equipment. Assume no further improvements needed.

   Erosion controls - will need to establish temporary silt fences and hay bales to protect adjacent wetlands. Polypropylene [022 704 1100]. Total linear ft silt fence = 100 LF.

Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down .5 acres per day, 20 days per month [18 05 0413].

5. Excavation:

Excavate 260 CY from topographic depression and drainage way. Haul to treatment area on Site 19.

6. Field confirmatory analyses: to verify or confirm that desired PRG levels (concentrations) have been achieved through excavation. Will need to field screen for metals. Assume use of field screening kits for metals.

ODCs & supplies: ~$1000/month

7. Solidification Treatment Rate:

Solidification: up to 35 CY/HR can be treated daily using small, transportable mixing units. Assume an effective 30 CY/HR soil/sediment processing capability including downtime. Using reasonable estimated soil-cement ratio of 5:1, to meet TCLP. Treatability study should be conducted. A soil-like treated product is anticipated.

Process: Soils/sediments from source areas are excavated and stockpiled. Load into shaker screen, which feeds conveyor, which feeds into batch plant [cement, soil, and water in 10 CY mixer]. Will require small (3/4 CY) loader to feed screen and convey mixed product to stock pile or to load into trucks.

Assume rental of solidification equipment is 1/2 of purchase price.

- Equipment mob.: $17513 [33 15 0436]
- Vibrating screen: $1445/wk + $16.5/hr operating cost [016 408 3720]
- 41.5 FT Belt conveyor: $6020 ea [33 18 8401]
- 50 CY/HR batch plant: use $10000 for 2 week
- Water system for mixer: $2003 [33 15 0426]
- Water pump: $2623 [33 15 0431]
- Dust collection system: $4020 [33 15 0430]
- 41.5 FT belt conveyor: $6020 ea [33 18 8401]
- Ancillary equipment: $7420 [33 15 0435]
- Maintenance of solid. equip.: $7652/yr
- Pressure washer: $3960 + $32/hr op.
- Labor: Supervisor + 3 technicians @ $30/HR
- Portland cement Type I: $68.02/ton [33 15 0405]
- Truck scale: $1484/MO

Solidification Rate:

- 260 CY @ 35 CY/HR = 680 HR = 7.5 days = 2 weeks
- Qty. of cement = [260 CY x 1.5 TON/CY]/5 = 65 TONS

- Labor = 4 x 10 x 10 HR/day = 400 HR

Bulk After solidification, expect up to 25% bulking of volume:

Vol. = 1.25 x 260 CY = 325 CY

Confirmatory TCLP analyses: Use 10% batch sampling rate to confirm leachate below 40 CFR 261.24 requirements using TCLP. 10 samples

8. Backfill - backfill treated materials into topographic depression which is 419 CY.

Assume F.E. loader, 150 ft haul, to move stockpiled materials to desired areas [022 246 1350].

9. Grading and Compaction - Grade [025 122 3310] and compaction [17 03 0514]. Use 3000 SF = 335 SY

10. Barricade Demolition

Estimated 1280 CY of backfill from barricade.
Use 4-men crew of laborers (B-2) to dismantle barricade, @ 10 days
Estimated barricade treated lumber of 108 FT x 35 FT (12 ft @ top) x 15 ft H; each lumber of 12" x 18"
Total wood volume = 2[0.5 x (15)(35 +12)] 1 ft + [106 x 15] x 1 ft = 2295 CF
Stage materials on Site 19 for future use.

11. Backfill Depression and Pave

Add 94 CY of barricade material to depression. Grade and compact. Stockpile remainder of soils
Pave 3000 SY with 6" asphalt.

12. Backfill Drainage way

- Replace excavated drainage way with common earth. Use barricade materials if suitable.

LONG-TERM O & M COST ITEMS:

1. Long-term monitoring. Would be same as for no action. For FS to be consistent with NCP requirements, will need to cost out for 30-year duration. It is possible after one of the 5-year reviews that long-term monitoring would be discontinued once groundwater quality meets the NJ GWGS and surface water quality meets SWQS.

a. Long-term annual post-closure groundwater, surface water, and sediment monitoring:

- From 6 existing monitoring wells, 3 QC samples. Total 9 samples annually.
- From 3 surface water locations, 3 QC samples. Total 6 samples annually.
- From 3 sediment locations (same as surface water), 3 QC samples. Total 6 samples annually.

BROWN & ROOT ENVIRONMENTAL		COST ESTIMATE ASSUMPTIONS	
CLIENT: Navy CLEAN	FILE NO.:	BY: LC	PAGE 4 of 4
SUBJECT: Site 19, Alt. 4 Assumptions and Cost Basis. NWS Earle FS, CTO 279		REVIEWED BY: MJW 7/31/97	15 OCT 96

Sampling and analysis for site-specific contaminants: VOCs and metals.

Labor: 1 event/year.

- GW/SW/SED sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
- Sampling » 52 hours @ $60/hr (w/overhead & profit) = $3120
- Proj. mgmt/coord. » 20 hours/year @ $80/hr (CAP) = $1600
- Annual: add $300 M&IE. ODCs & supplies @ $200; & shipp[illegible] @ $200.

Total ≈ $5420 annually

Estimated analytical costs:

- VOCs (EPA Method 624) $324/sample @ 21 samples/yr = $6804
- metals (EPA 601D/7000s) @ $254/sample @ 21 samples/yr = $5334

Total = $ 12138 = $12200

b. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

c. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 19 - Alternative 5A - Excavation, Off-Site Disposal, Nat. Atten., Long-ter
Colts Neck New Jersey
Present Worth Analysis
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PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	375			375.30
1	0.935		21.60		20.19
2	0.873		21.60		18.87
3	0.816		21.60		17.63
4	0.763		21.60		16.48
5	0.713		21.60	15.5	26.45
6	0.666		21.60		14.39
7	0.623		21.60		13.45
8	0.582		21.60		12.57
9	0.544		21.60		11.75
10	0.508		21.60	15.5	18.86
11	0.475		21.60		10.26
12	0.444		21.60		9.59
13	0.415		21.60		8.96
14	0.388		21.60		8.38
15	0.362		21.60	15.5	13.45
16	0.339		21.60		7.32
17	0.317		21.60		6.84
18	0.296		21.60		6.39
19	0.277		21.60		5.97
20	0.258		21.60	15.5	9.59
21	0.242		21.60		5.22
22	0.226		21.60		4.88
23	0.211		21.60		4.56
24	0.197		21.60		4.26
25	0.184		21.60	15.5	6.84
26	0.172		21.60		3.72
27	0.161		21.60		3.48
28	0.150		21.60		3.25
29	0.141		21.60		3.04
30	0.131		21.60	15.5	4.87
		TOTAL PRESENT WORTH =			$676.781

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 5A - EXCAVATION, OFF-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT5A.WK4] 15 OCT 96

Sheet 1 of 3

Item	Qty	Unit	Unit Cost ($) Sub	Mat	Labor	Equip	Total Cost ($) Sub	Mat	Labor	Equip	Total Direct Cost ($)	Comments
INITIAL ACTIVITIES												
1) Field delineation of soils	1	LS	0.00	1,200.00	2,000.00	400.00	0	1,200	2,000	400	3,600	[013 306 0100]
3) Engineering design (see page 3)												
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	0.5	MO	4,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
5) 1 Pick-up Truck (rental)	0.5	MO	500.00	100.00	0.00	0.00	250	50	0	0	300	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000.00	0.00	100.00	0.00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	500	GAL	0.20	0.00	0.00	0.00	100	0	0	0	100	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	0.5	MO	2,500.00	0.00	200.00	0.00	1,250	0	100	0	1,350	Vendor catalog
6) PPE rolloff cont.	0.5	MO	700.00	0.00	0.00	0.00	350	0	0	0	350	Historical data
SITE MANAGEMENT STAFFING												
1) Site manager	90	HR	0.00	0.00	35.86	0.00	0	0	3,227	0	3,227	
2) Site supervisor/foreman	90	HR	0.00	0.00	30.00	0.00	0	0	2,700	0	2,700	
3) Site safety officer	10	HR	0.00	0.00	25.00	0.00	0	0	250	0	250	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	10	HR	0.00	0.00	45.00	0.00	0	0	450	0	450	
2) Project administrator	10	HR	0.00	0.00	30.00	0.00	0	0	300	0	300	
3) Health and Safety director	2	HR	0.00	0.00	35.00	0.00	0	0	70	0	70	
4) Procurement/subcontracting	100	HR	0.00	0.00	30.00	0.00	0	0	3,000	0	3,000	
4) Clerical support	100	HR	0.00	0.00	12.36	0.00	0	0	1,236	0	1,236	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 5A - EXCAVATION, OFF-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT5A.WK4] 15 OCT 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip	Sub.	Mat.	Labor	Equip	Cost ($)	Comments
SITE PREPARATION												
1) clear & grub Site 19	0.5	AC	0.00	0.00	595.00	1,775.00	0	0	0	0	0	[021 108 0550]
2) cut & chip medium trees	0.5	AC	0.00	0.00	1425.00	1575.00	0	0	713	788	1,500	[021 104 0200]
4) Erosion control, silt fences	100	LF	0.00	0.37	0.33	0.00	0	37	33	0	70	[022 704 1100]
4) Erosion control, hay bales	0.5	ton	0.00	45.00	157.00	54.00	0	23	79	27	128	[022 704 1200]
7) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
7a) Spray from tank truck	2	MO	0.00	0.00	1160.00	1292.80	0	0	2,320	2,586	4,906	[18 05 0413]
EXCAVATION												
1)Excavate Site 19 soils/sediments	260	CY	0.00	0.00	1.06	1.24	0.00	0.00	276	322	598	[022 238 0360]
2) Haul 300 ft to treatment area	260	CY	0.00	0.00	0.51	0.51	0.00	0.00	133	133	265	[022 208 2200]
OFF-SITE DISPOSAL												
1) load dump trucks	260	CY	0.00	0.00	0.51	0.42	0	0	133	109	242	[022 216 4050]
2) Haul to TSDF, 260 CY @ 20 CY @ 350 miles	4550	miles	3.46	0.00	0.00	0.00	15,743	0	0	0	15,743	@ 350 miles/trip
3) Offsite disposal charge	260	CY	450.00	0.00	0.00	0.00	117,000	0	0	0	117,000	[33 19 7265]
BACKFILL TOPO. DEPRESSION												
1) Backfill with barricade materials	354	CY	0.00	0.00	0.51	0.51	0.00	0.00	181	181	361	[022 208 2200]
2) Compact barricade mat'l, 6" lifts in depression	354	CY	0.00	0.00	0.21	0.42	0.00	0.00	74	149	223	[022 226 5600]
BARRICADE DEMOLITION												
1) Remove 1280 CY soils	1,280	CY	0.00	0.00	0.51	0.51	0.00	0.00	653	653	1,306	[022 208 2200]
2) Haul to stockpile area (1000 ft)	926	CY	0.00	0.00	0.21	0.42	0.00	0.00	194	389	583	[022 226 5600]
3) Disassemble/demolish wood structure (B-2 crew)	10	days	0.00	0.00	792.00	100.00	0.00	0.00	7,920	1,000	8,920	B-4 daily rate
4) Haul to stockpile area	85	CY	0.00	0.00	0.21	0.42	0.00	0.00	18	36	54	[022 226 5600]
Pave Depression												
1) 3" asphalt binder	335	SY	0.00	3.94	0.38	0.34	0.00	0.00	127	114	241	[025 104 016[illegible]
2) 3" asphalt wearing course	335	SY	0.00	4.32	0.42	0.39	0.00	0.00	141	131	271	[025 104 046[illegible]
Fill Cement Pipe												
1) Block buried cement pipe	2	CY	0.00	54.00	0.00	0.00	0.00	108	0.00	0.00	108	[025 104 046[illegible]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 5A - EXCAVATION, OFF-SITE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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	Total Cost ($) Sub	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
PAGE 3 TOTAL	152,493	8,918	27,783	7,291	196,485	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	1,389	365	1,754	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	834	219	1,052	
Subtotal Direct Costs	152,493	8,918	29,173	7,656	199,291	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	13,480	0	13,480	
Field Construction Labor Overhead @ 60%	0	0	9,930	0	9,930	
Subcontract Overhead @ 5%	7,625	0	0	0	7,625	
Tax on Materials @ 5%	0	446	0	0	446	
G & A @ 10% (on labor, equip., & matl's.)	0	892	2,917	766	4,575	
Subtotal Direct and Indirect Costs	160,118	10,255	55,500	8,422	235,347	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	6,405	410	2,220	337	9,372	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					49,423	
Adjusted Direct and Indirect Costs	166,522	10,665	57,720	8,759	294,141	
Engineering @ 6 % of total direct and indirect					17,648	
Prime Contractor Fee @ 10% of Total Adjusted Cost					29,414	
Total Costs					341,204	
Contingency @ 10% of Total Cost					34,120	
TOTAL ESTIMATED COST					375,324	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA
3) Historical data based on competitive bids submitted by subcontractors at this or other sites.

NWS Earle Site FS
Site 19 - Alternative 5A - Excavation, Off-site disposal, Natural Attentuation, Long-term monitoring
Colts Neck New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM19-5A.WK4] 15 OCT 96

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater, surface water, & sediment monitoring	$17,620		collect 9 GW (6 + 3 QC), 6 SW (3 + 3QC), and 6 SED (3 + 3QC) samples annually plus travel, living & shipping
2. Reporting	$4,000		50 LOE hours for annual reports plus other direct costs
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

NWS Earle Site FS
Site 19 - Alternative 5B - Excavation, On-Base Disposal, Nat. Atten[illegible]
Colts Neck New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW19-5B.WK4] 15 OCT 96

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	153			153.10
1	0.935		21.60		20.19
2	0.873		21.60		18.87
3	0.816		21.60		17.63
4	0.763		21.60		16.48
5	0.713		21.60	15.5	26.45
6	0.666		21.60		14.39
7	0.623		21.60		13.45
8	0.582		21.60		12.57
9	0.544		21.60		11.75
10	0.508		21.60	15.5	18.86
11	0.475		21.60		10.26
12	0.444		21.60		9.59
13	0.415		21.60		8.96
14	0.388		21.60		8.38
15	0.362		21.60	15.5	13.45
16	0.339		21.60		7.32
17	0.317		21.60		6.84
18	0.296		21.60		6.39
19	0.277		21.60		5.97
20	0.258		21.60	15.5	9.59
21	0.242		21.60		5.22
22	0.226		21.60		4.88
23	0.211		21.60		4.56
24	0.197		21.60		4.26
25	0.184		21.60	15.5	6.84
26	0.172		21.60		3.72
27	0.161		21.60		3.48
28	0.150		21.60		3.25
29	0.141		21.60		3.04
30	0.131		21.60	15.5	4.87
		TOTAL PRESENT WORTH =			$454.581

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY **COLTS NECK, NJ**
SITE 19 ALT. 5B - EXCAVATION, ON-BASE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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Sheet 1 of 3

Item	Qty	Unit	Unit Cost ($) Sub.	Mat	Labor	Equip	Total Cost ($) Sub.	Mat	Labor	Equip	Total Direct Cost ($)	Comments
INITIAL ACTIVITIES												
1) Field delineation of soils	1	LS	0.00	1,200.00	2,000.00	400.00	0	1,200	2,000	400	3,600	[013 306 0100]
3) Engineering design (see page 3)												
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	0.5	MO	4,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
5) 1 Pick-up Truck (rental)	0.5	MO	500.00	100.00	0.00	0.00	250	50	0	0	300	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc	2	MO	1,000.00	0.00	100.00	0.00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	500	GAL	0.20	0.00	0.00	0.00	100	0	0	0	100	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	0.5	MO	2,500.00	0.00	200.00	0.00	1,250	0	100	0	1,350	Vendor catalog
6) PPE rolloff cont.	0.5	MO	700.00	0.00	0.00	0.00	350	0	0	0	350	Historical data
SITE MANAGEMENT STAFFING												
1) Site manager	90	HR	0.00	0.00	35.86	0.00	0	0	3,227	0	3,227	
2) Site supervisor/foreman	90	HR	0.00	0.00	30.00	0.00	0	0	2,700	0	2,700	
3) Site safety officer	10	HR	0.00	0.00	25.00	0.00	0	0	250	0	250	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	10	HR	0.00	0.00	45.00	0.00	0	0	450	0	450	
2) Project administrator	10	HR	0.00	0.00	30.00	0.00	0	0	300	0	300	
3) Health and Safety director	2	HR	0.00	0.00	35.00	0.00	0	0	70	0	70	
4) Procurement/subcontracting	100	HR	0.00	0.00	30.00	0.00	0	0	3,000	0	3,000	
4) Clerical support	100	HR	0.00	0.00	12.36	0.00	0	0	1,236	0	1,236	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 5B - EXCAVATION, ON-BASE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\19-ALT5B.WK4] 15 OCT 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip	Sub.	Mat.	Labor	Equip	Cost ($)	Comments
SITE PREPARATION												
1) clear & grub Site 19	0.5	AC	0.00	0.00	595.00	1,775.00	0	0	0	0	0	[021 108 0550]
2) cut & chip medium trees	0.5	AC	0.00	0.00	1425.00	1575.00	0	0	713	788	1,500	[021 104 0200]
4) Erosion control, silt fences	100	LF	0.00	0.37	0.33	0.00	0	37	33	0	70	[022 704 1100]
4) Erosion control, hay bales	0.5	ton	0.00	45.00	157.00	54.00	0	23	79	27	128	[022 704 1200]
7) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
7a) Spray from tank truck	2	MO	0.00	0.00	1160.00	1292.80	0	0	2,320	2,586	4,906	[18 05 0413]
EXCAVATION												
1)Excavate Site 19 soils/sediments	260	CY	0.00	0.00	1.06	1.24	0.00	0.00	276	322	598	[022 238 0360]
2) Haul 300 ft to treatment area	260	CY	0.00	0.00	0.51	0.51	0.00	0.00	133	133	265	[022 208 2200]
ON-BASE DISPOSAL												
1) load dump trucks	260	CY	0.00	0.00	0.51	0.42	0	0	133	109	242	[022 216 4050]
2) Haul to Site 4, 260 CY @ 20 CY @ 2 miles	26	miles	3.46	0.00	0.00	0.00	90	0	0	0	90	@ 2 miles/trip
BACKFILL TOPO DEPRESSION												
1) Backfill with barricade materials	354	CY	0.00	0.00	0.51	0.51	0.00	0.00	181	181	361	[022 208 2200]
2) Compact barricade mat'l, 6" lifts in depression	354	CY	0.00	0.00	0.21	0.42	0.00	0.00	74	149	223	[022 226 5600]
BARRICADE DEMOLITION												
1) Remove 1280 CY soils	1,280	CY	0.00	0.00	0.51	0.51	0.00	0.00	653	653	1,306	[022 208 2200]
2) Haul to stockpile area (1000 ft)	926	CY	0.00	0.00	0.21	0.42	0.00	0.00	194	389	583	[022 226 5600]
3) Disassemble/demolish wood structure (B-2 crew)	10	days	0.00	0.00	792.00	100.00	0.00	0.00	7,920	1,000	8,920	B-4 daily rate
4) Haul to stockpile area	85	CY	0.00	0.00	0.21	0.42	0.00	0.00	18	36	54	[022 226 5600]
Pave Depression												
1) 3" asphalt binder	335	SY	0.00	3.94	0.38	0.34	0.00	0.00	127	114	241	[025 [illegible] 016[illegible]
2) 3" asphalt wearing course	335	SY	0.00	4.32	0.42	0.39	0.00	0.00	141	131	271	[025 [illegible] 0460]
Fill Cement Pipe												
1) Block buried cement pipe	2	CY	0.00	54.00	0.00	0.00	0.00	108	0.00	0.00	108	[[illegible] 046[illegible]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 19 ALT. 5B - EXCAVATION, ON-BASE DISPOSAL, NAT. ATTEN. LONG-TERM MONIT.
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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	Total Cost ($) Sub	Mat.	Labor	Equip	Total Direct Cost ($)	Comments
PAGE 2 TOTAL	19,840	8,918	27,783	7,291	63,832	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	1,389	365	1,754	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	834	219	1,052	
Subtotal Direct Costs	19,840	8,918	29,173	7,656	66,638	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	13,480	0	13,480	
Field Construction Labor Overhead @ 60%	0	0	9,930	0	9,930	
Subcontract Overhead @ 5%	992	0	0	0	992	
Tax on Materials @ 5%	0	446	0	0	446	
G & A @ 10% (on labor, equip., & matl's.)	0	892	2,917	766	4,575	
Subtotal Direct and Indirect Costs	20,832	10,255	55,500	8,422	96,061	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	833	410	2,220	337	3,800	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					20,173	
Adjusted Direct and Indirect Costs	21,665	10,665	57,720	8,759	120,034	
Engineering @ 6 % of total direct and indirect					7,202	
Prime Contractor Fee @ 10% of Total Adjusted Cost					12,003	
Total Costs					139,240	
Contingency @ 10% of Total Cost					13,924	
TOTAL ESTIMATED COST					153,164	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA
3) Historical data based on competitive bids submitted by subcontractors at this or other sites.

NWS Earle Site FS
Site 19 - Alternative 5B - Excavation, On-Base Disposal, Natural Attentuation Long-term monitoring
Colts Neck New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM19-5B.WK4] 15 OCT 96

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater, surface water, & sediment monitoring	$17,620		collect 9 GW (6 + 3 QC), 6 SW (3 + 3QC), and 6 SED (3 + 3QC) samples annually plus travel, living & shipping
2. Reporting	$4,000		50 LOE hours for annual reports plus other direct costs
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

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Site 19 Alternative 5: Excavation, Off-site Disposal, Nat. Atten., Long-term Monitoring

Scenario A: Off-site disposal

Scenario B: On-base disposal at Site 4

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Cost estimating sources:

- ECHOS Environmental Restoration. Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.
- Means Heavy Construction Cost Data, 9th edition. R.S. Means Company, Inc., 1995.
- Means Site Work & Landscape Cost Data, 14th edition. R.S. Means Company, Inc., 1995.

iii. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

CAPITAL COST ITEMS:

1. Initial Activities

   - Field delineation of contaminated soils 2 people @ 10 hours @ @ 5 days @ $20/hr + $1000 M&IE + $400 equip + $200 supplies = $3600.

2. Mobilization/Demobilization Require portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines), decon. trailer. Will require drinking and wash water, and sanitary facilities.

3. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

4. Site Preparation:

   Clearing and grubbing 0.5 acres - Clear brush, shrubs, etc.

   Access road - Existing access roads appear to be adequate to sustain heavy equipment. Assume no further improvements needed.

   Erosion controls - will need to establish temporary silt fences and hay bales to protect adjacent

wetlands. Polypropylene [022 704 1100]. Total linear ft silt fence = 100 LF.

Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down .5 acres per day, 20 days per month [18 05 0413].

5. Excavation:

Excavate 260 CY from topographic depression and drainage way. Haul to treatment area on Site 19.

6. Field confirmatory analyses: to verify or confirm that desired PRG levels (concentrations) have been achieved through excavation. Will need to field screen for metals. Assume use of field screening kits for metals.

ODCs & supplies: ~$1000/month

7. Scenario 1: Off-site disposal

Assume worst case, that contaminated soils would fail TCLP. Dispose of in RCRA C landfill. Model City, New York. Distance from Tinton Falls.to Model City ~ 350 miles

8. Scenario 2: On-base disposal

Consolidate into Site 4 for closure if materials are not hazardous by regulatory definition.

9. Backfill - backfill treated materials into topographic depression which is 419 CY.

Assume F.E. loader, 150 ft haul, to move stockpiled materials to desired areas [022 246 1350].

10. Grading and Compaction - Grade [025 122 3310] and compaction [17 03 0514]. Use 3000 SF = 335 SY

11. Barricade Demolition

Estimated 1280 CY of backfill from barricade.
Use 4-men crew of laborers (B-2) to dismantle barricade, @ 10 days
Estimated barricade treated lumber of 108 FT x 35 FT (12 ft @ top) x 15 ft H; each lumber of 12" x 18"
Total wood volume = 2[0.5 x (15)(35 +12)] 1 ft + [106 x 15] x 1 ft = 2295 CF
Stage materials on Site 19 for future use.

12. Backfill Depression and Pave

Add 94 CY of barricade material to depression. Grade and compact. Stockpile remainder of soils
Pave 3000 SY with 6" asphalt.

13. Backfill Drainage way
- Replace excavated drainage way with common earth. Use barricade materials if suitable.

LONG-TERM O & M COST ITEMS:

1. Long-term monitoring. Would be same as for no action. For FS to be consistent with NCP requirements, will need to cost out for 30-year duration. It is possible after one of the 5-year reviews that long-term monitoring would be discontinued once groundwater quality meets the NJ GWGS and surface water quality meets SWQS.

   a. Long-term annual post-closure groundwater, surface water, and sediment monitoring:

   - From 6 existing monitoring wells, 3 QC samples. Total 9 samples annually.
   - From 3 surface water locations, 3 QC samples. Total 6 samples annually.
   - From 3 sediment locations (same as surface water), 3 QC samples. Total 6 samples annually.

   Sampling and analysis for site-specific contaminants: VOCs and metals.

   Labor: 1 event/year.

   - GW/SW/SED sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
   - Sampling » 52 hours @ $60/hr (w/overhead & profit) = $3120
   - Proj. mgmt/coord. » 20 hours/year @ $80/hr (w/O&P) = $1600
   - Annual: add $300 M&IE; ODCs & supplies @ $200; & shipping @ $200.

   Total ≈ $5420 annually

   Estimated analytical costs:

   - VOCs (EPA Method 624) $324/sample @ 21 samples/yr = $6804
   - metals (EPA 6010/7000s) @ $254/sample @ 21 samples/yr = $5334

   Total = $ 12138 = $12200

   b. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

   c. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 26 - Alternative 1 - No Action
Colts Neck. New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW26ALT1.WK4]12 NOV 96

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	0			0.00
1	0.935		26.80		25.05
2	0.873		12.72		11.11
3	0.816		12.72		10.38
4	0.763		12.72		9.70
5	0.713		12.72	15.5	20.12
6	0.666		12.72		8.48
7	0.623		12.72		7.92
8	0.582		12.72		7.40
9	0.544		12.72		6.92
10	0.508		12.72	15.5	14.35
11	0.475		12.72		6.04
12	0.444		12.72		5.65
13	0.415		12.72		5.28
14	0.388		12.72		4.93
15	0.362		12.72	15.5	10.23
16	0.339		12.72		4.31
17	0.317		12.72		4.03
18	0.296		12.72		3.76
19	0.277		12.72		3.52
20	0.258		12.72	15.5	7.29
21	0.242		12.72		3.07
22	0.226		12.72		2.87
23	0.211		12.72		2.68
24	0.197		12.72		2.51
25	0.184		12.72	15.5	5.20
26	0.172		12.72		2.19
27	0.161		12.72		2.05
28	0.150		12.72		1.91
29	0.141		12.72		1.79
30	0.131		12.72	15.5	3.71
		TOTAL PRESENT WORTH =			$204.448

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Brown & Root Environmental		Calc. Sheet
Client: Navy CLEAN File No.	By: LC	Page
Subject: Site 26, Alt. 1 - Assumptions and Cost Basis, NWS Earle FS, CTO 279	Checked by: MJW 7/31/97	Date: 11 Nov 96

[C:\CLEAN\CTO279\DRFS\COST\26-ALT1.DOC]

Site 26 Alternative 1: No Action

ASSUMPTIONS:

1. Long-term annual groundwater monitoring:

- Year 1 - Install 4 new monitoring wells or piezometers, approx. 25 feet lengths.
- Sample 3 existing and 4 new monitoring wells, 3 QC samples. Total 10 samples annually.
- Sampling and analysis for site-specific contaminants: VOCs

Wells installation:

- Use cased drilling techniques, since sandy aquifer difficult to drill with augers. Install 5 ft or 10 ft screens at bottom of well, or where highest VOCs detected. Drilling and monitoring well construction rate of 25 ft/day. Well development of 4 hr/well. Est. 1 week duration incl. mob/demob driller, drilling, and wells installation and development.

- Driller mob/demob @ $2000
- $25/LF drilling, $15/LF well construction = 4 @ 25 ft @ $40 = $4000
- $15/split spoon sample @ 20 samples = $300
- $100/hr well develop, up to 4 hours ea. = $1600
- Misc. - decon.spoons, drums, standby, etc. = $ 1000
- Drilling subcon. subtotal = $8900

- 1 geologist oversight for 6 days (inc. prep. & travel) @ 10 hr/day @ $60/hr w/overhead & profit, $125/day M&IE @ 5 days, $600 ODCs/PID, supplies.
- Mgmt coord. 4 hr @ $90/hr = $360
- Oversight subtotal = $5185 ≈ $5200

Labor: 1 sampling event/year.

- GW sampling 2 people @ 10 hr/day @ 2 days (add 10 hr each for prep./mob/demob.) ≈ 60 hr annually.
- Sampling ≈ 60 hours @ $60/hr (w/O&P) = $ 3600
- Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
- Annual: add $300 M&IE; ODCs & supplies @ $200; & shipping @ $200.

Total ≈ $5420 annually

Estimated analytical costs:

- VOCs (EPA Method 624) $324/sample @ 10 samples/yr = $ 3240 ≈ $3300

2. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

3. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 26 - Alternative 2A - Limited Action
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW26-2A.WK4] 13 NOV 96

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	157			156.78
1	0.935		12.72		11.89
2	0.873		12.72		11.11
3	0.816		12.72		10.38
4	0.763		12.72		9.70
5	0.713		12.72	15.5	20.12
6	0.666		12.72		8.48
7	0.623		12.72		7.92
8	0.582		12.72		7.40
9	0.544		12.72		6.92
10	0.508		12.72	15.5	14.35
11	0.475		12.72		6.04
12	0.444		12.72		5.65
13	0.415		12.72		5.28
14	0.388		12.72		4.93
15	0.362		12.72	15.5	10.23
16	0.339		12.72		4.31
17	0.317		12.72		4.03
18	0.296		12.72		3.76
19	0.277		12.72		3.52
20	0.258		12.72	15.5	7.29
21	0.242		12.72		3.07
22	0.226		12.72		2.87
23	0.211		12.72		2.68
24	0.197		12.72		2.51
25	0.184		12.72	15.5	5.20
26	0.172		12.72		2.19
27	0.161		12.72		2.05
28	0.150		12.72		1.91
29	0.141		12.72		1.79
30	0.131		12.72	15.5	3.71
			TOTAL PRESENT WORTH =		$348.069

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2A - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION A: OFF-SITE DISPOSAL CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2A - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION A: OFF-SITE DISPOSAL CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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Sheet 1 of 3

Item	Qty	Unit	Unit Cost ($)				Total Cost ($)				Total Direct Cost ($)	Comments
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.		
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400 00	0 00	0 00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000 00	0 00	0 00	0 00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	1,000 00	0 00	0 00	0 00	1,000	0	0	0	1,000	Historical data
4) Site Utilities	0.5	MO	4,000 00	0 00	0 00	0 00	2,000	0	0	0	2,000	
5) 1 Pick-up Truck (rental)	0.5	MO	500 00	100 00	0 00	0 00	250	50	0	0	300	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0 00	0.00	0 70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0 00	0.00	0.11	0 36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0 00	1,000 00	500 00	200 00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000 00	0 00	100 00	0 00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	500	GAL	0 20	0 00	0 00	0 00	100	0	0	0	100	
3) Clean Water Storage Tank	1	EA	0 00	1,500.00	300 00	0 00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0 00	2,500 00	400.00	0 00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	0 5	MO	2,500 00	0 00	200 00	0 00	1,250	0	100	0	1,350	Vendor catalog
6) PPE rolloff cont.	0.5	MO	700 00	0.00	0.00	0 00	350	0	0	0	350	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	100	HR	0.00	0.00	35.86	0.00	0	0	3,586	0	3,586	
2) Site safety officer	20	HR	0.00	0.00	25.00	0 00	0	0	500	0	500	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	10	HR	0.00	0.00	45.00	0.00	0	0	450	0	450	
2) Project administrator	10	HR	0 00	0.00	30.00	0.00	0	0	300	0	300	
3) Health and Safety director	5	HR	0 00	0 00	35 00	0 00	0	0	175	0	175	
4) Procurement/subcontracting	50	HR	0 00	0 00	30 00	0 00	0	0	1,500	0	1,500	
4) Clerical support	20	HR	0 00	0 00	12 36	0 00	0	0	247	0	247	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2A - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION A: OFF-SITE DISPOSAL CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\26-ALT2A.WK 12 NOV 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip	Sub.	Mat.	Labor	Equip	Cost ($)	Comments
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	0.5	MO	0.00	0.00	1160.00	1292.80	0	0	580	646	1,226	[18 05 0413]
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0.00	0.51	0.51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0.00	0.00	1.06	1.24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon. area	6	CY	0.00	0.00	0.51	0.51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0.00	0.05	0.24	0.00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0.00	4.64	20.03	0.22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324.00	0.00	15.00	0.00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1.98	0.00	0.00	0.00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324.00	0.00	0.00	0.00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0.00	10.00	20.00	0.00	0	100	200	0	300	
OFF-SITE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0.42	0	0	10	8	18.60	[022 216 4050]
2) Haul to TSDF, 20 CY @ 350 miles	350	miles	3.46	0.00	0.00	0.00	1,211	0	0	0	1211.00	@ 350 miles/trip
3) Offsite disposal charge	20	CY	450.00	0.00	0.00	0.00	9,000	0	0	0	9000.00	[33 19 7265]
BACKFILL TANK AREA												
1) Backfill with on-base fill material	56	CY	0.00	0.00	0.51	0.51	0	0	29	29	57	[022 208 2200]
2) Compact materials, 6" lifts	56	CY	0.00	0.00	0.21	0.42	0	0	12	24	35	[022 226 5600]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Drilling	100	LF	25.00	0.00	0.00	0.00	2,500	0	0	0	2,500	Historical data
3) Split barrel sampling	20	EA	15.00	0.00	0.00	0.00	300	0	0	0	300	Historical data
4) Well installation	100	LF	15.00	0.00	0.00	0.00	1,500	0	0	0	1,500	Historical data
5) Well development	16	HR	100.00	0.00	0.00	0.00	1,600	0	0	0	1,600	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	Historical data
6) Oversight (1 geologist)	60	HR	0.00	0.00	20.00	0.00	0	0	1,200	0	1,200	
8) Mgmt coord.	5	HR	0.00	0.00	35.00	0.00	0	0	175	0	175	
7) Oversight ODCs, M&IE	1	LS	0.00	625.00	0.00	0.00	0	625	0	0	625	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2A - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION A: OFF-SITE DISPOSAL CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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	Total Cost ($) Sub.	Mat.	Labor	Equip	Total Direct Cost ($)	Comments
Page 3 Total	58,915	8,514	11,952	1,029	80,411	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	598	51	649	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	359	31	389	
Subtotal Direct Costs	58,915	8,514	12,550	1,081	81,450	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	8,110	0	8,110	
Field Construction Labor Overhead @ 60%	0	0	3,117	0	3,117	
Subcontract Overhead @ 5%	2,946	0	0	0	2,946	
Tax on Materials @ 5%	0	426	0	0	426	
G & A @ 10% (on labor, equip., & matl's.)	0	851	1,255	108	2,215	
Subtotal Direct and Indirect Costs	61,861	9,792	25,031	1,189	98,262	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	2,474	392	1,001	48	3,915	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					20,635	
Adjusted Direct and Indirect Costs	64,335	10,183	26,033	1,237	122,812	
Engineering @ 6 % of total direct and indirect					7,369	
Prime Contractor Fee @ 10% of Total Adjusted Cost					12,281	
Total Costs					142,462	
Contingency @ 10% of Total Cost					14,246	
TOTAL ESTIMATED COST					$156,708	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 – Alternative 2A - Limited Action
Colts Neck, New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM26-2A.WK4] 13 NOV 96

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater monitoring	$8,720		collect 10 GW (7 + 3 QC) samples annually, plus travel, living & shipping
2. Reporting	$4,000		50 LOE hours & ODCs for annual reports plus other direct costs
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

NWS Earle Site FS
Site 26 - Alternative 2B - Limited Action; On-base consolidation of soils
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW26-2B.WK4] 13 NOV 96

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	140			139.61
1	0.935		12.72		11.89
2	0.873		12.72		11.11
3	0.816		12.72		10.38
4	0.763		12.72		9.70
5	0.713		12.72	15.5	20.12
6	0.666		12.72		8.48
7	0.623		12.72		7.92
8	0.582		12.72		7.40
9	0.544		12.72		6.92
10	0.508		12.72	15.5	14.35
11	0.475		12.72		6.04
12	0.444		12.72		5.65
13	0.415		12.72		5.28
14	0.388		12.72		4.93
15	0.362		12.72	15.5	10.23
16	0.339		12.72		4.31
17	0.317		12.72		4.03
18	0.296		12.72		3.76
19	0.277		12.72		3.52
20	0.258		12.72	15.5	7.29
21	0.242		12.72		3.07
22	0.226		12.72		2.87
23	0.211		12.72		2.68
24	0.197		12.72		2.51
25	0.184		12.72	15.5	5.20
26	0.172		12.72		2.19
27	0.161		12.72		2.05
28	0.150		12.72		1.91
29	0.141		12.72		1.79
30	0.131		12.72	15.5	3.71
			TOTAL PRESENT WORTH =		$330,899

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2B - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION B: ON-BASE CONSOLIDATION of SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2B - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION B: ON-BASE CONSOLIDATION of SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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Sheet 1 of 3

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400 00	0 00	0 00	0 00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000.00	0 00	0 00	0 00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	1,000 00	0 00	0 00	0 00	1,000	0	0	0	1,000	Historical data
4) Site Utilities	0 5	MO	4,000 00	0 00	0 00	0 00	2,000	0	0	0	2,000	
5) 1 Pick-up Truck (rental)	0 5	MO	500 00	100 00	0 00	0 00	250	50	0	0	300	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0 00	0.00	0 70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0 00	0.00	0.11	0 36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0 00	1,000 00	500 00	200 00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000 00	0 00	100 00	0 00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	500	GAL	0 20	0 00	0 00	0 00	100	0	0	0	100	
3) Clean Water Storage Tank	1	EA	0 00	1,500 00	300 00	0 00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0 00	2,500 00	400 00	0 00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	0 5	MO	2,500 00	0 00	200 00	0 00	1,250	0	100	0	1,350	Vendor catalog
6) PPE rolloff cont.	0.5	MO	700 00	0 00	0 00	0 00	350	0	0	0	350	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	100	HR	0.00	0.00	35.86	0.00	0	0	3,586	0	3,586	
2) Site safety officer	20	HR	0.00	0.00	25.00	0 00	0	0	500	0	500	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	10	HR	0.00	0.00	45.00	0.00	0	0	450	0	450	
2) Project administrator	10	HR	0 00	0 00	30.00	0 00	0	0	300	0	300	
3) Health and Safety director	5	HR	0 00	0 00	35 00	0 00	0	0	175	0	[illegible]	
4) Procurement/subcontracting	50	HR	0 00	0 00	30 00	0 00	0	0	1,500	0	[illegible]	
4) Clerical support	20	HR	0 00	0 00	12 36	0 00	0	0	247	0	247	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2B - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION B: ON-BASE CONSOLIDATION of SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\26-ALT2B.WK4 13 NOV 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub	Mat.	Labor	Equip	Sub	Mat.	Labor	Equip	Cost ($)	Comments
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0 00	2500 00	0 00	0 00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	0 5	MO	0 00	0 00	1160 00	1292 80	0	0	580	646	1,226	[18 05 0413]
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0 00	0 51	0 51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0 00	0 00	1 06	1 24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon area	6	CY	0 00	0 00	0 51	0 51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0 00	0 05	0 24	0 00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0 00	4 64	20 03	0 22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324 00	0 00	15 00	0 00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1 98	0 00	0 00	0 00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324 00	0.00	0.00	0 00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0 00	10 00	20 00	0 00	0	100	200	0	300	
ON-BASE CONSOLIDATION												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0 42	0	0	10	8	18 60	[022 216 4050]
2) Haul to Site 4, 20 CY @ 1 miles	1	miles	3 46	0 00	0 00	0 00	3	0	0	0	3 46	
BACKFILL TANK AREA												
1) Backfill with on-base fill material	56	CY	0.00	0.00	0.51	0.51	0	0	29	29	57	[022 208 2200]
2) Compact materials, 6" lifts	56	CY	0.00	0.00	0.21	0.42	0	0	12	24	35	[022 226 5600]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0 00	2,000	0	0	0	2,000	Historical data
2) Drilling	100	LF	25 00	0 00	0.00	0 00	2,500	0	0	0	2,500	Historical data
3) Split barrel sampling	20	EA	15 00	0 00	0.00	0 00	300	0	0	0	300	Historical data
4) Well installation	100	LF	15 00	0 00	0 00	0 00	1,500	0	0	0	1,500	Historical data
5) Well development	16	HR	100 00	0 00	0 00	0 00	1,600	0	0	0	1,600	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	1,000 00	0 00	0 00	0 00	1,000	0	0	0	1,000	Historical data
6) Oversight (1 geologist)	60	HR	0 00	0 00	20.00	0 00	0	0	1,200	0	1,200	
8) Mgmt coord	5	HR	0 00	0 00	35.00	0 00	0	0	175	0	175	
7) Oversight ODCs, M&IE	1	LS	0 00	625.00	0.00	0 00	0	625	0	0	625	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 2B - LIMITED ACTION (SOURCE REMOVAL, INST. CONTROLS, NAT. ATTEN., LONG-TERM MONIT.)
OPTION B: ON-BASE CONSOLIDATION of SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\26-ALT2B.WK4 13 NOV 96

	Total Cost ($) Sub.	Mat.	Labor	Equip	Total Direct Cost ($)	Comments
Page 3 Total	48,707	8,514	11,952	1,029	70,204	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	598	51	649	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	359	31	389	
Subtotal Direct Costs	48,707	8,514	12,550	1,081	71,242	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	8,110	0	8,110	
Field Construction Labor Overhead @ 60%	0	0	3,117	0	3,117	
Subcontract Overhead @ 5%	2,435	0	0	0	2,435	
Tax on Materials @ 5%	0	426	0	0	426	
G & A @ 10% (on labor, equip., & matl's.)	0	851	1,255	108	2,215	
Subtotal Direct and Indirect Costs	51,143	9,792	25,031	1,189	87,544	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	2,046	392	1,001	48	3,486	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					18,384	
Adjusted Direct and Indirect Costs	53,189	10,183	26,033	1,237	109,415	
Engineering @ 6 % of total direct and indirect					6,565	
Prime Contractor Fee @ 10% of Total Adjusted Cost					10,941	
Total Costs					126,921	
Contingency @ 10% of Total Cost					12,692	
TOTAL ESTIMATED COST					$139,613	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 2B - Limited Action: On-base soils consolidation
Colts Neck, New Jersey
O & M Analysis
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Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater monitoring	$8,720		collect 10 GW (7 + 3 QC) samples annually, plus travel, living & shipping
2. Reporting	$4,000		50 LOE hours & ODCs for annual reports plus other direct costs
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

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Site 26 Alternative 2: Limited Action (Source Removal, Institutional Controls, Natural Attenuation, and Long-term Monitoring)

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Cost estimating sources:

ECHOS Environmental Restoration, Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.

Means Heavy Construction Cost Data, 9th edition, R.S. Means Company, Inc., 1995.

Means Site Work & Landscape Cost Data, 14th edition, R.S. Means Company, Inc., 1995.

iii. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

iv. Process leach tank of approx. 10 ft W x 10 ft L x 6 ft H, cinder block construction, top of tank approx. 8 in below ground surface.

CAPITAL COST ITEMS:

1. Mobilization/Demobilization Require portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines; connect to Building BG-1), decon. trailer. Will require drinking and decon. water, and sanitary facilities.

2. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

3. Fugitive Dust Control:

Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down .5 acres per day, 20 days per month [18 05 0413].

4. Leach Tank Excavation:

- Excavate 10 ft x10 ft x 1 ft (3.7 CY ~ 4 CY) of soils overlying process leach tank. Stockpile onsite for backfill; which are probably uncontaminated based on RI sampling results.

- Remove standing liquids and sludges from the tank. Approx volume unknown. Assume all up to 100 gallons would be sent to off-site TSDF.

- Excavate process leach tank (approx. exterior dimensions of 6 ft H x 10 ft L x 10 ft W), which is composed of cinder blocks, and lift to surface. Total volume of concrete materials ≈ 4 x 10 ft x 6 ft x 8 in = 160 CF = 6 CY.

- Decon. leach tank rubble: high pressure spray, steam. and surfactant wash 3 times. Collect rinse water for offsite disposal. Total surface area requiring decon. ~ 4 walls x 2 sides x 6 FT H x 10 FT W = 480 SF. Once demolished. assume double surface area ~ 960 SF.

- 3 times steam clean ~ 2880 SF @ 138 SF/HR [33 17 0812] & equip/matls. labor @ 21 HR [33 17 0824]. Total rinse water @ 5GPM @ 21 HR = 6300 gal.

5. Rubble Disposal:

- perform wipe samples to determine action for rubble. Assume 20 wipe samples required, and analyses.

Option A: Send decontaminated demolished leach tank rubble to off-site disposal facility, if contaminants remain in concrete materials.

Option B: Send to Site 4 landfill for consolidation. if wipe samples do not reveal contamination.

6. Contaminated soils disposal:

- Assume soils surrounding and below process leach tank are likely contaminated by TCE and other solvents. Assume that up to 1 foot thick surrounding leach tank, and soils from the bottom of the tank to the water table are TCE-contaminated.

Total assumed cont. soil volume = 12 ft L x 12 ft W x 3 ft D = 432 CF = 16 CY. Probably would remove up to 20 CY total during excavation.

6. Field confirmatory analyses: to verify or confirm that desired PRG levels (concentrations) have been achieved through excavation.

Use 1 sampler @ 10 HR collecting 25 samples, send for VOCs analyses.

7. Backfilling

- Backfill with common fill materials. Assume that material available from on-base sources, only fill handling costs involved.

8. Monitoring wells/piezometers installation

- Install 4 new wells/piezometers downgradient of interpreted plume location. 4 wells @ approx. 25 feet lengths each.
- Used cased drilling techniques, since sandy aquifer difficult to drill with augers. Install 5 ft or 10 ft screens at bottom of well, or where highest VOCs detected. Drilling and monitoring well construction rate of 25 ft/day. Well development of 4 hr/well. Est. 1 week mob/demob driller, drilling, and installation.

- Driller mob/demob @ $2000
- $25/LF drilling, $15/LF well construction
- $15/split spoon sample
- $100/hr well develop, up to 4 hours ea.
- Misc. - decon.spoons, drums, standby, etc. = $ 1000
- Drilling subcon. subtotal = $8900

- 1 geologist oversight for 6 days (inc. prep. & travel) @ 10 hr/day @ $60/hr w/overhead & profit, $125/day M&IE @ 5 days, $600 CDCs/PID, supplies.
- Mgmt coord. 4 hr @ $90/hr = $360
- Oversight subtotal = $5185 ≈ $5200

LONG-TERM O & M ITEMS:

1. Long-term annual groundwater monitoring:

   - Sample 3 existing and 4 new monitoring wells, 3 QC samples. Total 10 samples annually.

   Sampling and analysis for site-specific contaminants: VOCs

   Labor: 1 sampling event/year.

   - GW sampling 2 people @ 10 hr/day @ 2 days (add 6 hr each for prep./mob/demob.) ≈ 52 hr annually.
   - Sampling ≈ 52 hours @ $60/hr (w/overhead & profit) = $ 3120
   - Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
   - Annual: add $300 M&IE; ODCs & supplies @ $200; & shipping @ $200.

   Total ≈ $5420 annually

   Estimated analytical costs:

   - VOCs (EPA Method 624) $324/sample @ 10 samples/yr = $ 3240

   Total = $3240 ≈ $3300

2. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

3. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 26 - Alternative 3A - In-Situ Treatment
Colts Neck, New Jersey
Present Worth Analysis
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YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,637			1637.36
1	0.935		60.06		56.13
2	0.873		60.06		52.46
3	0.816		60.06		49.03
4	0.763		60.06		45.82
5	0.713		60.06	28.5	63.14
6	0.666		53.12		35.40
7	0.623		53.12		33.08
8	0.582		53.12		30.92
9	0.544		53.12		28.89
10	0.508		53.12	28.5	41.49
11	0.475		53.12		25.24
12	0.444		53.12		23.59
13	0.415		53.12		22.04
14	0.388		53.12		20.60
15	0.362		53.12	28.5	29.58
16	0.339		53.12		17.99
17	0.317		53.12		16.82
18	0.296		53.12		15.72
19	0.277		53.12		14.69
20	0.258		53.12	28.5	21.09
21	0.242		53.12		12.83
22	0.226		53.12		11.99
23	0.211		53.12		11.21
24	0.197		53.12		10.47
25	0.184		53.12	28.5	15.04
26	0.172		53.12		9.15
27	0.161		53.12		8.55
28	0.150		53.12		7.99
29	0.141		53.12		7.47
30	0.131		53.12	28.5	10.72
		TOTAL PRESENT WORTH =			$2,386,481

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3A - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3A - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400 00	0 00	0 00	0 00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000 00	0 00	0 00	0 00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000 00	0 00	0 00	0 00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	2	MO	4,000 00	0 00	0 00	0 00	8,000	0	0	0	8,000	Historical data
5) 2 trailers	2	MO	4,000 00	0 00	0 00	0 00	8,000	0	0	0	8,000	
5) 1 Pick-up Truck (rental)	2	MO	500 00	100.00	0 00	0 00	1,000	200	0	0	1,200	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0 00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0 00	0.00	0 11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000 00	500 00	200 00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000 00	0 00	100 00	0 00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	2,000	GAL	0 20	0 00	0 00	0 00	400	0	0	0	400	
3) Clean Water Storage Tank	1	EA	0 00	1,500 00	300 00	0 00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0 00	2,500 00	400 00	0 00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	2	MO	2,500 00	0 00	200 00	0 00	5,000	0	400	0	5,400	Vendor catalog
6) PPE rolloff cont.	2	MO	700 00	0 00	0 00	0 00	1,400	0	0	0	1,400	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	400	HR	0 00	0.00	35 86	0.00	0	0	14,344	0	14,344	
2) Site supervisor/foreman	400	HR	0 00	0.00	30 00	0 00	0	0	12,000	0	12,000	
2) Site safety officer	50	HR	0 00	0.00	25 00	0 00	0	0	1,250	0	1,250	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	40	HR	0.00	0.00	45.00	0.00	0	0	1,800	0	1,800	
2) Project administrator	40	HR	0 00	0 00	30 00	0.00	0	0	1,200	0	1,200	
3) Health and Safety director	5	HR	0 00	0 00	35 00	0 00	0	0	175	0	175	
4) Procurement/subcontracting	100	HR	0 00	0 00	30 00	0.00	0	0	3,000	0	3 000	
4) Clerical support	40	HR	0 00	0.00	12.36	0.00	0	0	494	0	494	
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0 00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	2.0	MO	0 00	0 00	1160.00	1292.80	0	0	2,320	2,586	4,906	[18 05 0413]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3A - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0 00	0 00	1 06	1 24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0 00	0 00	0 51	0 51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0 00	0 00	1 06	1 24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon. area	6	CY	0 00	0 00	0 51	0 51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0 00	0 05	0 24	0 00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec , detergent, water, labor	21	HR	0 00	4 64	20 03	0 22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324 00	0 00	15 00	0 00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1.98	0 00	0 00	0 00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0 00	0.00	1 06	1 24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324 00	0 00	0 00	0 00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0 00	10 00	20 00	0 00	0	100	200	0	300	
OFF-SITE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0 51	0 42	0	0	10	8	18 60	[022 216 4050]
2) Haul to TSDF, 20 CY @ 350 miles	350	miles	3.46	0.00	0 00	0 00	1,211	0	0	0	1211 00	@ 350 miles/trip
3) Offsite disposal charge	20	CY	450 00	0 00	0 00	0 00	9,000	0	0	0	9000 00	[33 19 7265]
BACKFILL TANK AREA												
1) Backfill with on-base fill material	80	CY	0 00	0.00	0.51	0.51	0	0	41	41	82	[022 208 2200]
2) Compact materials, 6" lifts	80	CY	0 00	0 00	0 21	0 42	0	0	17	34	50	[022 226 5600]
TREATABILITY STUDY												
1) sample collection	20	HR	0.00	25.00	20.00	0 00	0	500	400	0	900	
2) reactive wall treat study	1	EA	25,000 00	0.00	0.00	0.00	25,000	0	0	0	25,000	Vendor quote
PRE-DESIGN INVESTIGATION												
1) Aquifer test and characterization	1	LS	40,000.00	0.00	0.00	0.00	40,000	0	0	0	40,000	
GROUNDWATER MODELING												
1) Vendor technical adviser	1	LS	20,000.00	0.00	0.00	0.00	20,000	0	0	0	20,000	Vendor quote
2) Groundwater modeler	180	HR	0 00	0 00	30 00	0 00	0	0	5,400	0	5,400	
3) Computer usage	140	HR	0 00	0 00	0 00	10 00	0	0	0	1,400	1 400	
4) Modeling ODCs	1	LS	0 00	1,000 00	0 00	10 00	0	1,000	0	10	1 010	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3A - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COST\26-ALT3A.WK 13 NOV 96

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
REACTIVE WALL CONSTRUCTION												
1) Specialty construction contractor mob/demob	1	LS	20,000 00	0 00	0 00	0 00	20,000	0	0	0	20,000	
2) Slurry wall and reactive wall construction	1	LS	450,000 00	0 00	0 00	0 00	450,000	0	0	0	450,000	
3) Reactive metal [~ 70 CY]	1	LS	100,000 00	0 00	0 00	0 00	100,000	0	0	0	100,000	
4) pea gravel [inc. delivery]	89	CY	0 00	21 00	0 00	0 00	0	1,869	0	0	1,869	[029 516 1600]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Drilling	225	LF	25.00	0.00	0 00	0 00	5,625	0	0	0	5,625	Historical data
3) Split barrel sampling	45	EA	15 00	0 00	0 00	0 00	675	0	0	0	675	Historical data
4) Well installation (9 wells/piezometers)	225	LF	15 00	0 00	0 00	0 00	3,375	0	0	0	3,375	Historical data
5) Well development	36	HR	100 00	0 00	0 00	0 00	3,600	0	0	0	3,600	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	3,000 00	0 00	0 00	0 00	3,000	0	0	0	3,000	Historical data
6) Oversight (1 geologist)	120	HR	0 00	0.00	20 00	0 00	0	0	2,400	0	2,400	
8) Mgmt coord	10	HR	0 00	0 00	35 00	0 00	0	0	350	0	350	
7) Oversight ODCs, M&IE	1	LS	0 00	2,250 00	0 00	0 00	0	2,250	0	0	2,250	
SHAKEDOWN PERIOD ACTIVITIES												
1) Weekly water level & chemical analyses	320	HR	0 00	0.00	20.00	0 00	0	0	6,400	0	6,400	
2) Vendor consulting services	4	EA	2,000 00	0.00	0.00	0.00	8,000	0	0	0	8,000	
TECHNOLOGY LICENSE FEE												
1) 15% of reactive wall construction costs	1	LS	91,431.60	0.00	0.00	0.00	91,432	0	0	0	91,432	Vendor quote

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3A - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
Page 3 Total	844,572	13,658	55,090	4,401	917,721	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	2,754	220	2,975	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	1,653	132	1,785	
Subtotal Direct Costs	844,572	13,658	57,844	4,621	922,480	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	41,116	0	41,116	
Field Construction Labor Overhead @ 60%	0	0	12,496	0	12,496	
Subcontract Overhead @ 5%	42,229	0	0	0	42,229	
Tax on Materials @ 5%	0	683	0	0	683	
G & A @ 10% (on labor, equip., & matl's.)	0	1,366	5,784	462	7,612	
Subtotal Direct and Indirect Costs	886,800	15,707	117,241	5,083	1,026,616	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	35,472	628	4,690	203	40,993	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					215,589	
Adjusted Direct and Indirect Costs	922,272	16,335	121,930	5,286	1,283,199	
Engineering @ 6 % of total direct and indirect					76,992	
Prime Contractor Fee @ 10% of Total Adjusted Cost					128,320	
Total Costs					1,488,510	
Contingency @ 10% of Total Cost					148,851	
TOTAL ESTIMATED COST					$1,637,361	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 3 - In-Situ Treatment
Colts Neck, New Jersey
O & M Analysis
[C:\CLEAN\CTO279\DFFS\COST\OM26-3.WK4] 14 NOV 96

Applies to both Alternatives 3A and 3B

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater monitoring (years 1 - 5)	$15,260		Sample 15 wells & 5 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs.
2. Groundwater monitoring (years 6 - 30)	$8,320		Sample 6 wells & 3 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs.
3. Process monitoring	$40,800		Monthly water levels. GC screen of groundwater to evaluate VOCs degrad. rate.
3. Reporting	$4,000		50 LOE hours & ODCs for annual reports plus other direct costs
4. Mix reactive wall medium		$13,025	1 rig & crew for 1 week & oversight
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

NWS Earle Site FS
Site 26 - Alternative 3B - In-Situ Treatment
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW26-3B.WK4] 14 NOV 96

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,620			1620.27
1	0.935		60.06		56.13
2	0.873		60.06		52.46
3	0.816		60.06		49.03
4	0.763		60.06		45.82
5	0.713		60.06	28.5	63.14
6	0.666		53.12		35.40
7	0.623		53.12		33.08
8	0.582		53.12		30.92
9	0.544		53.12		28.89
10	0.508		53.12	28.5	41.49
11	0.475		53.12		25.24
12	0.444		53.12		23.59
13	0.415		53.12		22.04
14	0.388		53.12		20.60
15	0.362		53.12	28.5	29.58
16	0.339		53.12		17.99
17	0.317		53.12		16.82
18	0.296		53.12		15.72
19	0.277		53.12		14.69
20	0.258		53.12	28.5	21.09
21	0.242		53.12		12.83
22	0.226		53.12		11.99
23	0.211		53.12		11.21
24	0.197		53.12		10.47
25	0.184		53.12	28.5	15.04
26	0.172		53.12		9.15
27	0.161		53.12		8.55
28	0.150		53.12		7.99
29	0.141		53.12		7.47
30	0.131		53.12	28.5	10.72
		TOTAL PRESENT WORTH =			$2,369,391

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3B - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3B - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip	Total Cost ($) Sub.	Mat.	Labor	Equip	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400 00	0 00	0 00	0 00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000.00	0 00	0 00	0 00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000 00	0 00	0 00	0 00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	2	MO	4,000 00	0 00	0 00	0 00	8,000	0	0	0	8,000	Historical data
5) 2 trailers	2	MO	4,000 00	0 00	0 00	0 00	8,000	0	0	0	8,000	
5) 1 Pick-up Truck (rental)	2	MO	500 00	100 00	0 00	0 00	1,000	200	0	0	1,200	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0 00	0 00	0 70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0 00	0 00	0 11	0 36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0 00	1,000 00	500 00	200 00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000 00	0 00	100 00	0 00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	2,000	GAL	0 20	0 00	0 00	0 00	400	0	0	0	400	
3) Clean Water Storage Tank	1	EA	0 00	1,500 00	300 00	0 00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0 00	2,500 00	400 00	0 00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	2	MO	2,500 00	0 00	200 00	0 00	5,000	0	400	0	5,400	Vendor catalog
6) PPE rolloff cont.	2	MO	700 00	0 00	0 00	0 00	1,400	0	0	0	1,400	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	400	HR	0.00	0.00	35.86	0.00	0	0	14,344	0	14,344	
2) Site supervisor/foreman	400	HR	0 00	0 00	30.00	0 00	0	0	12,000	0	12,000	
2) Site safety officer	50	HR	0 00	0.00	25 00	0 00	0	0	1,250	0	1,250	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	40	HR	0.00	0.00	45 00	0.00	0	0	1,800	0	1,800	
2) Project administrator	40	HR	0 00	0 00	30 00	0 00	0	0	1,200	0	1,200	
3) Health and Safety director	5	HR	0 00	0 00	35 00	0 00	0	0	175	0	175	
4) Procurement/subcontracting	100	HR	0 00	0 00	30 00	0 00	0	0	3,000	0	3,000	
4) Clerical support	40	HR	0 00	0 00	12 36	0 00	0	0	494	0	494	
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0 00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	2.0	MO	0 00	0 00	1160 00	1292.80	0	0	2,320	2,586	4,906	[18 05 0413]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3B - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0.00	0.51	0.51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0.00	0.00	1.06	1.24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon area	6	CY	0.00	0.00	0.51	0.51	0	0	3	3	6	[022 208 2200]
4) Decon rubble [3 steam cleaning rinses]	2,880	SF	0.00	0.05	0.24	0.00	0	143	677	0	819	[11 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0.00	4.64	20.03	0.22	0	97	416	5	520	[13 17 0824]
5) Wipe samples	20	EA	324.00	0.00	15.00	0.00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon rinse water disposal	6,300	GAL	1.98	0.00	0.00	0.00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324.00	0.00	0.00	0.00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0.00	10.00	20.00	0.00	0	100	200	0	300	
ON-BASE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0.42	0	0	10	8	18.60	[022 216 4050]
2) Haul to Site 4, 20 CY @ 1 miles	1	miles	3.46	0.00	0.00	0.00	3	0	0	0	3.46	
BACKFILL TANK AREA												
1) Backfill with on-base fill material	80	CY	0.00	0.00	0.51	0.51	0	0	41	41	82	[022 208 2200]
2) Compact materials, 6" lifts	80	CY	0.00	0.00	0.21	0.42	0	0	17	34	50	[022 226 5600]
TREATABILITY STUDY												
1) sample collection	20	HR	0.00	25.00	20.00	0.00	0	500	400	0	900	
2) reactive wall treat study	1	EA	25,000.00	0.00	0.00	0.00	25,000	0	0	0	25,000	Vendor quote
PRE-DESIGN INVESTIGATION												
1) Aquifer test and characterization	1	LS	40,000.00	0.00	0.00	0.00	40,000	0	0	0	40,000	
GROUNDWATER MODELING												
1) Vendor technical adviser	1	LS	20,000.00	0.00	0.00	0.00	20,000	0	0	0	20,000	Vendor quote
2) Groundwater modeler	180	HR	0.00	0.00	30.00	0.00	0	0	5,400	0	5,400	
3) Computer usage	140	HR	0.00	0.00	0.00	10.00	0	0	0	1,400	1,400	
4) Modeling ODCs	1	LS	0.00	1,000.00	0.00	10.00	0	1,000	0	10	1,010	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3B - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
REACTIVE WALL CONSTRUCTION												
1) Specialty construction contractor mob/demob	1	LS	20,000 00	0 00	0 00	0 00	20,000	0	0	0	20,000	
2) Slurry wall and reactive wall construction	1	LS	450,000 00	0 00	0 00	0 00	450,000	0	0	0	450,000	
3) Reactive metal [~ 70 CY]	1	LS	100,000 00	0 00	0 00	0 00	100,000	0	0	0	100,000	
4) pea gravel [inc. delivery]	89	CY	0 00	21 00	0 00	0 00	0	1,869	0	0	1,869	[029 516 1600]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Drilling	225	LF	25 00	0.00	0 00	0.00	5,625	0	0	0	5,625	Historical data
3) Split barrel sampling	45	EA	15 00	0 00	0 00	0 00	675	0	0	0	675	Historical data
4) Well installation (9 wells/piezometers)	225	LF	15 00	0 00	0 00	0 00	3,375	0	0	0	3,375	Historical data
5) Well development	36	HR	100 00	0 00	0 00	0 00	3,600	0	0	0	3,600	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	3,000 00	0 00	0 00	0 00	3,000	0	0	0	3,000	Historical data
6) Oversight (1 geologist)	120	HR	0 00	0 00	20 00	0 00	0	0	2,400	0	2,400	
8) Mgmt coord	10	HR	0 00	0 00	35 00	0 00	0	0	350	0	350	
7) Oversight ODCs, M&IE	1	LS	0 00	2,250 00	0 00	0 00	0	2,250	0	0	2,250	
SHAKEDOWN PERIOD ACTIVITIES												
1) Weekly water level & chemical analyses	320	HR	0.00	0.00	20.00	0.00	0	0	6,400	0	6,400	
2) Vendor consulting services	4	EA	2,000 00	0 00	0.00	0.00	8,000	0	0	0	8,000	
TECHNOLOGY LICENSE FEE												
1) 15% of reactive wall construction costs	1	LS	91,431.60	0.00	0.00	0.00	91,432	0	0	0	91,432	Vendor quote

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 3B - IN-SITU TREATMENT (IN-SITU GROUNDWATER TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
Page 3 Total	834,364	13,658	55,090	4,401	907,513	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	2,754	220	2,975	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	1,653	132	1,785	
Subtotal Direct Costs	834,364	13,658	57,844	4,621	912,273	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	41,116	0	41,116	
Field Construction Labor Overhead @ 60%	0	0	12,496	0	12,496	
Subcontract Overhead @ 5%	41,718	0	0	0	41,718	
Tax on Materials @ 5%	0	683	0	0	683	
G & A @ 10% (on labor, equip., & matl's.)	0	1,366	5,784	462	7,612	
Subtotal Direct and Indirect Costs	876,082	15,707	117,241	5,083	1,015,898	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	35,043	628	4,690	203	40,565	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					213,339	
Adjusted Direct and Indirect Costs	911,126	16,335	121,930	5,286	1,269,801	
Engineering @ 6 % of total direct and indirect					76,188	
Prime Contractor Fee @ 10% of Total Adjusted Cost					126,980	
Total Costs					1,472,969	
Contingency @ 10% of Total Cost					147,297	
TOTAL ESTIMATED COST					$1,620,266	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book, 1995, ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 3 - In-Situ Treatment
Colts Neck, New Jersey
O & M Analysis
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Applies to both Alternatives 3A and 3B

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Groundwater monitoring (years 1 - 5)	$15,260		Sample 15 wells & 5 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs.
2. Groundwater monitoring (years 6 - 30)	$8,320		Sample 6 wells & 3 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs.
3. Process monitoring	$40,800		Monthly water levels, GC screen of groundwater to evaluate VOCs degrad. rate.
3. Reporting	$4,000		50 LOE hours & ODCs for annual reports plus other direct costs
4. Mix reactive wall medium		$13,025	1 rig & crew for 1 week & oversight
3. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

Brown & Root Environmental		Calculation Sheet
Client: Navy CLEAN File No.	By: LC	Page [illegible]
Subject: Site 26, Alt. 3 - Assumptions and Cost Basis. NWS Earle FS. CTO 279	Checked by: MJW 7/31/97	Date: 13 Nov 96

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Site 26 Alternative 3: In-Situ Treatment (Source Removal, In-Situ Groundwater Treatment: Institutional Controls, and Long-term Monitoring)

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Cost estimating sources:

ECHOS Environmental Restoration. Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.

Means Heavy Construction Cost Data, 9th edition. R.S. Means Company, Inc., 1995.

Means Site Work & Landscape Cost Data, 14th edition. R.S. Means Company, Inc., 1995.

iii. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

iv. Process leach tank of approx. 10 ft W x 10 ft L x 6 ft H, cinder block construction, top of tank approx. 8 in below ground surface.

v. Permeable reactive wall selected as representative in-situ treatment technology. If in-situ treatment is selected as an interim or final remedy, then treatability studies will be required to assess the effectiveness of the candidate process options (in-situ biodegradation, in-situ chemical degradation), and to evaluate operating parameters.

vi. Discussions with Enviromental Technologies, Inc. of Guelph, Ontario, Canada. ETI is listed in the EPA VISITT 5.0 database.

vii. All sizing of components are conceptual for the purpose of the Feasibility Study, only. Actual sizes of reactive wall, slurry wall or sheet pile walls are to be determined based on results of pre-design investigation, groundwater modeling, and treatability studies.

CAPITAL COST ITEMS:

1. Mobilization/Demobilization Require portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines; connect to Building GB-1), office trailer. Will require drinking and decon. water, and sanitary facilities.

2. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

3. Fugitive Dust Control:

Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down .5 acres per day, 20 days per month [18 05 0413].

4. Leach Tank Excavation:

- Excavate 10 ft x 10 ft x 1 ft (3.7 CY ~ 4 CY) of soils overlying process leach tank. Stockpile onsite for backfill: which are probably uncontaminated based on RI sampling results.

- Remove standing liquids and sludges from the tank. Approx volume unknown. Assume all up to 100 gallons would be sent to off-site TSDF.

- Excavate process leach tank (approx. exterior dimensions of 6 ft H x 10 ft L x 10 ft W), which is composed of cinder blocks, and lift to surface. Total volume of concrete materials ≈ 4 walls x 10 ft x 6 ft x 8 in = 160 CF = 6 CY.

- Decon. leach tank rubble: high pressure spray, steam, and surfactant wash 3 times. Collect rinse water for offsite disposal. Total surface area requiring decon. ~ 4 walls x 2 sides x 6 FT H x 10 FT W = 480 SF. Once demolished, assume double surface area ~ 960 SF.

- 3 times steam clean ~ 2880 SF @ 138 SF/HR [33 17 0812] & equip/matls, labor @ 21 HR [33 17 0824]. Total rinse water @ 5GPM @ 21 HR = 6300 gal.

5. Rubble Disposal:

- perform wipe samples to determine action for rubble. Assume 20 wipe samples required, and analyses.

Option A: Send decontaminated demolished leach tank rubble to off-site disposal facility, if contaminants remain in concrete materials.

Option B: Send to Site 4 landfill for consolidation, if wipe samples do not reveal contamination.

6. Contaminated soils disposal:

- Assume soils surrounding and below process leach tank are likely contaminated by TCE and other solvents. Assume that up to 1 foot thick surrounding leach tank, and soils from the bottom of the tank to the water table are TCE-contaminated.

Total assumed cont. soil volume = 12 ft L x 12 ft W x 3 ft D = 432 CF = 16 CY. Probably would remove up to 20 CY total during excavation.

7. Field confirmatory analyses: to verify or confirm that desired PRG levels (concentrations) have been achieved through excavation.

Use 1 sampler @ 10 HR collecting 25 samples, send for VOCs analyses.

8. Backfilling of Process Leach Tank Area

- Backfill with common fill materials. Assume that material available from on-base sources, only fill handling costs involved. Estimated void volume ~ 12 FT x 12 FT x 15 FT = 2160 CF = 80 CY

9. Treatability Studies

- To prepare 1 bench-scale treatability study, need to collect ground water samples and ship to vendor. Assume 1 treatability study required. $25000 each. Sampling 2 people @ 10 HR @ $20/HR w/0 O&P + $500 ODCs. shipping.

- If multiple treat. studies need to be performed to assess different treatment technologies, then total cost of bench-scale will increase accordingly.

10. Pre-Design Investigation

- Will require hydrogeologic evaluation, and sampling and analysis of groundwater and aquifer materials. Assume $40000 to perform field tests, sampling, data reduction, and interpret results.

11. Groundwater modeling

- Obtain consulting engineer to assist in design of impermeable and reactive walls @ $ 20000
- Perform computer modeling for 20 days. 1 modeler @ $30/HR @ 9 HR/day @ 20 days, & computer usage of $10/HR @ 7 HR/day @ 20 days, & $1000 ODCs for report prep.

12. Reactive wall construction

Actual design and configuration of slurry wall and reactive wall dependent on results of treatability study, hydrogeologic investigation, computer modeling, and engineering design. For FS purposes, will estimate order of magnitude construction costs developed by vendor for an actual full-scale construction in Kansas.

Reactive wall location will be near leading edge of TCE plume. Excavation spoils are therefore unlikely to be heavily contaminated. Excavated soils from the trench can be stockpiled and used for backfilling the process leach tank excavation.

- Specialty construction team mobilization: assume at ~ $20000
- Assume installation of 1000 LF of slurry wall @ 2 FT W x 25 FT H.
- Assume excavation of trench of 40 FT L x 4 FT W x 25 FT D.
- may need to dewater at 10 feet below ground surface.
- Rough estimated construction costs of $450000

13. Reactive wall materials

- Iron filings: assume reactive wall size 40 FT L x 3 FT deep x 15 FT H = 1800 CF = 67 CY. Estimated cost to purchase = $100,000, based on data provided by technology vendor.

- Pea gravel: Assume 40 ft L x 4 ft deep x 15 ft H = 2400 CF = 89 CY

14. Monitoring wells/piezometers installation

- Install 9 new groundwater and process monitoring wells/piezometers within and downgradient of interpreted plume location. 9 wells @ approx. 25 feet lengths each.
- Used cased drilling techniques, since sandy aquifer difficult to drill with augers. Install 5 ft or 10 ft screens at bottom of well, or where highest VOCs detected. Drilling and monitoring well construction rate of 25 ft/day. Well development of 4 hr/well. Est. 1 week mob/demob driller, drilling, and installation.

- Driller mob/demob @ $2000
- $25/LF drilling, $15/LF well construction
- $15/split spoon sample
- $100/hr well develop. up to 4 hours ea.
- Misc. - decon.spoons, drums, standby, etc. = $ 3000

- 1 geologist oversight for 12 days (inc. prep. & travel) @ 10 hr/day @ $60/hr w/overhead & profit, $125/day M&IE @ 10 days, $1000 ODCs/PID, supplies.
- Mgmt coord. 10 hr @ $90/hr
- Oversight subtotal = $5185 ≈ $5200

- 6 compliance monitoring wells and 3 process monitoring wells would be incorporated into reactive wall during construction.

15. Shakedown Period Activities:

- Assume for 4 months period after reactive wall installation, will monitor groundwater and water levels weekly to assess progress and effectiveness. Will require water levels measurement, sampling of groundwater for field screening of VOCs and metals analysis, record field data, prepare reports. Assume 2 samplers @ 10 HR @ $20/HR w/o O&P, & ODCs &500. Assume vendor representative would need to review results, provide interpretation @ $2000 per month.

16. License Fee:

- To use technology, will need to pay 15% of construction costs as part of licensing of technology for use.

LONG-TERM O & M ITEMS:

1. Long-term annual groundwater monitoring:

I. For years 1 - 5 only.

- Sample 15 monitoring wells. 5 QC samples for compliance monitoring. Total 20 samples annually. Sampling and analysis for site-specific contaminants: VOCs

Labor: 1 sampling event/year.

- GW sampling 2 people @ 10 hr/day @ 4 days (add 8 hr each for prep./mob/demob.) ≈ 96 hr annually.
- Sampling ≈ 96 hours @ $60/hr (w/overhead & profit) = $ 5760
- Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
- Annual: add $600 M&IE; ODCs & supplies @ $400; & shipping @ $400.

Total ≈ $8760 annually

Estimated analytical costs:

- VOCs (EPA Method 624) $324/sample @ 20 samples/yr = $ 6480 ≈ $6500

ii. For years 6 - 30 only.

- Sample 6 monitoring wells. 3 QC samples for compliance monitoring. Total 9 samples annually. Sampling and analysis for site-specific contaminants: VOCs

Labor: 1 sampling event/year.

- GW sampling 2 people @ 10 hr/day @ 2 days (add 8 hr each for prep./mob/demob.) ≈ 52 hr annually.
- Sampling ≈ 52 hours @ $60/hr (w/overhead & profit) = $ 3120
- Proj. mgmt/coord. ≈ 20 hours/year @ $80/hr (w/O&P) = $1600
- Annual: add $300 M&IE: ODCs & supplies @ $200; & shipping @ $200.

Total ≈ $5420 annually

Estimated analytical costs:

- VOCs (EPA Method 624) $324/sample @ 9 samples/yr = $ 2916 ≈ $2900

2. Process monitoring

Perform monthly water level measurements and field GC screening of groundwater samples obtained from 9 process monitoring wells (embedded in reactive wall). Also measure pH, DO, temp., etc. Would require 2 people @ 10 HR @ 2 days @ $60/HR, $400 M&IE, & $600 ODCs/supplies (GC, comb. meter, etc.).

- cost ~ $3400/month or $40800/year

3. Reporting of results: data review and report prep. @ 50 hr/yr @ $70 = $3500, add $500 ODCs. Total = $4000

4. Per recommendations of vendor, the permeable metal wall matrix should be mechanically agitated to disrupt precipitate bridging that may form, and is likely to be require once every 5 to 10 years. Assume 1 week field crew time with auger drill rig would be adequate to agitate the reactive metals medium. Worst case scenario: need to replace the reactive wall.

- Drill rig mob. @ $400
- Drill rig rate @ $1425/day @ 5 days
- Misc. drilling items: $1000
- Geologist oversight: 50 HR @ $60/HR + $ 500 ODCs
- Vendor consultant @ $1000

- Subtotal = $13025

5. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event

NWS Earle Site FS
Site 26 - Alternative 4A - Ex-Situ Treatment
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW26-4v3.WK4] 26 JUN 97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	712			712.00
1	0.935		215.74		201.63
2	0.873		215.74		188.44
3	0.816		185.30		151.26
4	0.763		185.30		141.36
5	0.713		185.30	15.5	143.17
6	0.666		185.30		123.47
7	0.623		185.30		115.40
8	0.582		185.30		107.85
9	0.544		185.30		100.79
10	0.508		185.30	15.5	102.08
11	0.475		185.30		88.03
12	0.444		185.30		82.28
13	0.415		185.30		76.89
14	0.388		185.30		71.86
15	0.362		185.30	15.5	72.78
16	0.339		185.30		62.77
17	0.317		185.30		58.66
18	0.296		185.30		54.82
19	0.277		185.30		51.24
20	0.258		185.30	15.5	51.89
21	0.242		185.30		44.75
22	0.226		185.30		41.82
23	0.211		185.30		39.09
24	0.197		185.30		36.53
25	0.184		185.30	15.5	37.00
26	0.172		185.30		31.91
27	0.161		185.30		29.82
28	0.150		185.30		27.87
29	0.141		185.30		26.05
30	0.131		185.30	15.5	26.38
		TOTAL PRESENT WORTH =			$3,100,078

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4A - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	1	MO	4,000.00	0.00	0.00	0.00	4,000	0	0	0	4,000	Historical data
5) 2 trailers	1	MO	4,000.00	0.00	0.00	0.00	4,000	0	0	0	4,000	
5) 1 Pick-up Truck (rental)	1	MO	500.00	100.00	0.00	0.00	500	100	0	0	600	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	1	MO	1,000.00	0.00	100.00	0.00	1,000	0	100	0	1,100	Historical data
2) Decon Water (1000 gal/mon)	1,000	GAL	0.20	0.00	0.00	0.00	200	0	0	0	200	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	1	MO	2,500.00	0.00	200.00	0.00	2,500	0	200	0	2,700	Vendor catalog
6) PPE rolloff cont.	1	MO	700.00	0.00	0.00	0.00	700	0	0	0	700	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	200	HR	0.00	0.00	35.86	0.00	0	0	7,172	0	7,172	
2) Site supervisor/foreman	200	HR	0.00	0.00	30.00	0.00	0	0	6,000	0	6,000	
2) Site safety officer	25	HR	0.00	0.00	25.00	0.00	0	0	625	0	625	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	20	HR	0.00	0.00	45.00	0.00	0	0	900	0	900	
2) Project administrator	20	HR	0.00	0.00	30.00	0.00	0	0	600	0	600	
3) Health and Safety director	5	HR	0.00	0.00	35.00	0.00	0	0	175	0	175	
4) Procurement/subcontracting	80	HR	0.00	0.00	30.00	0.00	0	0	2,400	0	2,400	
4) Clerical support	40	HR	0.00	0.00	12.36	0.00	0	0	494	0	494	
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	1	MO	0.00	0.00	1160.00	1292.80	0	0	1,160	1,293	2,453	118 05 04

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4A - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0.00	0.51	0.51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0.00	0.00	1.06	1.24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon. area	6	CY	0.00	0.00	0.51	0.51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0.00	0.05	0.24	0.00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0.00	4.64	20.03	0.22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324.00	0.00	15.00	0.00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1.98	0.00	0.00	0.00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324.00	0.00	0.00	0.00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0.00	10.00	20.00	0.00	0	100	200	0	300	
OFF-SITE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0.42	0	0	10	8	18.60	[022 216 4050]
2) Haul to TSDF, 20 CY @ 350 miles	350	miles	3.46	0.00	0.00	0.00	1,211	0	0	0	1211.00	@ 350 miles/tri
3) Offsite disposal charge	20	CY	450.00	0.00	0.00	0.00	9,000	0	0	0	9000.00	[33 19 7265]
BACKFILL TANK AREA												
1) Backfill with on-base fill material	80	CY	0.00	0.00	0.51	0.51	0	0	41	41	82	[022 208 2200]
2) Compact materials, 6" lifts	80	CY	0.00	0.00	0.21	0.42	0	0	17	34	50	[022 226 5600]
TREATABILITY STUDY (if needed)												
1) sample collection	20	HR	0.00	25.00	20.00	0.00	0	500	400	0	900	
2) air stripper and carbon adsorption treat. studies	1	EA	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	Vendor data
PRE-DESIGN INVESTIGATION												
1) Aquifer test and characterization	1	LS	40,000.00	0.00	0.00	0.00	40,000	0	0	0	40,000	
TREATMENT SYSTEM												
1) Clear and grade area	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
2) Place concrete pad [25 ft x 35 ft x 8"]	22	CY	0.00	8.01	3.90	12.00	0	173	84	259	516	[033 172 4650
3) pre-engineered bldg for treat. syst. [20 ft x 30 ft]	600	SF	0.00	54.00	0.00	0.00	0	32,400	0	0	32,400	[33 43 0101]
4) Connect utilities [elec. hookups]	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
5) 1000 gal poly equal. tank	1	EA	0.00	800.00	0.00	0.00	0	800	0	0	800	
6) Hardness removal - ion exchange tanks	1	EA	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	
7) Low profile air stripper	1	EA	15,000.00	0.00	1,000.00	0.00	15,000	0	1,000	0	16,000	Vendor data
8) Blower starter, controls, and panel	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	Vendor data
9) Piping, valves, connectors	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	
10) Lighting	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4A - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
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			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
TREATMENT SYSTEM (cont.)												
11) Vapor phase carbon [400 lb units]	6	EA	2,987.00	0.00	0.00	0.00	17,922	0	0	0	17,922	[33 13 1908]
12) Liquid phase carbon [1050 lb unit]	6	EA	4,168.00	0.00	0.00	0.00	25,008	0	0	0	25,008	[33 13 2011]
EXTRACTION WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Drilling [10" dia borehole]	350	LF	51.00	0.00	0.00	0.00	17,850	0	0	0	17,850	[33 23 1133]
3) Split barrel sampling	70	EA	15.00	0.00	0.00	0.00	1,050	0	0	0	1,050	Historical data
4) Well casing [4" ID]	280	LF	13.58	0.00	0.00	0.00	3,802	0	0	0	3,802	[33 23 0115]
5)Well screens [4" ID PVC]	70	LF	15.93	0.00	0.00	0.00	1,115	0	0	0	1,115	[33 23 0212]
6) Filter pack	140	LF	24.47	0.00	0.00	0.00	3,426	0	0	0	3,426	[33 23 1403]
7) Annular seals	280	LF	25.00	0.00	0.00	0.00	7,000	0	0	0	7,000	[33 23 1803]
5) Well development	56	HR	100.00	0.00	0.00	0.00	5,600	0	0	0	5,600	
6) Misc., decon., setups, security casings, etc.	1	LS	8,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
7) Pumps (14 & 1 standby)	15	EA	0.00	650.00	300.00	0.00	0	9,750	4,500	0	14,250	
8) Piping & connections to treatment system	1	LS	8,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
INFILTRATION GALLERY												
1) Excavate trench [1000 FT L x 2 FT D x 2 FT W	148	CY	0.00	3.75	2.38	1.37	0	555	352	203	1,110	[022 254 0050]
2) Backfill with soil	148	CY	0.00	0.00	0.61	0.61	0	0	90	90	181	[022 208 2000]
3) Excavate area 100 ft x 100 ft x 4 ft D	1,482	CY	0.00	0.00	0.61	0.61	0	0	904	904	1,808	[022 242 2000]
4) Place 2 ft of gravel	741	CY	0.00	11.68	1.72	1.56	0	8,655	1,275	1,156	11,085	[17 03 0430]
5) Install 4 in. dia perf. PCV pipe	2,200	LF	0.00	0.70	1.41	0.00	0	1,540	3,102	0	4,642	[027 168 2000]
6) Backfill with soil	741	CY	0.00	0.00	0.61	0.61	0	0	452	452	904	[022 208 2000]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob [included in above]	0	LS	2,000.00	0.00	0.00	0.00	0	0	0	0	0	Historical data
2) Drilling	100	LF	25.00	0.00	0.00	0.00	2,500	0	0	0	2,500	Historical data
3) Split barrel sampling	20	EA	15.00	0.00	0.00	0.00	300	0	0	0	300	Historical data
4) Well installation (4 wells/piezometers)	100	LF	15.00	0.00	0.00	0.00	1,500	0	0	0	1,500	Historical data
5) Well development	16	HR	100.00	0.00	0.00	0.00	1,600	0	0	0	1,600	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	Historical data
6) Oversight (1 geologist)	60	HR	0.00	0.00	20.00	0.00	0	0	1,200	0	1,200	
8) Mgmt coord.	10	HR	0.00	0.00	35.00	0.00	0	0	350	0	350	
7) Oversight ODCs, M&IE	1	LS	0.00	2,250.00	0.00	0.00	0	2,250	0	0	2,250	
SHAKEDOWN PERIOD ACTIVITIES												
1) Weekly water level & chemical analyses	320	HR	0.00	0.00	20.00	0.00	0	0	6,400	0	6,400	
2) ODCs	1	EA	0.00	2,000.00	0.00	0.00	0	2,000	0	0	2,000	
PERMIT EQUIVALENCY												
1) waiver permit/CEA processing	1	EA	15,000.00	0.00	0.00	0.00	15,000	0	0	0	15,000	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4A - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
Page 3 Total	263,638	66,562	42,892	4,762	377,855	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	2,145	238	2,383	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	1,287	143	1,430	
Subtotal Direct Costs	263,638	66,562	45,037	5,000	381,667	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	22,040	0	22,040	
Field Construction Labor Overhead @ 60%	0	0	14,715	0	14,715	
Subcontract Overhead @ 5%	13,182	0	0	0	13,182	
Tax on Materials @ 5%	0	3,328	0	0	3,328	
G & A @ 10% (on labor, equip., & matl's.)	0	6,656	4,504	500	11,660	
Subtotal Direct and Indirect Costs	276,820	76,547	86,296	5,500	446,592	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	11,073	3,062	3,452	220	17,807	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					93,784	
Adjusted Direct and Indirect Costs	287,893	79,608	89,747	5,721	558,183	
Engineering @ 6 % of total direct and indirect					33,491	
Prime Contractor Fee @ 10% of Total Adjusted Cost					55,818	
Total Costs					647,493	
Contingency @ 10% of Total Cost					64,749	
TOTAL ESTIMATED COST					$712,242	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 4B - Ex-Situ Treatment
Colts Neck, New Jersey
Present Worth Analysis
[C:\CLEAN\CTO279\DFFS\COST\PW26-4v3.WK4] 26 JUN 97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	695			695.15
1	0.935		214.94		200.88
2	0.873		214.94		187.74
3	0.816		184.50		150.61
4	0.763		184.50		140.75
5	0.713		184.50	15.5	142.60
6	0.666		184.50		122.94
7	0.623		184.50		114.90
8	0.582		184.50		107.38
9	0.544		184.50		100.36
10	0.508		184.50	15.5	101.67
11	0.475		184.50		87.65
12	0.444		184.50		81.92
13	0.415		184.50		76.56
14	0.388		184.50		71.55
15	0.362		184.50	15.5	72.49
16	0.339		184.50		62.50
17	0.317		184.50		58.41
18	0.296		184.50		54.59
19	0.277		184.50		51.02
20	0.258		184.50	15.5	51.68
21	0.242		184.50		44.56
22	0.226		184.50		41.64
23	0.211		184.50		38.92
24	0.197		184.50		36.37
25	0.184		184.50	15.5	36.85
26	0.172		184.50		31.77
27	0.161		184.50		29.69
28	0.150		184.50		27.75
29	0.141		184.50		25.93
30	0.131		184.50	15.5	26.27
		TOTAL PRESENT WORTH =			$3,073,097

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4B - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
4) Site Utilities	1	MO	4,000.00	0.00	0.00	0.00	4,000	0	0	0	4,000	Historical data
5) 2 trailers	1	MO	4,000.00	0.00	0.00	0.00	4,000	0	0	0	4,000	
5) 1 Pick-up Truck (rental)	1	MO	500.00	100.00	0.00	0.00	500	100	0	0	600	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	1	MO	1,000.00	0.00	100.00	0.00	1,000	0	100	0	1,100	Historical data
2) Decon Water (1000 gal/mon)	1,000	GAL	0.20	0.00	0.00	0.00	200	0	0	0	200	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	1	MO	2,500.00	0.00	200.00	0.00	2,500	0	200	0	2,700	Vendor catalog
6) PPE rolloff cont.	1	MO	700.00	0.00	0.00	0.00	700	0	0	0	700	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	200	HR	0.00	0.00	35.86	0.00	0	0	7,172	0	7,172	
2) Site supervisor/foreman	200	HR	0.00	0.00	30.00	0.00	0	0	6,000	0	6,000	
2) Site safety officer	25	HR	0.00	0.00	25.00	0.00	0	0	625	0	625	
HOME OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	20	HR	0.00	0.00	45.00	0.00	0	0	900	0	900	
2) Project administrator	20	HR	0.00	0.00	30.00	0.00	0	0	600	0	600	
3) Health and Safety director	5	HR	0.00	0.00	35.00	0.00	0	0	175	0	175	
4) Procurement/subcontracting	80	HR	0.00	0.00	30.00	0.00	0	0	2,400	0	2,400	
4) Clerical support	40	HR	0.00	0.00	12.36	0.00	0	0	494	0	494	
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500		0	2,500	10 000 gal
2) Spray from tank truck	1	MO	0.00	0.00	1160.00	1292.80	0	0	[illegible]	1,29[illegible]	2,45[illegible]	[18 05 0[illegible]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4B - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0.00	0.51	0.51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0.00	0.00	1.06	1.24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon. area	6	CY	0.00	0.00	0.51	0.51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0.00	0.05	0.24	0.00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0.00	4.64	20.03	0.22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324.00	0.00	15.00	0.00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1.98	0.00	0.00	0.00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324.00	0.00	0.00	0.00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0.00	10.00	20.00	0.00	0	100	200	0	300	
OFF-SITE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0.42	0	0	10	8	18.60	[022 216 4050]
2) Haul to Site 4, 20 CY @ 1 miles	1	miles	3.46	0.00	0.00	0.00	3	0	0	0	3.46	@ 350 miles/tri
BACKFILL TANK AREA												
1) Backfill with on-base fill material	80	CY	0.00	0.00	0.51	0.51	0	0	41	41	82	[022 208 2200]
2) Compact materials, 6" lifts	80	CY	0.00	0.00	0.21	0.42	0	0	17	34	50	[022 226 5600]
TREATABILITY STUDY (if needed)												
1) sample collection	20	HR	0.00	25.00	20.00	0.00	0	500	400	0	900	
2) air stripper and carbon adsorption treat. studies	1	EA	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000	Vendor data
PRE-DESIGN INVESTIGATION												
1) Aquifer test and characterization	1	LS	40,000.00	0.00	0.00	0.00	40,000	0	0	0	40,000	
TREATMENT SYSTEM												
1) Clear and grade area	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
2) Place concrete pad [25 ft x 35 ft x 8"]	22	CY	0.00	8.01	3.90	12.00	0	173	84	259	516	[033 172 4650]
3) pre-engineered bldg for treat. syst. [20 ft x 30 ft]	600	SF	0.00	54.00	0.00	0.00	0	32,400	0	0	32,400	[33 43 0101]
4) Connect utilities [elec. hookups]	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
5) 1000 gal poly equal. tank	1	EA	0.00	800.00	0.00	0.00	0	800	0	0	800	
6) Hardness removal - ion exchange tanks	1	EA	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	
7) Low profile air stripper	1	EA	15,000.00	0.00	1,000.00	0.00	15,000	0	1,000	0	16,000	Vendor data
8) Blower starter, controls, and panel	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	Vendor data
9) Piping, valves, connectors	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	
10) Lighting	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4B - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
TREATMENT SYSTEM (cont.)												
11) Vapor phase carbon [400 lb units]	6	EA	2,987.00	0.00	0.00	0.00	17,922	0	0	0	17,922	[33 13 1908]
12) Liquid phase carbon [1050 lb unit]	6	EA	4,168.00	0.00	0.00	0.00	25,008	0	0	0	25,008	[33 13 2011]
EXTRACTION WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Drilling [10" dia borehole]	350	LF	51.00	0.00	0.00	0.00	17,850	0	0	0	17,850	[33 23 1133]
3) Split barrel sampling	70	EA	15.00	0.00	0.00	0.00	1,050	0	0	0	1,050	Historical data
4) Well casing [4" ID]	280	LF	13.58	0.00	0.00	0.00	3,802	0	0	0	3,802	[33 23 0115]
5)Well screens [4" ID PVC]	70	LF	15.93	0.00	0.00	0.00	1,115	0	0	0	1,115	[33 23 0212]
6) Filter pack	140	LF	24.47	0.00	0.00	0.00	3,426	0	0	0	3,426	[33 23 1403]
7) Annular seals	280	LF	25.00	0.00	0.00	0.00	7,000	0	0	0	7,000	[33 23 1803]
5) Well development	56	HR	100.00	0.00	0.00	0.00	5,600	0	0	0	5,600	
6) Misc., decon., setups, security casings, etc.	1	LS	8,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
7) Pumps (14 & 1 standby)	15	EA	0.00	650.00	300.00	0.00	0	9,750	4,500	0	14,250	
8) Piping & connections to treatment system	1	LS	8,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
INFILTRATION GALLERY												
1) Excavate trench [1000 FT L x 2 FT D x 2 FT W]	148	CY	0.00	3.75	2.38	1.37	0	555	352	203	1,110	[022 254 0050]
2) Backfill with soil	148	CY	0.00	0.00	0.61	0.61	0	0	90	90	181	[022 208 2000]
3) Excavate area 100 ft x 100 ft x 4 ft D	1,482	CY	0.00	0.00	0.61	0.61	0	0	904	904	1,808	[022 242 2000]
4) Place 2 ft of gravel	741	CY	0.00	11.68	1.72	1.56	0	8,655	1,275	1,156	11,085	[17 03 0430]
5) Install 4 in. dia perf. PCV pipe	2,200	LF	0.00	0.70	1.41	0.00	0	1,540	3,102	0	4,642	[027 168 2000]
6) Backfill with soil	741	CY	0.00	0.00	0.61	0.61	0	0	452	452	904	[022 208 2000]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob [included in above]	0	LS	2,000.00	0.00	0.00	0.00	0	0	0	0	0	Historical data
2) Drilling	100	LF	25.00	0.00	0.00	0.00	2,500	0	0	0	2,500	Historical data
3) Split barrel sampling	20	EA	15.00	0.00	0.00	0.00	300	0	0	0	300	Historical data
4) Well installation (4 wells/piezometers)	100	LF	15.00	0.00	0.00	0.00	1,500	0	0	0	1,500	Historical data
5) Well development	16	HR	100.00	0.00	0.00	0.00	1,600	0	0	0	1,600	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	Historical data
6) Oversight (1 geologist)	60	HR	0.00	0.00	20.00	0.00	0	0	1,200	0	1,200	
8) Mgmt coord.	10	HR	0.00	0.00	35.00	0.00	0	0	350	0	350	
7) Oversight ODCs, M&IE	1	LS	0.00	2,250.00	0.00	0.00	0	2,250	0	0	2,250	
SHAKEDOWN PERIOD ACTIVITIES												
1) Weekly water level & chemical analyses	320	HR	0.00	0.00	20.00	0.00	0	0	6,400	0	6,400	
2) ODCs	1	EA	0.00	2,000.00	0.00	0.00	0	2,000	0	0	2,000	
PERMIT EQUIVALENCY												
1) waiver permit/CEA processing	1	EA	15,000.00	0.00	0.00	0.00	15,000	0	0	0	15,000	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT. 4B - EX-SITU TREATMENT (GROUNDWATER EXTR. & TRTMT., SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION B: ON-BASE DISPOSAL of CONTAMINATED SOILS; 7 extr. wells at plume edge, 7 wells at plume center
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
[C:\CLEAN\CTO279\DRFS\COSTREV\26-4Ev3.WK4] 26 JUN 97

	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
Page 3 Total	253,431	66,562	42,892	4,762	367,647	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	2,145	238	2,383	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	1,287	143	1,430	
Subtotal Direct Costs	253,431	66,562	45,037	5,000	371,460	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	22,040	0	22,040	
Field Construction Labor Overhead @ 60%	0	0	14,715	0	14,715	
Subcontract Overhead @ 5%	12,672	0	0	0	12,672	
Tax on Materials @ 5%	0	3,328	0	0	3,328	
G & A @ 10% (on labor, equip., & matl's.)	0	6,656	4,504	500	11,660	
Subtotal Direct and Indirect Costs	266,102	76,547	86,296	5,500	435,875	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	10,644	3,062	3,452	220	17,378	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					91,534	
Adjusted Direct and Indirect Costs	276,746	79,608	89,747	5,721	544,786	
Engineering @ 6 % of total direct and indirect					32,687	
Prime Contractor Fee @ 10% of Total Adjusted Cost					54,479	
Total Costs					631,952	
Contingency @ 10% of Total Cost					63,195	
TOTAL ESTIMATED COST					$695,147	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 4 - Ex-Situ Treatment
Colts Neck, New Jersey
O & M Analysis
14-Jul-97

Applies to both Alternatives 4A and 4B

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
'1. Activated carbon usage & metals ion-exchange cannister	$8,336 $1,000		Liquid phase (2 @ 1050 lb) Ion-exchange resin cannister
2. Weekly systems checks	$83,200		Inspect extraction and treatment systems, take readings. 20 HR/wk @ $60/HR + $400 ODCs
'3. Annual equipment maint. & Repairs - 4A - 4B	 $35,610 $34,760		5% of treatment and extraction system capital costs
4. Electrical Costs	$14,600		Operate blower and compressor
5. Groundwater monitoring [years 1-2, quarterly]	$40,640		Sample 7 wells & 3 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs.
6. Groundwater monitoring [years 3-30, annually]	$10,160		Sample 7 wells & 3 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs.
7. Reporting	$4,000		50 LOE hours & ODCs for annual reports plus other direct costs
8. 5-year Site reviews		$15,550	Reviews performed for years 5, 10, 15, 20, 25, and 30

Site 26 Alternative 4: Ex-Situ Treatment (Source Removal, Groundwater Extraction and Treatment; Institutional Controls, and Long-term Monitoring)

Alternative 4: include up to 7 extraction wells at leading edge, 7 wells in the plume center ("hot spot")

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Cost estimating sources:

ECHOS Environmental Restoration, Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.

Means Heavy Construction Cost Data, 9th edition, R.S. Means Company, Inc., 1995.

Means Site Work & Landscape Cost Data, 14th edition, R.S. Means Company, Inc., 1995.

iii. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

iv. Process leach tank of approx. 10 ft W x 10 ft L x 6 ft H, cinder block construction, top of tank approx. 8 in below ground surface.

v. Use air stripping as representative treatment process option.

vi. All sizing of components are conceptual for the purpose of the Feasibility Study, only. Actual sizes of pumps, vessels, etc., chemical consumption rates, pumping rates, etc. are to be determined based on results of pre-design investigation and treatability studies.

CAPITAL COST ITEMS:

1. Mobilization/Demobilization Require portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines; connect to Building GB-1), office trailer. Will require drinking and decon. water, and sanitary facilities.

2. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

3. Fugitive Dust Control:

   Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down .5 acres per day, 20 days per month [18 05 0413].

4. Leach Tank Excavation:

   - Excavate 10 ft x10 ft x 1 ft (3.7 CY ~ 4 CY) of soils overlying process leach tank. Stockpile onsite for backfill; which are probably uncontaminated based on RI sampling results.

- Remove standing liquids and sludges from the tank. Approx volume unknown. Assume all up to 100 gallons would be sent to off-site TSDF.

- Excavate process leach tank (approx. exterior dimensions of 6 ft H x 10 ft L x 10 ft W), which is composed of cinder blocks, and lift to surface. Total volume of concrete materials ≈ 4 walls x 10 ft x 6 ft x 8 in = 160 CF = 6 CY.

- Decon. leach tank rubble; high pressure spray, steam, and surfactant wash 3 times. Collect rinse water for offsite disposal. Total surface area requiring decon. ~ 4 walls x 2 sides x 6 FT H x 10 FT W = 480 SF. Once demolished, assume double surface area ~ 960 SF.

- 3 times steam clean ~ 2880 SF @ 138 SF/HR [33 17 0812] & equip/matls, labor @ 21 HR [33 17 0824]. Total rinse water @ 5GPM @ 21 HR = 6300 gal.

5. Rubble Disposal:

- perform wipe samples to determine action for rubble. Assume 20 wipe samples required, and analyses.

Option A: Send decontaminated demolished leach tank rubble to off-site disposal facility, if contaminants remain in concrete materials.

Option B: Send to Site 4 landfill for consolidation, if wipe samples do not reveal contamination.

6. Contaminated soils disposal:

- Assume soils surrounding and below process leach tank are likely contaminated by TCE and other solvents. Assume that up to 1 foot thick surrounding leach tank, and soils from the bottom of the tank to the water table are TCE-contaminated.

Total assumed cont. soil volume = 12 ft L x 12 ft W x 3 ft D = 432 CF = 16 CY. Probably would remove up to 20 CY total during excavation.

7. Field confirmatory analyses: to verify or confirm that desired soil PRG levels (concentrations) have been achieved through excavation.

Use 1 sampler @ 10 HR collecting 25 samples, send for VOCs analyses.

8. Backfilling of Process Leach Tank Area

- Backfill with common fill materials. Assume that material available from on-base sources, only fill handling costs involved. Estimated void volume ~ 12 FT x 12 FT x 15 FT = 2160 CF = 80 CY

9. Pre-Design Investigation

- Will require hydrogeologic evaluation, and sampling and analysis of groundwater and aquifer materials. Assume $40000 to perform field tests, sampling, data reduction, and interpret results.

10. Extraction Wells Installation

Capture zone analysis prepared by D. McKenna indicate up to 7 extraction wells needed, because of small capture zone for each well, to intercept leading edge of plume. Actual number of wells, size and screened intervals, and pumping rates to be determined after completion of the Pre-design Investigation.

Based on hydrogeologic evaluations, assume 7 wells would be located near the leading edge of the plume whose radius of influence would capture the contaminant plume, and 7 wells near the plume center ('hot spot").

- assume 14 wells @ 25 deep, @ 6 in dia. of stainless steel construction.

11. Treatment System

- May require treatability study to assess effectiveness of air stripping and activated carbon adsorption for site specific contaminants to size equipment to meet discharge limits.

- Available data suggests only an expected 2 GPM extraction rate. Use of a package treatment system with horizontal, low profile tray air strippers would be effective. All VOCs are amenable to air stripping.

- For FS, use equivalent of Cascade LP 5002, low profile air stripper.

- RI data indicates low turbidity. Metals concentrations of iron and manganese do not appear pose potential fouling problems. Tray air strippers are less susceptible to metal precipitate fouling than the column air strippers. Use in-line hardness removal cartridges (probably ion exchange) to remove iron and manganese from water to prevent potential fouling.

- Erect weather proof shed to house poly equalization tank, air stripper, activated carbon units. Attach utilities.

12. Est. volume of contaminated portion of aquifer is approx. 160 FT W x 420 FT L x 15 FT H = 1,008,000 CF. Use porosity of 25%.

Est. quantity of cont. groundwater ~ 0.25 x 1,008,000 CF = 252000 CF
Est. quantity of TCE = 705 µg/L (avg. conc.) x 252,000 CF x 28.32 L/CF = 5031 g
Est. total VOCs if TCE ~ 30% of VOCs detected = 5031 g/0.3 = 16770 g = 16.77 kg = 36.89 lb

Est. quantity of cont. soils ~ 0.75 x 1008000 CF = 756000 CF
Est. quantity of TCE using soil-water partitioning. Use TCE Kd = 1.66 E-01 L/kg , same as used in ECTRAN modeling.

using Kd = Sc/Wc

Sc = soil conc. (µg/kg)
Wc = aqueous conc. (µg/L)

Kd = 1.66 E-01 = Sc/705 ∴ Sc = 1.66 E-01 * 705 = 117 µg/kg

Est. quantity of TCE in saturated soils = 756000 CF x 117 µg/kg x 100 lb/CF x kg/2.2 lb
= 4,020,545,455 µg = 4021 g TCE

Est. total VOCs in sat. soil if 30% as TCE = 4021/0.3 = 13403 g @ 454 g/lb = 29.52 lb

Total estimated VOCs in contaminated portion of aquifer ~ 37 + 30 ~ 67 lb

13. Vapor phase carbon requirements

ACTUAL CARBON CONSUMPTION RATES TO BE DETERMINED BASED ON ACTUAL CONTAMINANT CONCENTRATIONS AND POSSIBLY TREATABILITY STUDIES.

- At rate of treatment, release of VOCs to ambient air is not expected to pose problems. Using an average and maximum groundwater TCE concentrations of 705 and 3000 µg/L, respectively, estimated TCE emissions rates to ambient air would be:

Est. average TCE emissions rate:

705 µg/L TCE x 4 gal/min x 3.785 L/gal x 1440 min/day = 15.37 g/day = 0.0339 lb/day (at start)
= 5610 g/year = 12.37 lb/yr

Est. average VOC emissions rate:

Assume TCE only comprises 30% of detected VOCs.
Total VOCs emissions would be approximately = 51.23 g/day = 0.113 lb/day (at start)
= 18,700 g/yr = 41.25 lb/yr

IMPORTANT NOTE:

Item 12 estimates total VOCs (avg of 705 ug/L) ~ 67 lb in saturated soils and groundwater.
Item 13 estimates VOCs generation based on current TCE levels, which will decline with time.
Item 12 is more realistic estimate and will be used to size carbon units.

To estimate vapor phase carbon usage (capture VOCs to prevent nuisance to workers in Building GB-1), use estimated adsorption rate of 45 lb TCE per 200 lb carbon (based on Calgon product literature). Assume total VOC adsorption rate similar to TCE adsorption rate. For FS, use estimated 67 lb VOCs that would be extracted from aquifer over life of system operation, would require 1 @ 200 lb carbon canister (on line), with 1unit on standby.

14. Liquid phase carbon polishing consumption rates:

- Use liquid phase carbon for polishing of treated groundwater. Use carbon consumption rate of 0.25 lb carbon/1000 gal.

At 4 GPM = 2,102,400 gallons per year x 0.25 lb/1000 gal = 525.6 lb/year. Assuming TCE only comprises 30% of all VOCs, or total carbon consumption rate of ~1752 lb/year. For FS, use 1 @ 2000 lb unit, with 1 standby unit.

15. Treated water disposal

Assuming treated water meets regulatory requirements, would discharge to infiltration gallery or spray aeration in area adjacent to Site 26. For FS, select infiltration gallery. Located 100 FT x 100 FT plot of unused land approximately 500 to 100 feet downgradient of extraction wells. Excavate to 4 FT depth, fill 1 FT with gravel, place perforated 2 IN PVC pipe, fill 1 FT with gravel, backfill 2 FT to surface.

16. Monitoring wells/piezometers installation

- Install 4 new groundwater monitoring wells/piezometers within and downgradient of interpreted plume location. 4 wells @ approx. 25 feet lengths each.

- Used cased drilling techniques, since sandy aquifer difficult to drill with augers. Install 5 ft or 10 ft screens at bottom of well, or where highest VOCs detected. Drilling and monitoring well construction rate of 25 ft/day. Well development of 4 hr/well. Est. 1 week mob/demob driller, drilling, and installation.
- Driller mob/demob @ $2000
- $25/LF drilling, $15/LF well construction
- $15/split spoon sample
- $100/hr well develop, up to 4 hours ea.
- Misc. - decon.spoons, drums, standby, etc. = $ 1000
- 1 geologist oversight for 6 days (inc. prep. & travel) @ 10 hr/day @ $20/hr w/o overhead & profit, $125/day M&IE @ 5 days, $500 ODCs/PID, supplies.
- Mgmt coord. 10 hr @ $35/hr w/o O&P

17. Shakedown Period Activities:

- Assume for 1 month period after installation of treatment system, technical specialist will monitor groundwater extraction system and treatment system performances. As necessary, system performance would be optimized. Use 1 specialist for 4 weeks @ 8 HR/day @ 20 days. Add $2000 ODCs (GC, supplies, electronic water level gauge, data loggers).

- Monitor water levels, screen treated effluent with GC for VOCs content, compile data, prepare reports.

18. Permit equivalency

- Based on information developed by M. Weirman, estimate capital cost of $5000 for air waiver processing, and ~$10000 for obtaining a CEA equivalence.

LONG-TERM O & M ITEMS:

1. Carbon replacement: - use disposable units, vendor pickup and replace

- 2000 lb/year for liquid phase carbon, for polishing

2. Weekly check of extraction and treatment systems

- 1 specialist @ 20 HR/week @ $60/hr to measure water levels, collect and field GC screen check treated effluent VOC concentrations. and inspect extraction system and treatment system. Add $400/wk for ODCs (travel, GC rental, supplies)

3. Annual systems maintenance:

- Allot 5% of capital costs for annual repairs and replacement of extraction or treatment system components.

4. Utility Costs

- Per estimates by M. Wierman/M. Snyder, air stripper using 3-HP blower, and air compressor of 50 HP.

- Electrical costs = 53 HP x 24 hr/day x 365 day/yr x 0.7457 kW/HP x 1/.8 eff = 432767 kW-HR/yr
- @ $0.09/kW-HR, annual cost = $38,949
- add 10% for general lighting, controls, HVAC, etc. = $3,895

- total annual utility costs = $42,900

5. Long-term annual groundwater monitoring:

- Sample 3 existing and 4 new monitoring wells, 3 QC samples. Total 10 samples per sampling event.

Sampling and analysis for site-specific contaminants [VOCs] and parameters specified by NJ DEP: COD, BOD, microorganism population. Field measurements of pH, DO, temperature, redox potential, and specific conductance.

Labor: For years 1-2, quarterly sampling (4 events/year); years 3 - 30, annually (1 event per year).

Labor Per event:

- GW sampling 2 people @ 10 hr/day @ 2 days (add 8 hr each for prep./mob/demob.) ≈ 56 hr/event.
- Sampling ≈ 56 hours @ $60/hr (w/overhead & profit) = $ 3360
- Proj. mgmt/coord. ≈ 20 hours @ $80/hr (w/O&P) = $1600
- add $300 M&IE; ODCs & supplies @ $300; & shipping @ $300.

Total ≈ $5860 per event

Estimated analytical costs, per event:: [use avg. cost provided in ECHOS manual]

- VOCs (EPA Method 624) $324/sample @ 10 samples = $3240
- BOD (EPA 405.1) $34.6/sample @ 10 samples = $346
- COD (EPA 410.1/410.2/410.3/410.4) $26.6/sample @ 10 samples = $266
- microbial count (total heterotrophic plate count) $43.3/sample @ 10 samples = $433

Total = $4285 ≈ $4300

6. Reporting of results: data review and report prep. @ 50 hr/event @ $70 = $3500, and $500 ODCs. Total = $4000/event

7. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $15500 per event

NWS Earle Site FS
Site 26 - Alternative 5A - Air Sparging/Soil Vapor Extraction
Colts Neck, New Jersey
Present Worth Analysis
26-Jun-97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,698			1697.50
1	0.935		499.18		466.52
2	0.873		499.18		436.00
3	0.816		499.18		407.43
4	0.763		499.18		380.82
5	0.713		499.18	15.55	366.99
6	0.666				0.00
7	0.623				0.00
8	0.582				0.00
9	0.544				0.00
10	0.508				0.00
11	0.475				0.00
12	0.444				0.00
13	0.415				0.00
14	0.388				0.00
15	0.362				0.00
16	0.339				0.00
17	0.317				0.00
18	0.296				0.00
19	0.277				0.00
20	0.258				0.00
21	0.242				0.00
22	0.226				0.00
23	0.211				0.00
24	0.197				0.00
25	0.184				0.00
26	0.172				0.00
27	0.161				0.00
28	0.150				0.00
29	0.141				0.00
30	0.131				0.00
			TOTAL PRESENT WORTH =		$3,755,303

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5A - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
26 JUN 97

Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	Historical data
4) Site Utilities	2	MO	4,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	Historical data
5) 2 trailers	2	MO	4,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
5) 1 Pick-up Truck (rental)	2	MO	500.00	100.00	0.00	0.00	1,000	200	0	0	1,200	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000.00	0.00	100.00	0.00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	2,000	GAL	0.20	0.00	0.00	0.00	400	0	0	0	400	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	2	MO	2,500.00	0.00	200.00	0.00	5,000	0	400	0	5,400	Vendor catalog
6) PPE rolloff cont.	2	MO	700.00	0.00	0.00	0.00	1,400	0	0	0	1,400	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	400	HR	0.00	0.00	35.86	0.00	0	0	14,344	0	14,344	
2) Site supervisor/foreman	400	HR	0.00	0.00	30.00	0.00	0	0	12,000	0	12,000	
2) Site safety officer	50	HR	0.00	0.00	25.00	0.00	0	0	1,250	0	1,250	
OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	40	HR	0.00	0.00	45.00	0.00	0	0	1,800	0	1,800	
2) Project administrator	40	HR	0.00	0.00	30.00	0.00	0	0	1,200	0	1,200	
3) Health and Safety director	5	HR	0.00	0.00	35.00	0.00	0	0	175	0	175	
4) Procurement/subcontracting	80	HR	0.00	0.00	30.00	0.00	0	0	2,400	0	2,400	
4) Clerical support	40	HR	0.00	0.00	12.36	0.00	0	0	494	0	494	
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	1	MO	0.00	0.00	1160.00	1292.80	0	0	1,160	1,293	2,453	[18 05 0413]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5A - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
26 JUN 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0.00	0.51	0.51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0.00	0.00	1.06	1.24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon. area	6	CY	0.00	0.00	0.51	0.51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0.00	0.05	0.24	0.00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0.00	4.64	20.03	0.22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324.00	0.00	15.00	0.00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1.98	0.00	0.00	0.00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324.00	0.00	0.00	0.00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0.00	10.00	20.00	0.00	0	100	200	0	300	
OFF-SITE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0.42	0	0	10	8	18.60	[022 216 4050]
2) Haul to TSDF, 20 CY @ 350 miles	350	miles	3.46	0.00	0.00	0.00	1,211	0	0	0	1211.00	@ 350 miles/trip
3) Offsite disposal charge	20	CY	450.00	0.00	0.00	0.00	9,000	0	0	0	9000.00	[33 19 7265]
BACKFILL TANK AREA												
1) Backfill with on-base fill material	80	CY	0.00	0.00	0.51	0.51	0	0	41	41	82	[022 208 2200]
2) Compact materials, 6" lifts	80	CY	0.00	0.00	0.21	0.42	0	0	17	34	50	[022 226 5600]
PRE-DESIGN INVESTIGATION												
1) Aquifer test and characterization	1	LS	20,000.00	0.00	0.00	0.00	20,000	0	0	0	20,000	
2) Air permeability study, pilot test	1	LS	30,000.00	0.00	0.00	0.00	30,000	0	0	0	30,000	
AS/SVE EQUIP. & BLDG.												
1) Clear and grade area	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
2) Place concrete pad [25 ft x 35 ft x 8"]	22	CY	0.00	8.01	3.90	12.00	0	173	84	259	517	[033 172 4650]
3) pre-engineered bldg for AS/SVE syst. [20 ft x	600	SF	0.00	54.00	0.00	0.00	0	32,400	0	0	32,400	[33 43 0101]
4) Connect utilities [elec. hookups]	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
5) Compressors (oil-free,)	3	EA	0.00	9,931.88	233.38	3.09	0	29,796	700	9	30,505	[33 13 9004]
6) Vacuum blowers	4	EA	0.00	17,805.95	233.38	3.09	0	71,224	934	12	72,170	[33 13 2342]
7) Knockout drums	4	EA	0.00	52.99	0.00	0.00	0	212	0	0	212	[33 13 2343]
8) Blower starters, controls, and panel	7	LS	0.00	1,200.00	300.00	0.00	0	8,400	2,100	0	10,500	
10) valves, pressure/vacuum gauges, connectors	7	LS	0.00	900.00	200.00	0.00	0	6,300	1,400	0	7,700	
11) Lighting	1	LS	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	
12) Carbon steel piping 4 IN dia.	45	LF	0.00	9.25	4.49	1.96	0	416	202	89	707	[026 856 4160]
13) concrete pads [2 FT x 2 FT x 4 in]	4	CY	0.00	8.01	3.90	12.00	0	33	16	50	99	[033 172 4650]
14) valves, gauges, samp. ports, piping	4	EA	0.00	500.00	150.00	0.00	0	2,000	600	[illegible]	[illegible]	
15) Vapor phase carbon [200 lb units]	2	EA	2,000.00	0.00	0.00	0.00	4,000	0	0	[illegible]	[illegible]	[illegible] 13 2011]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5A - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
26 JUN 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
AS/SVE WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Trenching [AS wells, ((16 x 160) + 420) x 2 x 1	331	CY	0.00	0.00	2.38	1.37	0	0	788	453	1,241	[022 254 0050]
3) Trenching [SVE wells, ((9 x 200)+ 450) x 2 x 1	250	CY	0.00	0.00	2.38	1.37	0	0	595	343	938	[022 254 0050]
4) Trench box installation [108 AS + 46 SVE]	152	EA	0.00	250.00	50.00	0.00	0	38,000	7,600	0	45,600	
5) sand bedding	193	CY	0.00	20.50	0.25	0.25	0	3,957	48	48	4,053	[041 032 0250]
6) backfilling	388	CY	0.00	0.00	0.29	0.29	0	0	113	113	225	[022 208 2020]
7) Drilling [AS wells, 6" dia borehole]	2,160	LF	33.24	0.00	0.00	0.00	71,798	0	0	0	71,798	[33 23 1131]
8) Split barrel sampling	432	EA	15.00	0.00	0.00	0.00	6,480	0	0	0	6,480	Historical data
9) Well casing [2" ID]	2,484	LF	6.79	0.00	0.00	0.00	16,866	0	0	0	16,866	[33 23 0111]
10) Well screens [2" ID PVC]	216	LF	8.52	0.00	0.00	0.00	1,840	0	0	0	1,840	[33 23 0211]
11) Filter pack	432	LF	9.56	0.00	0.00	0.00	4,130	0	0	0	4,130	[33 23 1401]
12) Bentonite seals	216	LF	28.97	0.00	0.00	0.00	6,258	0	0	0	6,258	[33 23 2101]
13) Annular seals	1,728	LF	24.56	0.00	0.00	0.00	42,440	0	0	0	42,440	[33 23 1801]
14) Drilling [SVE wells, 10" dia borehole]	322	LF	51.00	0.00	0.00	0.00	16,422	0	0	0	16,422	[33 23 1133]
15) Well casing [4" ID]	40	LF	13.58	0.00	0.00	0.00	543	0	0	0	543	[33 23 0115]
16) Well screens [4" ID PVC]	10	LF	15.93	0.00	0.00	0.00	159	0	0	0	159	[33 23 0212]
17) Filter pack	230	LF	24.47	0.00	0.00	0.00	5,628	0	0	0	5,628	[33 23 1403]
18) Annular seals	0	LF	0.00	0.00	0.00	0.00	0	0	0	0	0	[33 23 1803]
8) Bentonite seals	138	LF	115.88	0.00	0.00	0.00	15,991	0	0	0	15,991	[33 23 2103]
19) Well development	432	HR	100.00	0.00	0.00	0.00	43,200	0	0	0	43,200	
20) Misc., decon., setups, security casings, etc.	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
21) Connections to manifolds & treatment system	1	LS	0.00	1,000.00	5,000.00	0.00	0	1,000	5,000	0	6,000	
22) ball valves (2 in PVC)	108	EA	96.00	0.00	0.00	0.00	10,368	0	0	0	10,368	[151 975 3290]
22) ball valves (4 IN PVC)	46	EA	277.00	0.00	0.00	0.00	12,742	0	0	0	12,742	[151 975 3320]
23) pressure/vacuum gauges	154	EA	124.68	0.00	0.00	0.00	19,201	0	0	0	19,201	[33 31 0209]
24) check valves	108	EA	136.84	0.00	0.00	0.00	14,779	0	0	0	14,779	[33 27 0402]
SURFACE SEALING												
1) Grade treatment area 180 x 260	5,200	SY	0.00	0.00	0.37	0.61	0	0	1,924	3,172	5,096	[022 304 0100]
2) Seal surface with 3 IN asphalt	5,200	SY	0.00	26.50	2.58	2.37	0	137,800	13,416	12,324	163,540	[025 104 0854]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob [included in above]	0	LS	2,000.00	0.00	0.00	0.00	0	0	0	0	0	Historical data
2) Drilling	200	LF	25.00	0.00	0.00	0.00	5,000	0	0	0	5,000	Historical data
3) Split barrel sampling	32	EA	15.00	0.00	0.00	0.00	480	0	0	0	480	Historical data
4) Well installation (8 wells/piezometers)	200	LF	15.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
5) Well development	32	HR	100.00	0.00	0.00	0.00	3,200	0	0	0	3,200	Historical data
6) Misc., decon., setups, security casings, etc.	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
6) Oversight (1 geologist)	60	HR	0.00	0.00	20.00	0.00	0	0	1,200	0	1,200	
8) Mgmt coord.	10	HR	0.00	0.00	35.00	0.00	0	0	350	0	350	
7) Oversight ODCs, M&IE	1	LS	0.00	2,250.00	0.00	0.00	0	2,250	0	0	2,250	
SHAKEDOWN PERIOD ACTIVITIES												
1) Optimize AS/SVE, GW levels & chem. analy.	320	HR	0.00	0.00	20.00	0.00	0	0	6,400	0	6,400	
2) ODCs	1	EA	0.00	4,000.00	0.00	0.00	0	4,000	0	0	4,000	
PERMIT EQUIVALENCY												
1) waiver permit/CEA processing	1	EA	15,000.00	0.00	0.00	0.00	15,000	0	0	0	15,000	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5A - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: OFF-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
26 JUN 97

	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
Page 3 Total	455,391	346,000	81,850	18,570	901,810	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	4,092	928	5,021	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	2,455	557	3,013	
Subtotal Direct Costs	455,391	346,000	85,942	19,498	909,843	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	40,396	0	40,396	
Field Construction Labor Overhead @ 60%	0	0	28,912	0	28,912	
Subcontract Overhead @ 5%	22,770	0	0	0	22,770	
Tax on Materials @ 5%	0	17,300	0	0	17,300	
G & A @ 10% (on labor, equip., & matl's.)	0	34,600	8,594	1,950	45,144	
Subtotal Direct and Indirect Costs	478,160	397,900	163,844	21,448	1,064,365	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	19,126	15,916	6,554	858	42,454	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					223,517	
Adjusted Direct and Indirect Costs	497,287	413,816	170,398	22,306	1,330,335	
Engineering @ 6 % of total direct and indirect					79,820	
Prime Contractor Fee @ 10% of Total Adjusted Cost					133,034	
Total Costs					1,543,189	
Contingency @ 10% of Total Cost					154,319	
TOTAL ESTIMATED COST					$1,69[illegible],508	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 5B - Air Sparging/Soil Vapor Extraction
Colts Neck, New Jersey
Present Worth Analysis
26-Jun-97

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS ($ 000s)	O & M COSTS ($ 000s)	5-YEAR COSTS ($ 000s)	PRESENT WORTH ($ 000s)
0	1.000	1,680			1680.00
1	0.935		499.18		466.[illegible]
2	0.873		499.18		436.00
3	0.816		499.18		407.48
4	0.763		499.18		380.82
5	0.713		499.18	15.55	366.99
6	0.666				0.00
7	0.623				0.00
8	0.582				0.00
9	0.544				0.00
10	0.508				0.00
11	0.475				0.00
12	0.444				0.00
13	0.415				0.00
14	0.388				0.00
15	0.362				0.00
16	0.339				0.00
17	0.317				0.00
18	0.296				0.00
19	0.277				0.00
20	0.258				0.00
21	0.242				0.00
22	0.226				0.00
23	0.211				0.00
24	0.197				0.00
25	0.184				0.00
26	0.172				0.00
27	0.161				0.00
28	0.150				0.00
29	0.141				0.00
30	0.131				0.00
		TOTAL PRESENT WORTH =			$3,737,803

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5B - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
15 JULY 97

Sheet 1 of 4

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
MOBILIZATION/DEMOBILIZATION												
1) Portable Communication Equipment	2	SETS	400.00	0.00	0.00	0.00	800	0	0	0	800	
2) Equipment Mobilization/Demobilization	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	
3) Site Utility Hook-ups (elec., phone, etc.)	1	LS	5,000.00	0.00	0.00	0.00	5,000	0	0	0	5,000	Historical data
4) Site Utilities	2	MO	4,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	Historical data
5) 2 trailers	2	MO	4,000.00	0.00	0.00	0.00	8,000	0	0	0	8,000	
5) 1 Pick-up Truck (rental)	2	MO	500.00	100.00	0.00	0.00	1,000	200	0	0	1,200	Historical data
PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES												
1) Truck/Heavy Equipment Decon Pad												
a) Excavate & grade area (40' x 50')	70	CY	0.00	0.00	0.70	0.70	0	0	49	49	98	[022 242 2020]
b) Compact area (40' x 50')	75	CY	0.00	0.00	0.11	0.36	0	0	8	27	35	[022 226 6200]
c) Curb & splash guard (poly & lumber)	1	LS	0.00	1,000.00	500.00	200.00	0	1,000	500	200	1,700	
d) Steam cleaner, pumps, hoses, sprayers, etc.	2	MO	1,000.00	0.00	100.00	0.00	2,000	0	200	0	2,200	Historical data
2) Decon Water (1000 gal/mon)	2,000	GAL	0.20	0.00	0.00	0.00	400	0	0	0	400	
3) Clean Water Storage Tank	1	EA	0.00	1,500.00	300.00	0.00	0	1,500	300	0	1,800	3000 Gallon
4) Spent Water Storage Tank	1	EA	0.00	2,500.00	400.00	0.00	0	2,500	400	0	2,900	5000 Gallon
5) Personnel Decon. Trailer	2	MO	2,500.00	0.00	200.00	0.00	5,000	0	400	0	5,400	Vendor catalog
6) PPE rolloff cont.	2	MO	700.00	0.00	0.00	0.00	1,400	0	0	0	1,400	Historical data
SITE MANAGEMENT STAFFING												
1) Task manager	400	HR	0.00	0.00	35.86	0.00	0	0	14,344	0	14,344	
2) Site supervisor/foreman	400	HR	0.00	0.00	30.00	0.00	0	0	12,000	0	12,000	
2) Site safety officer	50	HR	0.00	0.00	25.00	0.00	0	0	1,250	0	1,250	
OFFICE PROJECT MANAGEMENT AND SUPPORT												
1) Project manager	40	HR	0.00	0.00	45.00	0.00	0	0	1,800	0	1,800	
2) Project administrator	40	HR	0.00	0.00	30.00	0.00	0	0	1,200	0	1,200	
3) Health and Safety director	5	HR	0.00	0.00	35.00	0.00	0	0	175	0	175	
4) Procurement/subcontracting	80	HR	0.00	0.00	30.00	0.00	0	0	2,400	0	2,400	
4) Clerical support	40	HR	0.00	0.00	12.36	0.00	0	0	494	0	494	
SITE PREPARATION												
1) Fugitive dusts control (water tank)	1	EA	0.00	2500.00	0.00	0.00	0	2,500	0	0	2,500	10,000 gal
2) Spray from tank truck	1	MO	0.00	0.00	1160.00	1292.80	0	0	1,160	1,293	2,453	[18 05 0413]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5B - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
15 JULY 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
LEACH TANK EXCAVATION												
1) Excavate soils overlying tank	4	CY	0.00	0.00	1.06	1.24	0	0	4	5	9	[022 238 0360]
2) Haul soils 50 ft to stockpile	4	CY	0.00	0.00	0.51	0.51	0	0	2	2	4	[022 208 2200]
2) Excavate leach tank concrete blocks	6	CY	0.00	0.00	1.06	1.24	0	0	6	7	14	[022 238 0360]
3) Haul 50 ft to decon. area	6	CY	0.00	0.00	0.51	0.51	0	0	3	3	6	[022 208 2200]
4) Decon. rubble [3 steam cleaning rinses]	2,880	SF	0.00	0.05	0.24	0.00	0	143	677	0	819	[33 17 0812]
5) Steam cleaning - elec., detergent, water, labor	21	HR	0.00	4.64	20.03	0.22	0	97	418	5	520	[33 17 0824]
5) Wipe samples	20	EA	324.00	0.00	15.00	0.00	6,480	0	300	0	6,780	[33 02 1720]
6) Decon. rinse water disposal	6,300	GAL	1.98	0.00	0.00	0.00	12,474	0	0	0	12,474	[33 19 7274]
CONTAMINATED SOILS EXCAVATION												
1) Excavate soils underlying and adjacent to tank	20	CY	0.00	0.00	1.06	1.24	0	0	21	25	46	[022 238 0360]
2) Confirmation sampling	25	EA	324.00	0.00	0.00	0.00	8,100	0	0	0	8,100	[33 02 1720]
3) Sampler	10	HR	0.00	10.00	20.00	0.00	0	100	200	0	300	
ON-SITE DISPOSAL												
1) Load dump trucks	20	CY	0.00	0.00	0.51	0.42	0	0	10	8	18.60	[022 216 4050]
2) Haul to Site 4	1	miles	3.46	0.00	0.00	0.00	3	0	0	0	3.46	
BACKFILL TANK AREA												
1) Backfill with on-base fill material	80	CY	0.00	0.00	0.51	0.51	0	0	41	41	82	[022 208 2200]
2) Compact materials, 6" lifts	80	CY	0.00	0.00	0.21	0.42	0	0	17	34	50	[022 226 5600]
PRE-DESIGN INVESTIGATION												
1) Aquifer test and characterization	1	LS	20,000.00	0.00	0.00	0.00	20,000	0	0	0	20,000	
2) Air permeability study, pilot test	1	LS	30,000.00	0.00	0.00	0.00	30,000	0	0	0	30,000	
AS/SVE EQUIP. & BLDG.												
1) Clear and grade area	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
2) Place concrete pad [25 ft x 35 ft x 8"]	22	CY	0.00	8.01	3.90	12.00	0	173	84	259	517	[033 172 4650]
3) pre-engineered bldg for AS/SVE syst. [20 ft x	600	SF	0.00	54.00	0.00	0.00	0	32,400	0	0	32,400	[33 43 0101]
4) Connect utilities [elec. hookups]	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
5) Compressors (oil-free,)	3	EA	0.00	9,931.88	233.38	3.09	0	29,796	700	9	30,505	[33 13 9004]
6) Vacuum blowers	4	EA	0.00	17,805.95	233.38	3.09	0	71,224	934	12	72,170	[33 13 2342]
7) Knockout drums	4	EA	0.00	52.99	0.00	0.00	0	212	0	0	212	[33 13 2343]
8) Blower starters, controls, and panel	7	LS	0.00	1,200.00	300.00	0.00	0	8,400	2,100	0	10,500	
10) valves, pressure/vacuum gauges, connectors	7	LS	0.00	900.00	200.00	0.00	0	6,300	1,400	0	7,700	
11) Lighting	1	LS	1,000.00	0.00	0.00	0.00	1,000	0	0	0	1,000	
12) Carbon steel piping 4 IN dia.	45	LF	0.00	9.25	4.49	1.96	0	416	202	88	707	[026 856 4160]
13) concrete pads [2 FT x 2 FT x 4 in]	4	CY	0.00	8.01	3.90	12.00	0	33	16	50	99	[033 1[illegible]2 4650]
14) valves, gauges, samp. ports, piping	4	EA	0.00	500.00	150.00	0.00	0	2,000	600	0	2,[illegible]00	
15) Vapor phase carbon [200 lb units]	2	EA	2,000.00	0.00	0.00	0.00	4,000	0	0	0	4,[illegible]	[33 [illegible] 2011]

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5B - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
15 JULY 97

			Unit Cost ($)				Total Cost ($)				Total Direct	
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Cost ($)	Comments
AS/SVE WELLS INSTALLATION												
1) Driller mob/demob	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	Historical data
2) Trenching [AS wells, ((16 x 160) + 420) x 2 x 1	331	CY	0.00	0.00	2.38	1.37	0	0	788	453	1,241	[022 254 0050]
3) Trenching [SVE wells, ((9 x 200)+ 450) x 2 x 1	250	CY	0.00	0.00	2.38	1.37	0	0	595	343	938	[022 254 0050]
4) Trench box installation [108 AS + 46 SVE]	152	EA	0.00	250.00	50.00	0.00	0	38,000	7,600	0	45,600	
5) sand bedding	193	CY	0.00	20.50	0.25	0.25	0	3,957	48	48	4,053	[041 032 0250]
6) backfilling	388	CY	0.00	0.00	0.29	0.29	0	0	113	113	225	[022 208 2020]
7) Drilling [AS wells, 6" dia borehole]	2,160	LF	33.24	0.00	0.00	0.00	71,798	0	0	0	71,798	[33 23 1131]
8) Split barrel sampling	432	EA	15.00	0.00	0.00	0.00	6,480	0	0	0	6,480	Historical data
9) Well casing [2" ID]	2,484	LF	6.79	0.00	0.00	0.00	16,866	0	0	0	16,866	[33 23 0111]
10) Well screens [2" ID PVC]	216	LF	8.52	0.00	0.00	0.00	1,840	0	0	0	1,840	[33 23 0211]
11) Filter pack	432	LF	9.56	0.00	0.00	0.00	4,130	0	0	0	4,130	[33 23 1401]
12) Bentonite seals	216	LF	28.97	0.00	0.00	0.00	6,258	0	0	0	6,258	[33 23 2101]
13) Annular seals	1,728	LF	24.56	0.00	0.00	0.00	42,440	0	0	0	42,440	[33 23 1801]
14) Drilling [SVE wells, 10" dia borehole]	322	LF	51.00	0.00	0.00	0.00	16,422	0	0	0	16,422	[33 23 1133]
15) Well casing [4" ID]	40	LF	13.58	0.00	0.00	0.00	543	0	0	0	543	[33 23 0115]
16) Well screens [4" ID PVC]	10	LF	15.93	0.00	0.00	0.00	159	0	0	0	159	[33 23 0212]
17) Filter pack	230	LF	24.47	0.00	0.00	0.00	5,628	0	0	0	5,628	[33 23 1403]
18) Annular seals	0	LF	0.00	0.00	0.00	0.00	0	0	0	0	0	[33 23 1803]
8) Bentonite seals	138	LF	115.88	0.00	0.00	0.00	15,991	0	0	0	15,991	[33 23 2103]
19) Well development	432	HR	100.00	0.00	0.00	0.00	43,200	0	0	0	43,200	
20) Misc., decon., setups, security casings, etc.	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000	
21) Connections to manifolds & treatment system	1	LS	0.00	1,000.00	5,000.00	0.00	0	1,000	5,000	0	6,000	
22) ball valves (2 in PVC)	108	EA	96.00	0.00	0.00	0.00	10,368	0	0	0	10,368	[151 975 3290]
22) ball valves (4 IN PVC)	46	EA	277.00	0.00	0.00	0.00	12,742	0	0	0	12,742	[151 975 3320]
23) pressure/vacuum gauges	154	EA	124.68	0.00	0.00	0.00	19,201	0	0	0	19,201	[33 31 0209]
24) check valves	108	EA	136.84	0.00	0.00	0.00	14,779	0	0	0	14,779	[33 27 0402]
SURFACE SEALING												
1) Grade treatment area 180 x 260	5,200	SY	0.00	0.00	0.37	0.61	0	0	1,924	3,172	5,096	[022 304 0100]
2) Seal surface with 3 IN asphalt	5,200	SY	0.00	26.50	2.58	2.37	0	137,800	13,416	12,324	163,540	[025 104 0854]
MONITORING WELLS INSTALLATION												
1) Driller mob/demob [included in above]	0	LS	2,000.00	0.00	0.00	0.00	0	0	0	0	0	Historical data
2) Drilling	200	LF	25.00	0.00	0.00	0.00	5,000	0	0	0	5,000	Historical data
3) Split barrel sampling	32	EA	15.00	0.00	0.00	0.00	480	0	0	0	480	Historical data
4) Well installation (8 wells/piezometers)	200	LF	15.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
5) Well development	32	HR	100.00	0.00	0.00	0.00	3,200	0	0	0	3,200	Historical data
6) Misc., decon , setups, security casings, etc.	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000	Historical data
6) Oversight (1 geologist)	60	HR	0.00	0.00	20.00	0.00	0	0	1,200	0	1,200	
8) Mgmt coord.	10	HR	0.00	0.00	35.00	0.00	0	0	350	0	350	
7) Oversight ODCs, M&IE	1	LS	0.00	2,250.00	0.00	0.00	0	2,250	0	0	2,250	
SHAKEDOWN PERIOD ACTIVITIES												
1) Optimize AS/SVE, GW levels & chem. analy.	320	HR	0.00	0.00	20.00	0.00	0	0	6,400	0	6,400	
2) ODCs	1	EA	0.00	4,000.00	0.00	0.00	0	4,000	0	0	4,000	
PERMIT EQUIVALENCY												
1) waiver permit/CEA processing	1	EA	15,000.00	0.00	0.00	0.00	15,000	0	[illegible]	0	[illegible]000	

NWS EARLE FEASIBILITY STUDY COLTS NECK, NJ
SITE 26 ALT.5B - AIR SPARGIN/SOIL VAPOR EXTR. (SOURCE REMOVAL, INST. CONTROLS, LONG-TERM MONIT.)
OPTION A: ON-BASE DISPOSAL of CONTAMINATED SOILS
NAVY CLEAN CTO 0279; B&RE JOB NO.7452
15 JULY 97

	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost ($)	Comments
Page 3 Total	445,183	346,000	81,850	18,570	891,602	
Direct Cost Adjustment Factors						
Safety Level D Multiplier (5% of labor and equipment, for non-Lev. C activities)	0	0	4,092	928	5,021	
Safety Level C Multiplier (25% of labor and equipment, as listed)	0	0	0	0	0	
Site & Industrial Health & Safety Monitoring (3% of labor and equipment)	0	0	2,455	557	3,013	
Subtotal Direct Costs	445,183	346,000	85,942	19,498	899,636	
Indirect Cost Adjustment Factors						
Labor Overhead @ 120% (for field mgmt. & home office, only)	0	0	40,396	0	40,396	
Field Construction Labor Overhead @ 60%	0	0	28,912	0	28,912	
Subcontract Overhead @ 5%	22,259	0	0	0	22,259	
Tax on Materials @ 5%	0	17,300	0	0	17,300	
G & A @ 10% (on labor, equip., & matl's.)	0	34,600	8,594	1,950	45,144	
Subtotal Direct and Indirect Costs	467,442	397,900	163,844	21,448	1,053,647	
Cost Adjustment Factors						
1995 to 1996 Cost Correction Factor @ 4%	18,698	15,916	6,554	858	42,025	
City/Location Cost Adjustment Factor @ 21% (ref. 2)					221,266	
Adjusted Direct and Indirect Costs	486,140	413,816	170,398	22,306	1,316,938	
Engineering @ 6 % of total direct and indirect					79,016	
Prime Contractor Fee @ 10% of Total Adjusted Cost					131,694	
Total Costs					1,527,648	
Contingency @ 10% of Total Cost					152,765	
TOTAL ESTIMATED COST					$1,680,413	

References used for cost estimates:

1) Means Site Work and Landscape Cost Data, 1995, 14th Annual Edition, R.S. Means Co., Inc., Kingston, MA
2) Environmental Restoration: Assemblies Cost Book; 1995; ECHOS, Los Angeles, CA

NWS Earle Site FS
Site 26 - Alternative 5 - Air Sparging/Soil Vapor Extraction
Colts Neck, New Jersey
O & M Analysis
26-Jun-97
Applies to both Alternatives 5A and 5B

Annual Costs

ITEM	ANNUAL O & M ITEMS ($)	5-YEAR ITEMS ($)	NOTES
1. Activated carbon usage			none
2. Weekly systems checks	$83,200		Inspect extraction and treatment systems, take readings. 20 HR/wk @ $60/HR + ODCs
3. Annual equipment maint. & repairs - 5A - 5B	 $50,925 $50,412		3% of treatment and extraction system capital costs
4. Power usage	$287,050		@ $0.09/kw-hr
5. Groundwater monitoring	$62,000		Sample 11 wells & 3 QC, incl. VOCs analyses. Inc. labor, M&IE, ODCs. 4 times/yr
6. Reporting	$16,000		200 LOE hours & ODCs for annual reports plus other direct costs
7. 5-year Site reviews		$15,550	Reviews performed at year 5

Site 26 Alternative 5: Air Sparging/Soil Vapor Extraction (Source Removal, Institutional Controls, and Long-term Monitoring)

ASSUMPTIONS:

i. Discount rate for net present worth calculation at 7% per OSWER Directive No. 9355.3-20, June 25, 1993.

ii. Cost estimating sources:

ECHOS Environmental Restoration, Unit Cost Book and Assemblies Cost Book, Delta Technologies Group, Inc. and Marshall & Swift, 1995.

Means Heavy Construction Cost Data, 9th edition, R.S. Means Company, Inc., 1995.

Means Site Work & Landscape Cost Data, 14th edition, R.S. Means Company, Inc., 1995.

iii. Abbreviations: SF = square feet; CF = cubic feet; SY = square yard; CY = cubic yard; LF = linear feet; MSF = 1000 SF

iv. Process leach tank of approx. 10 FT W x 10 FT L x 6 FT H, cinder block construction, top of tank approx. 8 in below ground surface.

v. It is presumed that field pilot studies will be conducted to determine air permeability, radii of influences for air sparging and soil vapor extraction, air injection and extraction rates, for system design.

vi. All sizing of components are conceptual for the purpose of the Feasibility Study, only. Actual sizes of pumps, vessels, blowers, pumping rates, etc. are to be determined based on results of pre-design investigation and treatability studies.

vii. The associated cost estimates conservatively assumes an operation period of approx. 5 years for the entire site area and affected portion of aquifer. If during this period, portions of the site or aquifer become remediated, then application of AS/SVE in those areas would be discontinued and could result in lower O&M costs.

vii. Bibliography

- Bruell, Clifford, Michael Marley, and Harley Hopkins; American Petroleum Institute In Situ Air Sparging Database; Tenth Annual Conference on Contaminated Soils, October 1995

- Schima, Susan, Douglas LaBreques, and Paul Lundegard; Monitoring Air Sparging Using Resistivity Tomography, Ground Water Monitoring Review, Spring 1996

- US EPA, Subsurface Volatilization and Ventilation System (SVVS), Innovative Technology Evaluation Report; EPA/540/R-94/529, August 1995

- US EPA, Guide for Conducting Treatability Studies under CERCLA: Soil Vapor Extraction; EPA/540/2-91/019A, September 1991

Bibliography (cont.)

- US EPA, Soil Vapor Extraction Technology. Reference Handbook: EPA/540/2-91/003; February 1991

CAPITAL COST ITEMS:

1. Mobilization/Demobilization Require portable communications, equipment mob/demob [lump sum], site utilities (elec./phone lines; connect to Building GB-1), office trailer. Will require drinking and decon. water, and sanitary facilities.

2. Personnel & equipment decon. facilities and services Establish truck\heavy equipment decon. pad, personnel decon. pad, clean water storage, spent water storage.

3. Fugitive Dust Control:

   Fugitive dust control - One 10000 gal tank. Have 1 water wagon spray down .5 acres per day, 20 days per month [18 05 0413].

4. Leach Tank Excavation:

   - Excavate 10 FT x10 FT x 1 FT (3.7 CY ~ 4 CY) of soils overlying process leach tank. Stockpile onsite for backfill; which are probably uncontaminated based on RI sampling results.

   - Remove standing liquids and sludges from the tank. Approx volume unknown. Assume all up to 100 gallons would be sent to off-site TSDF.

   - Excavate process leach tank (approx. exterior dimensions of 6 FT H x 10 FT L x 10 FT W), which is composed of cinder blocks, and lift to surface. Total volume of concrete materials ≈ 4 walls x 10 FT x 6 FT x 8 in = 160 CF = 6 CY.

   - Decon. leach tank rubble; high pressure spray, steam, and surfactant wash 3 times. Collect rinse water for offsite disposal. Total surface area requiring decon. ~ 4 walls x 2 sides x 6 FT H x 10 FT W = 480 SF. Once demolished, assume double surface area ~ 960 SF.

   - 3 times steam clean ~ 2880 SF @ 138 SF/HR [33 17 0812] & equip/matls, labor @ 21 HR [33 17 0824]. Total rinse water @ 5GPM @ 21 HR = 6300 gal.

5. Rubble Disposal:

   - perform wipe samples to determine action for rubble. Assume 20 wipe samples required, and analyses.

   Option A: Send decontaminated demolished leach tank rubble to off-site disposal facility, if contaminants remain in concrete materials.

   Option B: Send to Site 4 landfill for consolidation, if wipe samples do not reveal contamination.

6. Contaminated soils disposal:

- Assume soils surrounding and below process leach tank are likely contaminated by TCE and other solvents. Assume that up to 1 foot thick surrounding leach tank, and soils from the bottom of the tank to the water table are TCE-contaminated.

Total assumed cont. soil volume = 12 FT L x 12 FT W x 3 FT D = 432 CF = 16 CY. Probably would remove up to 20 CY total during excavation.

7. Field confirmatory analyses: to verify or confirm that desired PRG levels (concentrations) have been achieved through excavation.

Use 1 sampler @ 10 HR collecting 25 samples, send for VOCs analyses.

8. Backfilling of Process Leach Tank Area

- Backfill with common fill materials. Assume that material available from on-base sources, only fill handling costs involved. Estimated void volume ~ 12 FT x 12 FT x 15 FT = 2160 CF = 80 CY

9. Pre-Design Investigation

- Will require limited hydrogeologic evaluation, and sampling and analysis of groundwater and aquifer materials. Assume $20000 to perform field tests, sampling, data reduction, and interpret results.

- Perform field air permeability tests and to determine radius of influence for air sparging and soil vapor extraction, install air piezometers to monitor vadose zone. Estimate at $30000 for equipment, setup, field tests, and interp. of results.

10. Install air sparging & soil vapor extraction network.

- Erect weatherproof, pre-engineered building to house compressors and blowers, power supply, control panels, and vapor phase activated carbon cannisters. Connect utilities to building.

- Install all piping below ground surface in trench to protect them. Place piping in trench approx. 2 FT deep, bedded in 8 IN sand. Backfill to ground surface.

- Each air sparging and extraction well head will be installed in a precast vault box [2 FT x 2 FT x 2 FT], with water tight locking cover. A sampling port would be included in each well head.

11. Estimate air injection well spacing and conceptual design

- Based on RI, Site 26 saturated subsurface soils are fine to medium sands [hydraulic conductivity from 1.92 10 E-3 to 7.09 10 E-4].

- Actual air sparging (AS) radius of influence (ROI) to be determined during pilot test. For FS, will use data developed by the American Petroleum Institute [Bruell, et al., 1995] for sites where AS has been implemented. Typical AS ROI for BTEX contaminated sites is estimated between 10 - 26 feet, which cover a variety of subsurface soil conditions; for FS it is reasonable that Site 26 subsurface saturated and unsaturated soil conditions would be comparable to those evaluated in the API study. Since Site 26 soils are generally fine to medium and coarse sands, which are relatively permeable, it

is reasonable to selected an anticipated ROI of probably 15 - 20 feet. Use 15 feet ROI, or AS well spacing of 30 feet.

- Use conceptual air sparging network with following conditions (based on general guidelines presented in API database summary and HWC Jan/Feb 1993 article):

* 2 IN dia PVC sparging wells
* 6 IN dia borehole
* 2 FT slotted screen intervals, sealed by bentonite above screened zone, filter pack around screens to 2 FT above screened interval, min. 2 FT thi[illegible]ite seal [illegible]nd pack.
* screens positioned appox. 14 feet below water table (1 foot above clay a[illegible] or 24 ft bgs.
* max. overpressure of 5 PSI (pressure in excess of hydrostatic head, and capillary action)
* air flow rate of ~ 10 scfm
* vertical pipes tied to headers/manifolds

12. Est. total pressure to be delivered at each sparge point
hydrostatic head = approx. 1 PSI per 2.3 feet hydraulic head
14 feet hydraulic head ~ 6.09 PSI
Total pressure delivered at each sparge point = 5 (max) + 6.1 ~ 11.1 PSI.

13. Number of AS wells and lengths of pipe

- currently delineated extent of groundwater TCE plume (> 1 ug/L) extent of approx. 160 FT x 24 FT slotted screen intervals, sealed by bentonite above screened zone, filter pack around screens to 2 FT above screened interval, min. 2 FT thick bentonite seal over sand pack. At AS spacing of approx. 30 feet, will require ~ 108 wells (112 wells - 4 corner wells)

- surface PVC piping: 16 rows @ 160 FT, add 2 FT/well @ 108 wells = 2776, add 10% for misc. extensions, connections, etc. 280 FT. Total ~ 3100 LF PVC.

- 1 row of header @ 4 IN PVC @ 420 FT

- carbon steel 4 IN piping @ 45 FT leading from blowers for because of heat buildup from compressors, and to reduce head loss.

- provide 1 pressure gauge, 1 ball valve per well, and 1 check valve.

14. Size compressors/blowers for AS

- divide 16 rows of AS wells into ~ 3 zones [5, 5, 6 rows], and use 3 compressors each providing approx. 35 - 42 AS wells with between 5 to 10 cfm of air [420 cfm total] at max. total pressure of 12 PSI. 3 compressors provide flexibility in turndown or closing off zones are completion of treatment.

- use oil-free compressors/blowers with downstream coalescing and particulate filters

- select positive displacement or rotary-lobe blowers to provide pressurized air. Use 426 SCFM blower, 84 HP, 30 PSI, [33 13 9004], which would provide for over capacity for head loss due to air friction flow losses and form losses (valves, gauges, bends, tees, etc.)

- will need to check if friction headloss due to air flow in piping pose problems for selected compressor. If a problem, add another compressor and reduce load to each compressor.

15. SVE well spacing and conceptual well design

- Will require field air permeability test to determine actual ROI vs. vacuum and distance from test extraction well.

- From API database summary, most commonly used SVE ROI to AS ROI ratio was 1 - 2. Use ratio of 2 for the at Site 26; if soils are more permeable than anticipated, then ROI ratio would be decreased. For FS, use SVE ROI of 30 FT, or well spacing of up to 60 FT.

- conceptual well design:

* 46 SVE wells with 2 FT section of 4 IN PVC Sch 80, 2 FT Riser, 4 FT Sch 80
* 10 IN boreholes
* bentonite seal above screened zone, filter pack around screens to 6 IN above screened interval, 2 FT bentonite seal over sand pack.
* bottom of screens positioned appox. 1 foot above water table
* All extraction wells manifolded at the surface to vacuum blowers.

- Total 4 IN PVC piping req'd = 46 x 4 FT + 420 FT header = 604 FT, add 10% (60 FT) for misc. connections, etc. Total piping ~ 670 FT.

- Total 4 IN slotted pipe = 92 FT

- Include 1 vacuum gauge, 1 ball valve for each extraction well

16. Vapor extraction rate

- From the literature, require higher vapor removal rate than injection rate to ensure capture of VOC gases that volatilize into the vadose zone from the groundwater. Use approx. double the air injection rate.

SVE rate ~ air injection rate 108 well x 10 scfm x 2 = 2160 cfm. Use 2200 scfm @ -20 psi (~46 IN water).

- Use 4 x 30 HP 580 SCFM vacuum blower [33 13 2342], $17805 each
- Use knockout drum/moisture separator on upstream side of the vacuum blower. Collected water will be filtered through liquid phase activated carbon units and discharged.
- Extracted VOC-laden gases would be passed through vapor phase activated carbon and discharged to ambient air.

12. Estimation of vapor phase carbon requirements

ACTUAL CARBON CONSUMPTION RATES TO BE DETERMINED BASED ON ACTUAL CONTAMINANT CONCENTRATIONS AND POSSIBLY TREATABILITY STUDIES.

Est. volume of contaminated portion of aquifer is approx. 160 FT W x 420 FT L x 15 FT H = 1,008,000 CF. Use porosity of 25%.

Est. quantity of cont. groundwater ~ 0.25 x 1,008,000 CF = 252000 CF
Est. quantity of TCE = 705 µg/L (avg. conc.) x 252,000 CF x 28.32 L/CF = 5031 g
Est. total VOCs if TCE ~ 30% of VOCs detected = 5031 g/0.3 = 16770 g = 16.77 kg = 36.89 lb

Est. quantity of cont. soils ~ 0.75 x 1008000 CF = 756000 CF
Est. quantity of TCE using soil-water partitioning. Use TCE Kd = 1.66 E-01 L/kg , same as used in ECTRAN modeling.

using Kd = Sc/Wc

Sc = soil conc. (µg/kg)
Wc = aqueous conc. (µg/L)

Kd = 1.66 E-01 = Sc/705 ∴ Sc = 1.66 E-01 * 705 = 117 µg/kg

Est. quantity of TCE in saturated soils = 756000 CF x 117 µg/kg x 100 lb/CF x kg/2.2 lb
= 4,020,545,455 µg = 4021 g TCE

Est. total VOCs in sat. soil if 30% as TCE = 4021/0.3 = 13403 g @ 454 g/lb = 29.52 lb

Total VOCs in contaminated portion of aquifer ~ 37 + 30 ~ 67 lb

- Will use vapor phase carbon to capture VOCs. Actual air emissions measurements should be performed to determine need for VOCs controls. Assume req'd to minimize impact to GB-1 workers. Use estimated adsorption rate of 45 lb TCE per 200 lb carbon [per Calgon product literature]. Assume total VOC adsorption rate similar to TCE adsorption rate.

Est. total carbon req'd = 200 lb.

Over life of AS/SVE treatment, will use 2 vapor phase carbon @ 200 lb carbon units, each, in line, 1 standby. Replace if primary carbon unit experiences breakthrough.

14. Estimated vapor recovery rate

- Field pilot test will provide more accurate data on expected recovery rates. Since TCE is a highly volatile gas, it is likely that recovery could be quick if air sparged into the groundwater is adequately distributed to a contaminated soils.

- Review of available literature indicates typical AS/SVE operation of systems for up to 24 months to achieve groundwater concentrations in the 1 E+2 to 1 E+1 µg/L TCE. Since target remediation concentration would be between 1 to 10 µg/L TCE for Site 26, greater time would be necessary to attain more stringent goal. Assume at least 2 to 2.5 times literature values(or 4 to 5 years); this is reasonable given the low target concentration.

- Probably the largest quantity of vapors recovered during initial AS/SVE treatment, and recovery rate will decline asymptotically.

- Assume that recovery rate will decline by 50% per year over 5 years.

Estimated VOCs recovery and carbon usage rates would be:

	~ VOC Mass Recovery Rate	~ VOC Mass (lb/yr)
Year 1	X	19.6
Year 1	0.5 X	9.8
Year 1	0.25 X	4.9
Year 1	0.125 X	2.45
Year 1	0.0625 X	1.23
Total	38	

15. Monitoring wells/piezometers installation

- Install 8 new groundwater monitoring wells/piezometers within and downgradient of interpreted plume location, since plume is not being contained. 6 wells @ approx. 25 feet lengths each.

- Use cased drilling techniques, since sandy aquifer difficult to drill with augers. Install 5 FT or 10 FT screens at bottom of well, or where highest VOCs detected. Drilling and monitoring well construction rate of 25 FT/day. Well development of 4 hr/well. Est. 2 week mob/demob driller, drilling, and installation.

- Driller mob/demob @ $2000
- $25/LF drilling, $15/LF well construction
- $15/split spoon sample
- $100/hr well develop, up to 4 hours ea.
- Misc. - decon.spoons, drums, standby, etc. = $ 2000

- 1 geologist oversight for 12 days (inc. prep. & travel) @ 10 hr/day @ $20/hr w/o overhead & profit, $125/day M&IE @ 10 days, $500 ODCs/PID, supplies.
- Mgmt coord. 10 hr @ $35/hr

16. Shakedown Period Activities:

- Assume for 1 month period after installation of treatment system, technical specialist will monitor AS/SVE system and treatment system performances. As necessary, system performance would be optimized. Use 2 specialists for 4 weeks @ 8 HR/day @ 20 days. Add $4000 ODCs (GC, supplies, electronic water level gauge, data loggers).

- Monitor water levels, screen groundwater and recovered vapor with GC for VOCs content, compile data, prepare reports.

17. Permit equivalency

- Based on information developed by M. Wierman, estimate capital cost of $5000 for air waiver processing, and ~$10000 for obtaining a CEA equivalence.

LONG-TERM O & M ITEMS:

Brown & Root Environmental		Calculation Sheet
Client: Navy CLEAN	File No.	**By:** LC
Subject: Site 26, Alt. 5 - Assumptions and Cost Basis, NWS Earle FS, CTO 279: Revision 3		**Checked by:** MJW 7/31/97 **Date:** [illegible]

1. Carbon replacement:: None required.

2. Weekly check of extraction and treatment systems

   - 1 specialist @ 20 HR/week @ $60/hr to measure water levels, collect and field GC screen GW and vapors for VOC concentrations, and inspect vapor extraction system and treatment system. Add $400 ODCs weekly for ODCs (travel, GC rentals, expendables). Weekly cost = $1600, annual cost = $83,200.

3. Annual systems maintenance:

   - Allot 3% of capital costs for annual repairs and replacement of air sparging, vapor extraction, or treatment system components.

4. Power consumption

   Assume that compressors [3 @ 84 HP] and vacuum blowers [4 @ 30 HP] would be operated at rated HP.

   AS/SVE Power = [[3 x 84 HP] + [4 x 30 HP]] x 24 HR/DAY x 365 DAY/YR x 0.7457 kW/HP
   = 2,430,028 kW-HR
   Assume 80% efficiency and electrical costs of $0.09/kW-HR.
   Annual energy cost = 2,430,028 kW-HR x 1.25 x $0.09/kW-HR = $273,380

   - Add 5% for general remedial action activities (lighting, compressors for carbon adsorption units, instruments, pre-heaters for winter usage, etc). ~ $13,670

   Total annual energy cost = $287,050

5. Long-term annual groundwater monitoring quarterly:

   - Sample 3 existing and 8 new monitoring wells. 5 QC samples. Total 16 samples per event.

   Sampling and analysis for site-specific contaminants: VOCs

   Labor: 4 sampling event/year.

   Each event :
   - GW sampling 2 people @ 10 hr/day @ 4 days (add 6 hr each for prep./mob/demob.) ≈ 92 hr
   - Sampling ≈ 92 hours @ $60/hr (w/overhead & profit) = $ 5520
   - Proj. mgmt/coord. ≈ 40 hours/year @ $80/hr (w/O&P) = $ 3200
   - Annual: add $600 M&IE; ODCs & supplies @ $500; & shipping @ $500.

   Total ≈ $ 10300 quarterly = $41200 annually

   Estimated analytical costs:

   - VOCs (EPA Method 624) $324/sample @ 16 samples/yr = $ 5184 per event = $20800

6. Reporting of results: data review and report prep. @ 200 hr/yr @ $70 = $14000, add $2000 ODCs. Total = $16000 annually.

7. 5-year reviews at 200 LOE @ $70/hr. Approx. $1500 ODCs. Total = $ 15500 per event