02.06-03/11/94-00613

ACTION MEMORANDUM

SITES 4, 16, AND 21
NAVAL WEAPONS STATION YORKTOWN

DEPARTMENT OF THE NAVY
NAVAL WEAPONS STATION
YORKTOWN, VIRGINIA 23691

5090.10K
09E32
11 MAR 1994

From: Commanding Officer, Naval Weapons Station Yorktown
To: Commander, Atlantic Division, Naval Facilities Engineering Command (Code 1822)

Subj: ACTION MEMORANDUM FOR SITES 4, 16, AND 21 REMOVALS

Ref: (a) Draft Federal Facilities Agreement (FFA) for Naval Weapons Station Yorktown

Encl: (1) Action Memorandum for Sites 4, 16, and 21

1. As required by reference (a), a copy of enclosure (1) is provided approving removal actions at Sites 4, 16, and 21.

2. If you have any questions regarding this approval, please contact Mr. Jeffrey Harlow at (804) 887-4536 or DSN 953-4536.

R. C. SCHOLES
Acting

ACTION MEMORANDUM

Sites 4, 16, and 21
Naval Weapons Station Yorktown

DATE: 9 March 1994

TO: Commanding Officer, Naval Weapons Station Yorktown

FROM: Commander, Atlantic Division, Naval Facilities Engineering Command

SUBJECT: Removal Actions at Sites 4, 16, and 21, Naval Weapons Station Yorktown

I. PURPOSE

The purpose of this Action Memorandum is to document the request for approval of the proposed removal actions at Sites 4 (Burning Pad Residue Landfill), 16 (West Road Landfill), and 21 (Battery and Drum Disposal Area), Naval Weapons Station Yorktown.

II. SITE CONDITIONS AND BACKGROUND

Surficial debris present at Sites 4, 16, and 21 have been determined to be a potential source of contamination of the groundwater, surface water, soils, and sediments at these sites. Explosives compounds, heavy metals, and base/neutral acid extractable compounds (BNAs) have been detected in at least one of these media at the three sites, which may be attributable in part to the surficial waste materials.

The removal actions proposed for Sites 4, 16, and 21 are non-time-critical removals; by definition, this means that the action may be delayed for a period of six months before cleanup is initiated, without harm to human health and/or the environment. During this six-month planning period, potential removal alternatives have been evaluated for 1) effectiveness in minimizing or stabilizing the threat to public health, 2) consistency with the anticipated final remedial action, 3) consistency with applicable or relevant and appropriate requirements (ARARs), and 4) cost effectiveness. This evaluation is presented in the "Engineering

Evaluation/Cost Analysis (EE/CA) for Sites 4, 16, and 21 Removal Actions, Naval Weapons Station, Yorktown, Virginia" (Baker/WESTON, March 1994), provided as an attachment to this Action Memorandum.

The following subsections present a brief summary of the site conditions and background for Sites 4, 16, and 21.

A. SITE DESCRIPTIONS

1. Removal Site Evaluation

An Initial Assessment Study (IAS) conducted at the Naval Weapons Station Yorktown and summarized in a report published in July 1984, identified Sites 4 and 16 as potential areas of concern. These sites were subsequently studied as part of the Confirmation Studies in 1986 and 1987, and as part of the Round One Remedial Investigation (RI) activities performed in 1992. These studies indicated that the surface water, sediment, groundwater, and soils have been impacted by the previous disposal activities at the sites.

Site 21 was discovered by Naval Weapons Station (WPNSTA) Yorktown personnel in November 1990. A Site Inspection (SI) was performed at the site in 1991; Site 21 was included in the Round One RI program. These investigations indicated that the groundwater and surface water in the vicinity of the site had been impacted by the wastes disposed.

Sites 4, 16, and 21 were investigated in December 1992, to obtain data for a potential removal action at these sites. This study consisted of the excavation of test trenches and the collection of samples from the excavated areas and the removed materials.

2. Physical Location

Site 4, the Burning Pad Residue Landfill, and Site 21, the Battery and Drum Disposal Area, are located in the north-central portion of WPNSTA Yorktown, along the eastern branch of

Felgates Creek. South of these sites is the explosives burning facility, which is operated as an interim status facility under the Resource Conservation and Recovery Act (RCRA). Due to the proximity of the burning pad, activities (such as removal actions) cannot be conducted during the intermittent operation of this facility. Sites 4 and 21 are separated by a distance of approximately 100 feet by a drainage way leading to Felgates Creek. Site 16, also included as part of this Action Memorandum, is located approximately 3/4-mile upstream of Site 21.

Site 16, the West Road Landfill, is located in the east-central area of WPNSTA Yorktown, adjacent to West Road near Indian Field Road. Site 16 is slightly downstream of Lee Pond, a manmade impoundment located upgradient of the eastern branch of Felgates Creek. A marsh area and tidal inundation occur directly south of this site along the eastern branch of Felgates Creek.

The land surrounding the three sites is a mixture of residential and light industrial. Sites 4, 16, and 21 are located in the northern portion of WPNSTA Yorktown; the population in the vicinity of the sites is limited to the station personnel and residents.

3. Site Characteristics

Site 4 consists of an approximately 6-acre area located adjacent to the explosives burning facility south of West Road. Site use began in 1940 and ended in approximately 1975. Carbon-zinc batteries (Leclanche type) from underwater weapons, burning pad residues (possibly containing aluminum, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)), tree stumps, fly ash from coal-fired boilers, mine casings, electrical equipment (possibly telephone poles, line hardware, etc.), and transformers (possibly containing polychlorinated biphenyls (PCBs)) were reportedly buried at this site. The landfill received an estimated 17 tons per year (tpy) of waste for approximately 35 years, totaling roughly 595 tons of waste disposed. The landfill is currently primarily clear, with scrub grasses and small trees; larger trees are present on the outer boundary of the landfill. An ash residue pile is located within

the grassy field at the northern boundary of Site 4.

Geophysical studies conducted as part of the Round One RI activities for Site 4 indicated that the depth of fill in the main fill area is approximately 5 to 10 feet. A test pit investigation performed in December 1992 identified a large battery disposal area located in the southeastern part of the site. The batteries are approximately 8 to 32 inches below ground surface (bgs). Landfill material, consisting of construction debris, pipe, glass, concrete, bottles, cans, and drums, was also identified at various locations within the site boundary.

Site 16 is approximately 5 acres in size, and was operated from the 1950s to the early 1960s. The site is currently wooded, except for the western end, which is covered with grasses. Wastes that were reportedly disposed in the landfill include dry-carbon zinc batteries, banding materials, pressure-transmitting fluids possibly containing PCBs, unknown types of chemicals, and 55-gallon drums (contents unknown). More than 100 tons of waste were estimated to be buried at this site.

An investigation performed in December 1992 confirmed the presence of drums, scrap metal, batteries, mine casings, and construction debris on the surface of the landfill. A second waste area was also identified below one of the drum piles during trenching activities. This landfill area, approximately 2 to 9 feet bgs, contained glass containers, cans, and newspapers, which was different from both the reported disposal materials and the observed surface wastes. The areal extent of this subsurface disposal is unknown.

Site 21, approximately 1 acre in size, was discovered in 1990. A site reconnaissance identified the presence of surficial drums of various size, batteries (Leclanche type), empty solvent containers, and scrap metal. Scattered waste was noted, as well as several areas of concentrated waste dumping. The amount of material disposed is unknown. Geophysical studies performed at Site 21 indicate that the fill area is approximately 200 ft by 200 ft, with well-defined boundaries.

Site 21 was also investigated as part of the test pit study performed in 1992. This investigation indicated the presence of approximately 5 to 8 inches of topsoil, under which battery fill was present at thicknesses of 2 to 6 ft. The batteries were carbon-zinc dry-chemistry type, consistent with the type observed on the surface.

WPNSTA Yorktown is a federally-owned facility. As such, the Department of the Navy (DON) has the responsibility and authority for conducting response actions. The response actions being proposed herein are being initiated as the first removals at these sites.

4. Release or Threatened Release into the Environment of a Hazardous Substance, Pollutant, or Contaminant

Previous investigations have detected contaminated media at Sites 4, 16, and 21. Heavy metals, nitramine compounds, and BNAs are the most prevalent constituents, with volatile organic compounds (VOCs) also detected in the groundwater at Sites 4 and 16. Several of these compounds are hazardous substances as defined by Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the remaining constituents are pollutants and/or contaminants as defined by Section 101(33) of CERCLA. Some of the levels of metals, including aluminum, beryllium, cadmium, chromium, iron, lead, manganese, mercury, and zinc, were present in the groundwater above the Virginia Groundwater Standards (VGS) and/or the federal Maximum Contaminant Levels (MCLs). Metals concentrations in the surface waters adjacent to these sites were also above state and federal standards. The trichloroethene concentrations present in the groundwater at Site 4 also exceeded federal MCLs.

The surficial wastes present at these three sites pose a threat of release from the potential leaking of containers and drums. The batteries and ash pile also present a threat of continued release from leaching of the materials and surface runoff.

5. National Priority List (NPL) Status

WPNSTA Yorktown was placed on the National Priority List on 15 October 1992. The station received a Hazard Ranking System (HRS) score of 50. Remedial investigation activities are currently in progress at WPNSTA Yorktown (see Subsection II.B.2)

6. Figures and Illustrations

Figure A-1 provides the location of WPNSTA Yorktown. Figures A-2 through A-4 provide the presently identified extents of surficial debris at Sites 4, 16, and 21, respectively.

B. OTHER ACTIONS TO DATE

1. Previous Actions

A Community Relations Plan was established for WPNSTA Yorktown in September 1991. Community relations brochures were distributed as part of the community relations plan to provide local residents with details on the investigation activities conducted to date and on proposed activities. Information repositories have been set up at the Naval Weapons Station Yorktown Library, Building 705; the Newport News City Public Library, Virgil Grissom Branch; Gloucester Public Library; Jamestown-Williamsburg Public Library; and York County Public Library. These repositories house copies of reports detailing previous studies, historic information, and the Community Relations Plan.

2. Current Actions

WPNSTA Yorktown is currently undergoing a Remedial Investigation being conducted in accordance with the CERCLA and Superfund Amendments and Reauthorization Act of 1986 (SARA) guidance. The current RI process at WPNSTA Yorktown was begun in May 1992 with the issue of the Round One RI Work Plans. The RI studies are expected to be completed in July 1996 for Site 16 and in September 1998 for Sites 4 and 21. Full-scale remedial

activities at WPNSTA Yorktown are currently scheduled to be initiated in November 1998 for Site 16 and in December 2000 for Sites 4 and 21.

C. FEDERAL, STATE AND LOCAL AUTHORITIES' ROLE

1. Federal, State and Local Actions to Date

The Virginia Department of Environmental Quality (VDEQ) has reviewed and provided comments on the EE/CA prepared for the removal actions at Sites 4, 16, and 21. In addition, since WPNSTA Yorktown is currently on the NPL, the EPA has been involved in the review and comment process for the removals proposed at the three sites. The VDEQ has the responsibility for determining the applicable State ARARs. The Department of the Navy, after working closely with the EPA, has the responsibility for determining Federal ARARs.

2. Potential for Continued Federal/State/Local Response

There is no involvement of the State or EPA in the removal actions other than providing advisory information, as the Navy is the lead agency for the removal actions. However, since the proposed removal actions include the collection of environmental samples, EPA and the VDEQ will have the role of reviewing and approving the field sampling plan and the quality assurance project plan prepared for these activities, in accordance with 40 CFR Part 300, Section 300.415. The VDEQ has the responsibility to contact other appropriate state and/or county agencies to establish the following:

- The presence of any threatened or endangered species at the three sites and what precautions will need to be taken during the proposed removal action to protect such species.

- The potential impact the removal actions may have on the Virginia Coastal Zone and what actions will need to be undertaken to protect the coastal area.

- The compliance requirements for the land disturbing activities in accordance with the Virginia Stormwater Management Regulations.

In addition, the disposal facility selected to receive any hazardous wastes must be approved by EPA. The determination of "acceptable facilities" means that the facility must be evaluated by EPA and found acceptable to receive CERCLA wastes; after this occurs, such a facility can continue to receive CERCLA wastes until otherwise notified (i.e., a separate evaluation is not required for each CERCLA waste). The Navy will notify EPA in a timely manner when the determination of the off-site disposal facility has been made.

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT

A. THREATS TO PUBLIC HEALTH OR WELFARE

The surficial waste materials present at Sites 4, 16, and 21 currently do not pose a threat to public health or welfare, as these sites are restricted by limited access to the Naval Weapons Station Yorktown. The sites are not located immediately adjacent to the residential areas of the station, so that the potential for contact with the waste by children at the station is minimal. WPNSTA Yorktown personnel may be required to conduct routine working activities in the vicinity of the sites (e.g., at the burning facility or at buildings and the railroad located near Site 16). However, the waste materials on the surface, for the most part, are located away from these areas, and direct contact is not anticipated to be a concern.

Although the concentration of VOCs and metals in the groundwater exceed state and/or federal standards, ingestion of groundwater presently is not a threat to public health or welfare, as on-site groundwater is not used as a drinking water source. WPNSTA Yorktown receives its drinking water from a public water supply fed by surface water reservoirs. However, the potential does exist for continued contamination of the groundwater due to the presence of these materials on the surface and their potential to provide an ongoing source of contamination.

B. THREATS TO THE ENVIRONMENT

Potential receptors, including benthic macroinvertebrates, birds, small mammals, and other aquatic and terrestrial life, may be exposed to chemical constituents (both hazardous substances and pollutants) in the soils, surface water, and sediment. The surficial wastes at Sites 4, 16, and 21 present a continued source of contamination at these sites, via surface runoff, leaching or direct release of contaminants.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances from Sites 4, 16, and 21, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, welfare, and/or the environment.

V. PROPOSED ACTION AND ESTIMATED COSTS

A. PROPOSED ACTIONS

1. Proposed Action Description

The proposed action is the excavation and disposal of contaminated surficial soils and debris. Contaminated material will be disposed in a hazardous waste (RCRA Subtitle C) landfill. Hazardous materials will be determined through sampling to be performed during the removal activities. Materials (wastes and/or soils) that are found not to be hazardous, but are still classified as wastes, will be recycled and/or disposed at a sanitary or industrial landfill, as deemed appropriate. The following quantities of wastes and soils have been estimated for the removal actions to be performed at the three sites:

- Hazardous Wastes (i.e., batteries, ash pile, drums and associated soils) - 7,523 cubic yards.

- Solid wastes (i.e., drums and surficial wastes) - 828 cubic yards.

The proposed actions will utilize conventional equipment and removal methods that will be effective in removing the threat to human health and the environment. No wetlands will be impacted as a result of the removal activities to be performed at these three sites.

Confirmation sampling will be performed following excavation. For the ash pile excavation, soil samples will be collected and the analytical results compared against EPA Region III risk-based concentrations. Excavation of the ash pile will continue until the criteria concentrations (presented in Appendix C of the EE/CA) have been met, or until further excavation is no longer feasible. For the excavation of other areas (waste materials and batteries), soil samples will also be collected. The analytical results from these samples will be used in future RI activities (e.g., baseline risk assessment).

2. Contribution to Remedial Performance

The implementation of the proposed removal actions will also have a positive affect on future remedial actions at the sites. The disposal of the surficial waste materials (e.g., mine casings, construction debris) will make the sites more accessible to equipment and personnel for any remedial activities to be performed. The removal and disposal of the other surficial wastes (drums and batteries) will also remove the potential for further contamination due to the existence of these source areas. This will aid in protecting the environment until the long-term remedial activities are implemented.

3. Description of Alternative Technologies

Alternatives that were considered but not retained for evaluation included those that do not involve off-site land disposal: containment, on-site treatment, and on-site disposal. These alternatives were not retained in the decision process due to their inability to alleviate the threat to human health and the environment in a timely or cost-effective manner. In addition, other removal scenarios (addressing surficial debris and associated soils) were considered. These alternatives did not meet the objectives of the removal actions, and were eliminated from the

evaluation process. The EE/CA prepared for these sites presents the alternatives considered and their associated costs.

4. EE/CA

The EE/CA prepared for these sites has been reviewed by EPA and the VDEQ. A 30- day public comment period was held from 30 May to 28 June 1993. During this comment period, EPA and the VDEQ provided comments on the EE/CA; these comments were incorporated into the final EE/CA. The comments received and the responses prepared are included as Attachment B to this Action Memorandum.

5. Applicable or Relevant and Appropriate Requirements (ARARs)

Federal and State ARARs that have been determined to be applicable to these sites include:

- Virginia Hazardous Waste Regulations
- Virginia Solid Waste Regulations
- Virginia Air Pollution Control Regulations
- Fish and Wildlife Coordination Act
- Occupational Safety and Health Administration (OSHA) Requirements for Hazardous Waste Workers
- Department of Transportation Rules for Transport of Hazardous Materials
- Endangered Species Act
- Coastal Zone Management Act
- National Historic Preservation Act
- RCRA Land Disposal Restriction Regulations
- Virginia Stormwater Management Act
- Virginia Erosion and Sedimentation Control Laws

6. Project Schedule

The proposed project schedule for the removal actions at Sites 4, 16, and 21 is:

- Action Memorandum approved — 11 March 1994
- Contractor Mobilization — 14 March 1994
- Removal Actions Completed — 1 August 1994

B. ESTIMATED COSTS

The estimated cost for this proposed action is $5,542,450. The details on the cost estimates are provided in the Appendix to the EE/CA.

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Contamination is expected to continue, via surface runoff or leaching through the ground surface. This would potentially impact the surface water, sediment, soils, and shallow groundwater in the vicinity of these sites.

VII. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues associated with this removal action.

VIII. ENFORCEMENT

The Navy, as the lead agency for this removal action, will perform the proposed removal action in a timely and efficient manner.

IX. RECOMMENDATION

Conditions at the site meet the National Oil and Hazardous Substances Contingency Plan (NCP) section 300.415(b)(2) criteria for a removal action; therefore, a proposed removal action is submitted for approval. Response actions should commence as soon as practical due the potential for the continued migration of contaminants from these sites into the surrounding media. The approval of the proposed removal action at Sites 4, 16, and 21 at the Naval Weapons Station Yorktown is thereby recommended.

Approval by:

Commanding Officer, Naval Weapons Station Yorktown: RCS ltr
R. C. SCHOLES
~~CDR USNR~~ ACTING

Date: 11 MARCH 1994

ATTACHMENT A

FIGURES

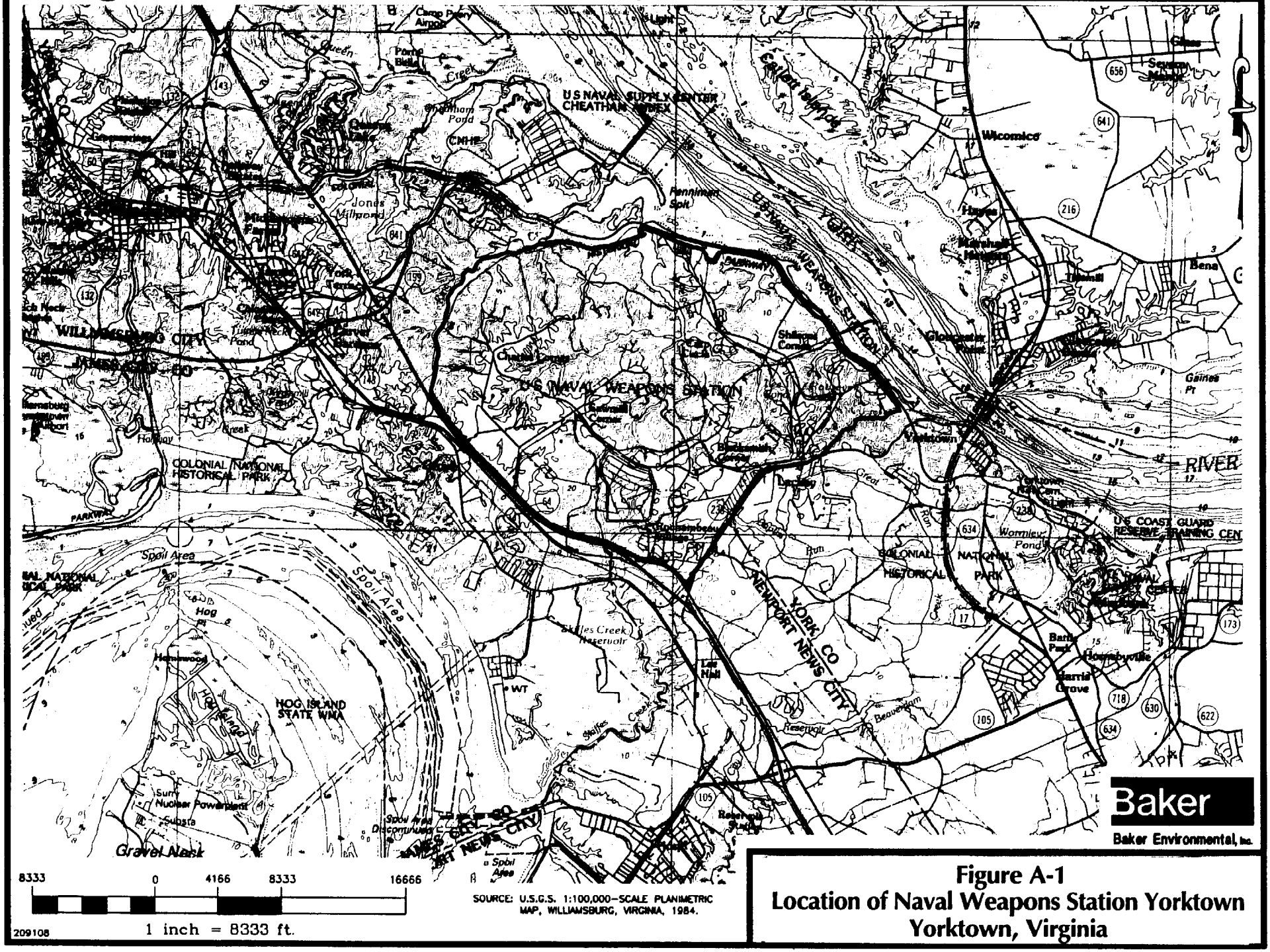
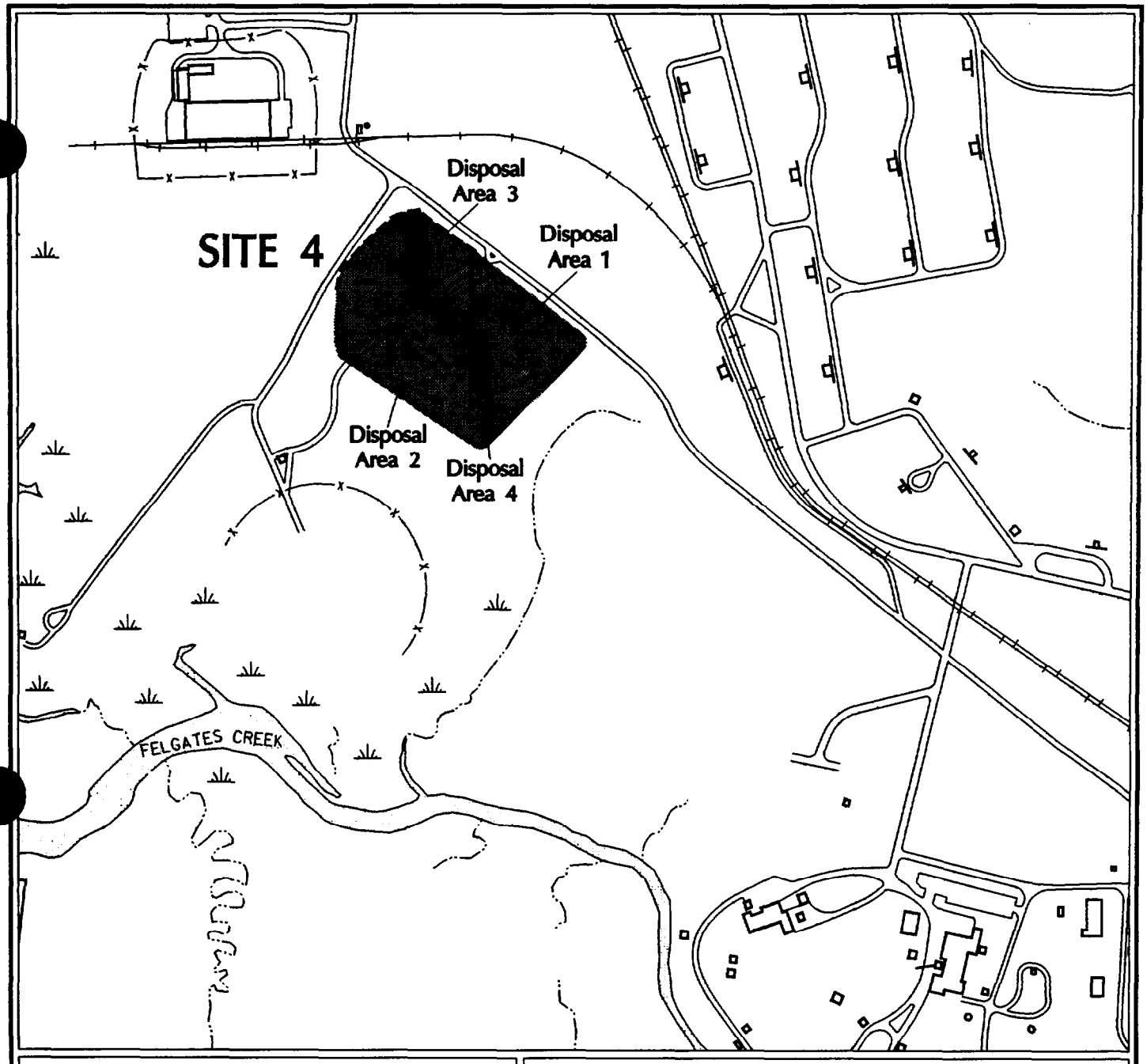
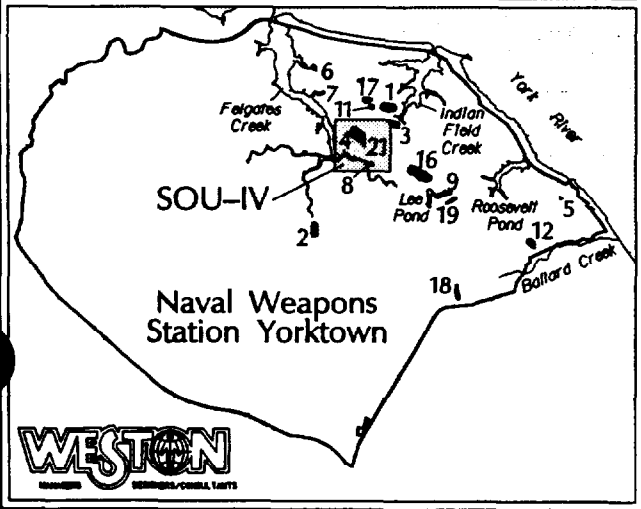


Figure A-1
Location of Naval Weapons Station Yorktown
Yorktown, Virginia



U. S. Navy
Naval Weapons Station Yorktown
Yorktown, VA – March, 1994



SITE 4 — Remedial Investigation Site

Disposal Area 1 — Limits of Waste Materials

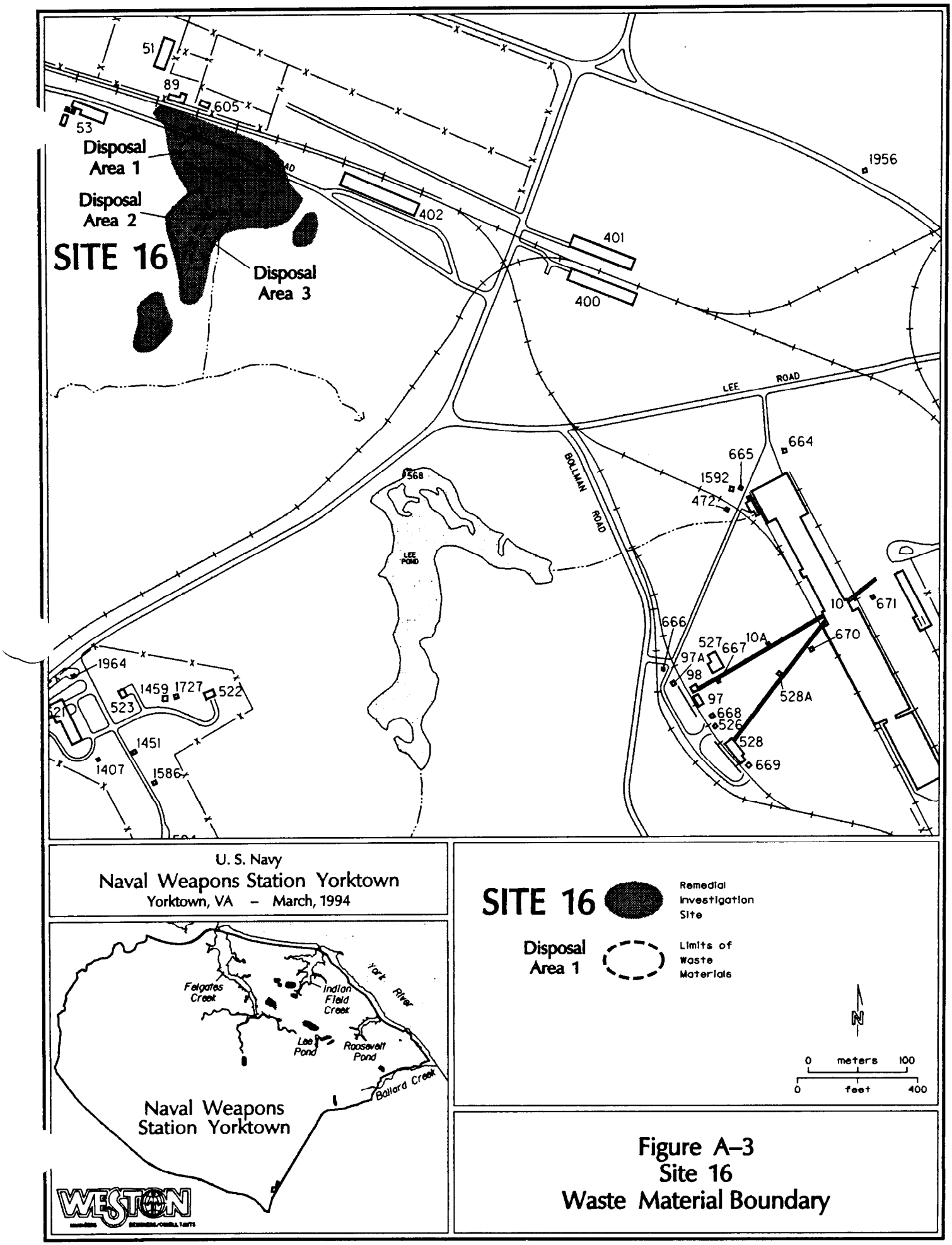
N

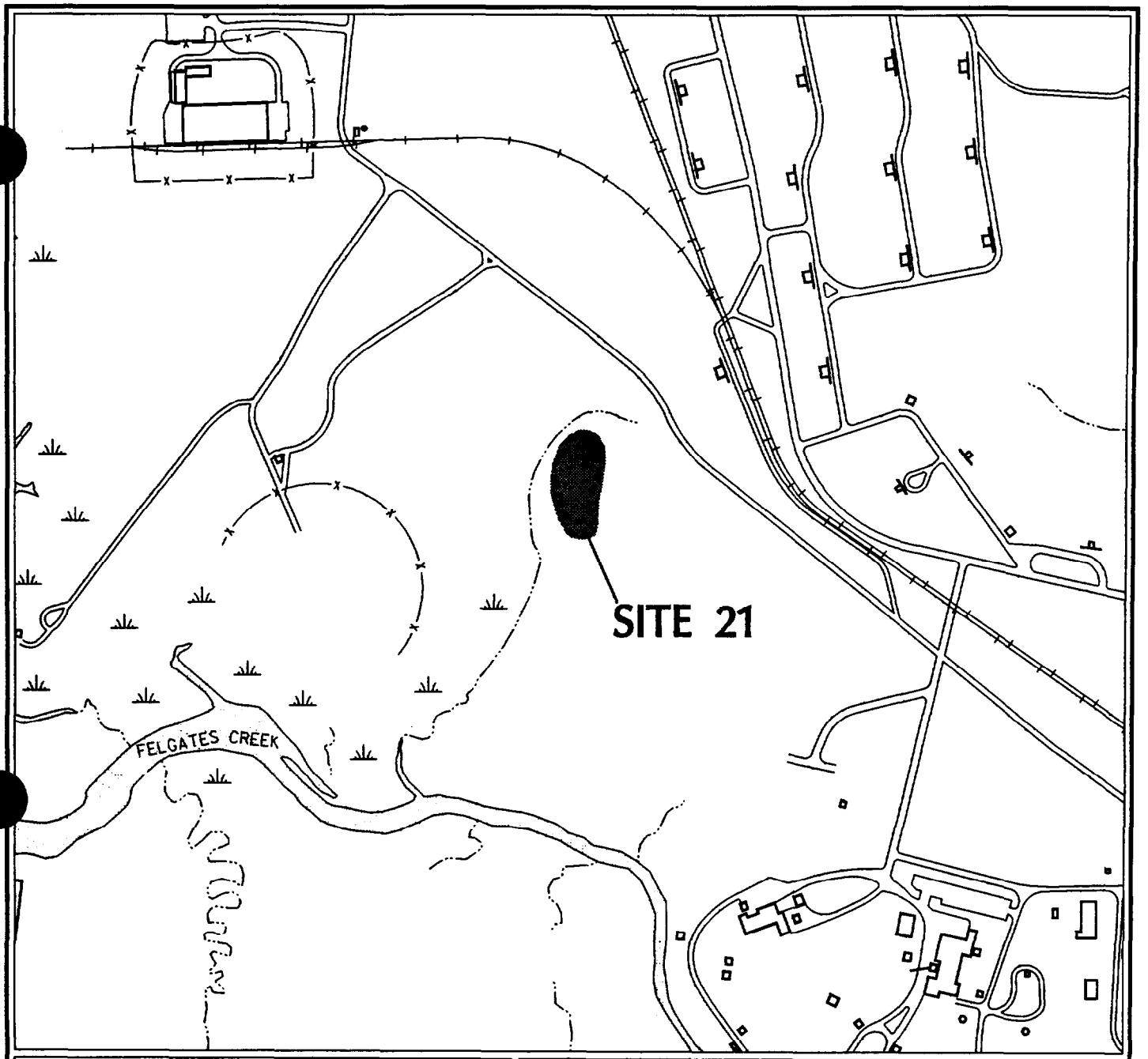
0 meters 100

0 feet 400

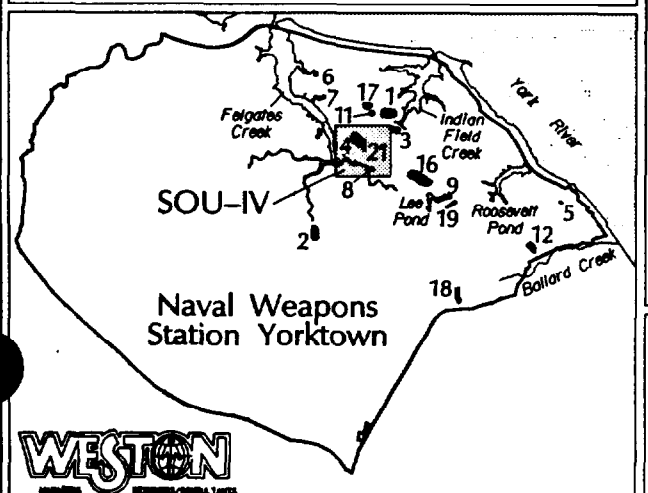
Figure A–2
Site 4
Waste Material Boundary

17-MAR-1994


Disposal Area 1
Disposal Area 2
SITE 16
Disposal Area 3
LEE ROAD
BOLLMAN ROAD
LEE POND
U. S. Navy
Naval Weapons Station Yorktown
Yorktown, VA - March, 1994
Naval Weapons Station Yorktown
Felgates Creek
Indian Field Creek
York River
Lee Pond
Roosevelt Pond
Ballard Creek
SITE 16
Remedial Investigation Site
Disposal Area 1
Limits of Waste Materials
N
0 meters 100
0 feet 400
Figure A-3
Site 16
Waste Material Boundary
17-MAR-1994



U. S. Navy
Naval Weapons Station Yorktown
Yorktown, VA – March, 1994



SITE 21 — Remedial Investigation Site

Limits of Waste Materials

N

0 meters 100
0 feet 400

Figure A–4
Site 21
Waste Material Boundary

17-MAR-1994

ATTACHMENT B

RESPONSIVENESS SUMMARY

RESPONSE TO U.S. ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE DRAFT FINAL ENGINEERING EVALUATION/ COST ANALYSIS FOR SITES 4, 16, AND 21 REMOVAL ACTIONS, NAVAL WEAPONS STATION, YORKTOWN VIRGINIA

These responses have been prepared to address comments received from the U.S. Environmental Protection Agency (US EPA), Region III, regarding the "Draft Final Engineering Evaluation/Cost Analysis (EE/CA) for Sites 4, 16, and 21 Removal Actions, Naval Weapons Station, Yorktown, Virginia" (Baker/WESTON, May 1993). The comments were transmitted to Mr. Thomas Black, Public Affairs Officer at the Naval Weapons Station (WPNSTA), in a letter dated 16 June 1993.

GENERAL COMMENTS

1. For areas where explosive compounds have been burned which include TNT (and possibly RDX), media sampling analysis should be expanded to include cyanide compounds. An important aspect of TNT reactivity involves redox reactions between the reactive methyl group and the nitro groups, a type of reaction which can be initiated by various energetic stimuli including thermal, photochemical and chemical. Thus, all types of nitro compounds react easily with bases forming diverse types of products. In the case of TNT, the 2,4,6-trinitrobenzyl anion is formed initially and rapidly, and is a highly reactive species thought to be intermediate in the many reactions of TNT conducted under basic conditions. The cyanide ion can form from a complex of this anion.

   Cyanide has been detected around the burning grounds at the former West Virginia Ordnance Works facility, where off-spec TNT was open-burned. Therefore, for Site 4 please include cyanide analyses in future sampling events.

   The concern for the presence of cyanide is unclear. In "Military Explosives" (Technical Manual TM-9-1300-214, Department of the Army, 1984), the cyanide (CN^-) ion can form a complex with the 2,4,6-trinitrobenzyl ion. The cyanide ion must be present from another source, since open burning degradation does not generate the CN^- ion. Electron impact degradation can generate HCN after several steps, but these conditions are different than those generated under simple open burning.

   As part of the sampling activities performed during the Round One RI activities at WPNSTA Yorktown, cyanide analyses were performed on surface soil samples at several TNT sites. No cyanide was detected above the method detection limit in any of the samples analyzed. In addition, cyanide was not present in any of the compounds historically burned at Site 4. However, cyanide analysis has been added to the analytical parameter list for the confirmatory sampling.

2. Please beware that, since the removal action areas have not been grid-sampled in their entirety, the possibility of encountering unanticipated contaminant concentrations in the soil is a real possibility. Additionally, some of the solvents disposed of in the landfills may be

listed RCRA wastes, and are therefore hazardous regardless of whether they fail TCLP or not. Please proceed with caution.

If the excavated materials indicate the possible presence of solvents or other hazardous constituents, additional analyses may be added to those specified. Otherwise, the samples will be tested for TCLP as specified.

3. Please note that the TCLP results for the removal action areas detected 2,4,5-trichlorophenol, while the sampling results from the draft RI did not detect this compound. Were the TCLP samples taken from the "worst" visually-contaminated areas at the removal sites?

As stated in the IT Testing Report for Sites 4, 16, and 21, the soil samples at Sites 4 and 16 were collected "from selected trench locations considered representative of the waste materials". The soil samples collected during the Round One Remedial Investigation (RI) program at these 2 sites were collected from the top 2 ft of the soil to evaluate immediate threats to human health and the environment. Since most of the wastes at these sites are not surficial, the absence of these compounds in the surface soil is understandable.

SPECIFIC COMMENTS

1. **Page 3-11, Table 3-2**

It is recommended that the title of this table be changed to: Risk-Based Cleanup Contaminant Removal Levels for Explosives at WPNSTA Yorktown.

This table has been deleted from the EE/CA. The EPA guidance manual has been added as an appendix, since compounds other than explosives will now be used for comparison of the soil samples collected from the ash pile excavation.

2. **Page 3-11, Table 3-2**

Please note that the referenced table has a mixed usage of the Hazard Quotient, H. Those explosive concentration removal levels calculated for H = 1 or 10^{-6} cancer risk include:

2,4-DNT
HMX
RDX
2,4,6-TNT
1,3,5-TNB

Those concentration removal levels calculated for H = 0.1 include:

2,6-DNT

It may be more appropriate to use H = 1 for all the removal action level concentrations. Therefore, the contaminant removal level for 2,6-DNT should be 42 mg/kg based upon H = 1.

See response to comment 1, above.

3. **Page 4-5, First Bullet**
Composite sampling is not recommended by EPA. Compositing tends to dilute the sample, especially in the case of volatiles. Discrete samples, taken at specified intervals, are recommended instead. Discrete samples not only give a more accurate picture of actual field conditions, they also enable one to compare the sample results with the field location. This would enable early detection of "hot spots" within the removal action areas which may contain contaminant levels which fail TCLP analyses.

Discrete samples will be collected instead of compositing. The EE/CA will be modified to reflect this correction.

4. **Page 5-8, Section 5.2.1.3**
As described above, composite sampling is not recommended.

See response No. 3.

5. **Page 5-22, Section 5.3.1.3**
As described above, composite sampling is not recommended.

See response No. 3.

6. **Page 7-2, First Bullet**
The manner in which the excavation boundaries are determined needs to be discussed in greater detail. Will there be a grid-sampling event performed at specified intervals for the entire removal action areas? With the numerous contaminants detected so far at each of the three removal action sites, the probability of discovering "hot spots" with significantly greater concentrations of contaminants, or possibly additional contaminants is real.

The ash pile will initially be excavated to remove all of the ash, plus an additional 6" of underlying soil. The excavated area will be sampled, and the results compared to the risk-based concentrations provided in the guidance document provided as Appendix C to the EE/CA. The exact sampling protocols will be outlined in the sampling plan.

The batteries and wastes will be excavated initially to the limits established through the work performed in the Testing Report. Additional excavation of the batteries will be conducted based on visual inspection and the use of metal detectors. Analytical testing will be performed in the excavated areas. The results of these analyses will be used in future RI/FS activities.

7. **Page 7-2, Second Bullet**
Beware of the TCLP analytical results listed in the Testing Report. These TCLP samples were composited and, therefore, may not be illustrative of the variation in actual field conditions that may be present at the removal action areas. Proceed with caution.

Comment acknowledged. The analytical results for TCLP samples have been used to illustrate, in addition to the results of the Round One RI, the types of contaminants and general concentrations that may be encountered.

8. **Page A-3, Table A-1**

What are the units for Table A-1? EPA is assuming µg/L?

As stated on page A-1, the groundwater data are presented in units of micrograms per liter (µg/L).

RESPONSE TO COMMONWEALTH OF VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY COMMENTS ON THE DRAFT FINAL ENGINEERING EVALUATION/ COST ANALYSIS FOR SITES 4, 16, AND 21 REMOVAL ACTIONS, NAVAL WEAPONS STATION, YORKTOWN VIRGINIA

These responses have been prepared to address comments received from the Commonwealth of Virginia Department of Environmental Quality (VDEQ), regarding the "Draft Final Engineering Evaluation/Cost Analysis (EE/CA) for Sites 4, 16, and 21 Removal Actions, Naval Weapons Station, Yorktown, Virginia" (Baker/WESTON, May 1993). The comments were transmitted to Mr. Thomas Black, Public Affairs Officer at the Naval Weapons Station (WPNSTA), in a letter dated 16 June 1993.

GENERAL COMMENTS

1. Throughout the document the E&S (Erosion and Sedimentation) Plan is cited. The DEQ does not have a copy of this plan on file for reference.

   The E&S plans, along with the Work Plans for the removal actions to be performed at Sites 4, 16, and 21, are currently being revised. These plans will be submitted, upon their completion, to the VDEQ and the EPA for review and comment.

2. The removal action is proposed to help alleviate threats to human health and the environment. However, no baseline risk assessment has been performed to identify these risks.

   The various types of surface debris (e.g., drums, scrap metal, wood and concrete) present at the three sites pose physical hazards to WPNSTA personnel and ecological receptors via accidental contact. The potential for environmental contamination also exists due to the presence of the surface debris and the ash pile. The removal of the surface debris and the ash pile would permanently eliminate the physical hazards to human health and the environment due to these materials, and would also remove potential sources of contamination from the three sites. In addition, the removal of the surficial debris will be beneficial in facilitating future RI/RS work (e.g., ground penetrating radar (GPR) and electro-magnetic (EM) surveys.

3. In many locations in the document, the Virginia Department of Environmental Quality (DEQ or VDEQ) is identified as the Virginia Department of Waste Management, VDWM, VDW, or DWM. These identifiers should consistently read DEQ or VDEQ Waste Division.

   The text will be changed to read VDEQ.

4. On page 4-5, a discussion of Removal Action Alternative 1 begins. In summary, Alternative 1 consists of the following: (1) Complete removal of the ash pile at Site 4 including six inches of underlying soil. A composite sample of the ash pile will then be analyzed for hazardous waste characteristics, followed by proper disposal determined by the analytical results; (2) Drums and other "hard waste" on the surface of Sites 16 and 21, along with other surficial debris and its "associated" soil, will be disposed. As is stated on page 4-5, "No testing is conducted under this response action to determine if all the wastes have been removed." As this is the case, it is unclear how it can be determined that the objectives of the removal action have been met, namely reduction in source, toxicity or mobility of the waste. It appears that additional source material will be left intact on the sites, in the area below 1 foot below ground surface (bgs). Also, compositing of the material in the ash pile for analysis is not a good decision. Compositing would serve to dilute any hot spots in the ash pile and its six inches of underlying soil. According to Ms. Norton, extensive sampling will take place, and all the waste will be removed. However, this is not made clear in the document.

   The sampling that would be performed under Alternative 1, as presented in the revised EE/CA, consists of grab soil samples collected from the ash pile, waste material, and battery excavations, to be analyzed for volatile organic compounds (VOCs), base/neutral acid compounds (BNAs), metals and cyanide, pesticides/polychlorinated biphenyls (PCBs), explosives, and total petroleum hydrocarbons (TPH). This modification is intended to provide additional information about those areas (namely the battery and waste material areas) which will be addressed in later studies, and to confirm the adequate removal of the ash pile and associated soils.

   The drums and other "hard waste", surficial debris, and associated soils will be removed to a depth of 1 ft below ground surface under Alternative 1. This removal would achieve the objective of reducing the source of potential contamination. The goal of the removal action to be selected based on the evaluations in this EE/CA is to address surficial wastes, not to attempt to remove the landfilled materials. These areas will be addressed as part of future RI/FS activities.

   The sampling that will be performed under the chosen alternative (Alternative 2) includes confirmation sampling of the ash pile excavation, waste excavations, and the excavated soils. All sampling conducted under Alternative 2 will be grab samples; no compositing will be done. All of the ash pile (from Site 4) and all of the batteries from the three sites will be removed.

5. On page 4-5, it is stated under Alternative 1 that any water that enters the excavation at Site 4 will be pumped, stored, sampled and disposed in accordance with Commonwealth of Virginia regulations. Please be advised that any wastewater found to be contaminated with any levels (from total levels analysis) above background cannot be considered "clean", and may not be returned to the ground or to another surface water body at the installation. The wastewater should either be drummed and disposed as solid or hazardous waste, as

appropriate, or discharged to the sanitary sewer system with the permission of the appropriate Sanitation District.

Comment acknowledged. Any water that enters the excavation will be pumped out, temporarily stored, and sampled for HW characteristics and any other analysis required by the selected disposal facility, or by the sanitation district, as appropriate. The water may also be processed, if determined to be feasible, through the carbon units that are currently in operation at WPNSTA Yorktown prior to discharge to the Hampton Roads Sanitation District, based on the analytical results.

6. On page 4-5, it is stated that drums containing non-solidified contents will be rinsed and placed in a "clean liquids drum". As the rinseate does not represent clean liquid, the analysis and disposition of this material is uncertain. Please clarify.

The phrase "clean liquids drum" was meant to indicate a liquids drum that was clean. The text will be revised to read "new liquids drum" for clarification.

7. On page 4-8, a brief description of possible on-site treatment alternatives is discussed. However, this discussion is not detailed enough, and should not be included in the EE/CA unless the treatment alternatives are part of the proposed removal action alternatives.

The possible on-site treatment alternatives will be removed from the text.

8. Section 4.3 discusses selective removal of identified waste materials. As I discussed with Ms. Norton, it seems contrary to the intent of the removal action to identify possible sources of additional contamination during the removal action. but then to leave the wastes in place because they were below a certain action depth. Ms. Norton stated that this would not be the case; rather. all identified "hard wastes" would be removed from the site. The EE/CA should be modified to reflect the actual activities which will take place during the removal action.

Selective removals of waste materials will be performed as part of Alternative 2. The ash pile at Site 4 and all of the batteries at the three sites will be removed. These materials pose immediate potential threats to human health and the environment. The batteries will continue to leach metals into the groundwater, surface water, sediment, and soils. Their removal will be beneficial in that the source will be eliminated. The batteries at these sites are, for the most part, present in concentrated areas and can be addressed relatively easily at a moderate removal cost. The intent of the removal action selected, as stated previously, is to remove surficial waste materials and debris. The "hard wastes" that are present in the landfills will be addressed as part of the continuing RI/FS process at WPNSTA Yorktown.

The ash pile presents a hazard in that runoff from the pile contributes to explosives contamination in the surrounding soils and surface water. The removal

of the ash pile can be achieved relatively simply and will mitigate a potential ongoing source of contamination in the vicinity of Site 4.

The removal actions proposed at Sites 4, 16, and 21 are meant to remove potential surficial sources of contamination and physical hazards which exist at these sites. The screening factors which are used to evaluate alternatives include protectiveness, or the ability of the alternative to be protective of the environment and human health. The chosen alternative does provide protection of human health and the environment through the removal of potential sources of contamination.

The selection criteria to evaluate alternatives also includes reasonable cost. Including the removal of all the "hard wastes" (i.e., mine casings, drums, construction debris) would increase the costs of the alternatives dramatically. This elevated cost would result in the elimination of all of the alternatives under consideration and, therefore, provide no protection to human health and the environment. Based on the available funding, the removal actions will provide an interim benefit by removing the surficial sources; the remaining wastes/contamination will be addressed as part of WPNSTA's continuing RI/FS process.

9. Will any dewatering of excavated soils take place? If so, how will the wastewater be managed? Please bear in mind that any discharge to an off-site location may require a VPDES discharge permit, as is stated on page 3-6.

The need for dewatering of soils is not anticipated as part of the removal actions. However, if the dewatering of soils is deemed necessary, the discharge will be disposed on-site, which does not require a permit.

10. Again it should be noted, as is stated on page 5-5, that no confirmation sampling takes place under Alternative 1. It may be prudent to sample remaining contaminant levels at the time of removal rather than during a later phase of the RI process to determine how the remaining contaminants are biodegrading, migrating and/or attenuating with time.

The revised EE/CA contains confirmatory sampling of the ash pile excavation, and sampling of the battery and waste material excavations. These samples will be analyzed for VOCs, BNAs, metals and cyanide, pesticides/PCBs, explosives, and TPH. The results of the analyses for the ash pile excavation will be compared against the risk-based criteria provided in the EPA guidance document provided in Appendix C of the revised EE/CA, and excavation will continue until the concentrations are below the criteria. The information from the sampling of the other excavated areas will be used in future RI/FS activities (e.g., ecological/baseline risk assessments).

11. On page 5-6, Alternative 2 staging areas for excavated wastes are discussed. As I conveyed to Ms. Norton, the DEQ has some reservations regarding the use of staging areas. According to the EE/CA, the soils have been characterized based upon composited soil

samples. Therefore, the actual characterization of the soils to be excavated is questionable. These soils may, in fact, be hazardous waste. In this case, the staging areas represent hazardous waste piles. While permits are not required at NPL sites, this exemption is contingent upon the fact that substantive permit requirements are complied with. In this case, if the excavated soils are hazardous, these staging areas would have to be placed upon some type of polymer sheeting which forms to the liner requirements for waste piles found in the Virginia Hazardous Waste Management Regulations. If the soils are not hazardous, but are still contaminated, it would still be appropriate to use this same type of liner for the staging areas. The specifics of the staging areas is not addressed in the EE/CA.

> *The EE/CA states that a separate staging area may be necessary. The staging areas will be lined with the appropriate grade of plastic sheeting and bermed to prevent the migration of contaminants from the waste piles. The piles will also be covered with plastic sheeting to minimize rainwater intrusion and the possibility of runoff from rain events.*

12. For Alternative 1, as stated on page 5-7, it is described that following excavation, the excavated areas will be backfilled with clean, low permeability fill material. However, for Alternative 2, as is described on page 5-21, will be backfilled with the excavated, staged, potentially contaminated soils from which surficial waste materials have been separated. As I discussed with Ms. Norton, I spoke with John Ely of DEQ's Compliance and Enforcement Program regrading this matter. Backfilling contaminated soils without a landfill permit, either for hazardous or solid wastes, is not allowed.

Since Yorktown NWS is a NPL site, however, the permit exemption exists provided substantive requirements are complied with. The substantive requirements for a landfill permit consist of a proper RCRA lining system, leachate collection system, RCRA cap, cover, etc., in accordance with the Virginia Solid Waste Management Regulations or Virginia Hazardous Waste Management Regulations, as applicable. It would be impractical to comply with the substantive requirements for a landfill at a site where the final remedy would probably require removal of the liner, cap, cover, etc. Therefore, the advisability of backfilling these contaminated soils is questionable, especially without sampling the soils prior to backfilling. Mr. Ely stated that if analysis is performed and risk calculations performed on the soils to be backfilled to show that backfilling will not pose a threat to human health and the environment, the requirements for the landfill substantive requirements can be waived. Ms. Norton stated in our phone conversation that the installation was intending to sample these soils heavily with the intent of performing the baseline risk assessment. However, the EE/CA does not reflect this information.

> *Clean backfill soil will be utilized for the excavated areas. This will consist of low-permeability soils and/or soils which are capable of sustaining vegetative cover similar to the natural cover in these areas. The excavated soils will be sampled to determine the appropriate disposal method. The EE/CA will be changed accordingly.*

13. The phrase "associated soils" is used throughout the report to identify those soils which will be disposed in addition to the hard wastes which are excavated. However, since no analyses

of wastes remaining in place is to be performed, it is unclear how associated soils will be identified and how it will be determined if all associated soils have been excavated.

"Associated soils," for the purpose of the EE/CA, means soils that are excavated along with removed wastes. It is not the intent of the removal action to remove all affected soils. For the ash pile excavation, the analytical results will be compared against the EPA risk-based criteria provided in Appendix C of the revised EE/CA. Residual contamination in the waste material and battery excavations will be addressed as part of the continuing RI/FS process for the three sites.

14. It is stated on page 5-22 that prior to backfilling the ash pile with clean fill, samples from the excavation will be analyzed for explosives. However, as indicated on page 2-14, other contaminants have been identified in the soils around the ash pile. It would be useful to analyze for all these contaminants now, as it may help avoid the need for future work at the site.

The analytical parameters for the soil samples to be collected from the ash pile, waste material, and battery excavations have been expanded to include VOCs, BNAs, metals and cyanide, pesticides, PCBs, explosives, and TPH.

15. On page 5-28, it is stated that using Alternative 2, wastes are removed, significantly reducing the potential threat of exposure to base personnel and animal populations, the potential for the waste material to migrate and the threat of hazardous substances, pollutants, or contaminants in drums or other containers to be released onto the surface. Based upon the information contained in the EE/CA, I do not agree with this statement. Leaving wastes in place below the 1 foot bgs level, and backfilling contaminated soils will not significantly reduce the potential for contaminant migration. On the contrary, actively managing what may currently be a stabilized site could result in further contamination and greater risk to human health and the environment. Contaminated soils which are disturbed and left on the surface could cause contaminated run off from the site, which could further contaminate soil, surface water and groundwater at the site. Also, as is described for Alternative 2, surficial wastes will be separated from non-associated soils and other wastes, by mechanical means or by hand, as necessary. This "by hand" separation of waste where explosives are involved seems to threaten human health. Based upon this, it appears that Alternative 1, as proposed, is the more protective alternative because contaminated soils are removed, not backfilled. As I stated to Ms. Norton, based upon the information provided in the report, it is unclear why Alternative 2 is the preferred alternative for remediation. Ms. Norton stated that the intended method of removal action is not accurately reflected in the EE/CA, nor is the EE/CA detailed enough to provide all the information necessary.

The removal of the waste as outlined under Alternative 2 will significantly reduce the potential threat of exposure to human and animal populations. As stated previously, the complete removal of the ash pile and batteries will eliminate a potential source of contamination. The wastes that will be left in place below the 1 ft bgs depth will be covered with clean backfill material (see response to comment 12). This will reduce the potential for dermal contact with contaminated

media and will also lessen the potential for contaminant migration due to surface runoff and percolation through the ground surface. Engineering controls and interim measures will also be used (e.g., erosion and sedimentation controls) to minimize the contaminant migration from the sites.

All explosives-related wastes (e.g., mine casings, weapons hardware) will first be evaluated by the WPNSTA Explosive Ordnance Disposal (EOD) to ensure that the wastes are inactive. The EOD have already conducted a preliminary assessment of the various weapons casings present at the sites; the weapons that will be removed are anticipated to be inert, with slight residues possible. The majority of the hand-picked wastes will be batteries or other isolated wastes, which would not be removed effectively using mechanical equipment. The mine casings, which are anticipated to be the majority of the potential explosives-containing waste, are large and will have to be removed with equipment.

Alternative 2 is the preferred alternative because it achieves the most overall benefit to human health and the environment at reasonable cost. The backfilling of contaminated soils will not be conducted, in response to your comments; clean, low permeability soils will be used, thereby limiting potential exposure and migration pathways.

bert Hicks, Jr.
Director

Administration
Natural Heritage
Planning & Recreation Resources
Soil & Water Conservation
State Parks

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 302

TDD (804) 786-2121 Richmond, Virginia 23219-2010 (804) 786-6124 FAX:(804) 786-6141

February 14, 1994

K.C. Das, Ph.D., P.E.
Department of Environmental Quality
P.O. Box 10009
Richmond, Virginia 23240-0009

re: Superfund Removal Activities for Sites 4, 16 and 21
Yorktown Naval Weapons Station

Dear Ms. Das:

The Department of Conservation and Recreation (DCR) has reviewed the subject project and offers the following comments.

DCR supports the reduction of nonpoint source pollution potential from the toxics leaching into groundwater from these sites. Care should be taken so that removal efforts do not exacerbate the situation by exposing toxic pollutants to rainfall events.

The proposed project is not anticipated to have any adverse impacts on existing or planned recreational facilities nor will it impact any streams on the National Park Service Nationwide Inventory-Final List of Rivers, potential State Scenic Rivers or existing or potential State Scenic Byways.

DCR has searched its Biological and Conservation Datasystem (BCD) for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources (NHR's) are defined as the habitat of rare, threatened or endangered plant and animal species, unique or exemplary natural communities and significant geologic formations. According to the information currently in our files, there are no natural heritage resources documented in the project area. The absence of data may indicate that the project area has not been surveyed, rather than confirm that the area lacks natural heritage resources. New and updated information is continually added to BCD. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

Thank you for the opportunity to comment on this project.

Sincerely,

John R. Davy, Jr.
Planning Bureau Manager

JRD:ikr

ATTACHMENT C

FINAL ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) FOR SITES 4, 16, AND 21 REMOVAL ACTIONS NAVAL WEAPONS STATION YORKTOWN

FINAL

ENGINEERING EVALUATION/ COST ANALYSIS (EE/CA) FOR SITES 4, 16, AND 21 REMOVAL ACTIONS NAVAL WEAPONS STATION, YORKTOWN, VIRGINIA

CONTRACT NO. N62470-89-D-4814

Prepared for:

Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia

March 1994

Prepared by:

Baker Environmental, Inc.
Coraopolis, Pennsylvania

Roy F. Weston, Inc.
West Chester, Pennsylvania

W.O. No.: 06629-001-012-3000-00

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LIST OF ACRONYMS

AET	Apparent Effects Threshold
ARARs	Applicable or Relevant and Appropriate Requirements
Baker	Baker Environmental, Inc.
BAT	Best Available Technology
bgs	below ground surface
BNA	Base/Neutral/Acid Organic Compounds
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CWA	Clean Water Act
DCA	Dichloroethane
DCE	Dichloroethylene
DNT	2,4-dinitrotoluene
DOT	Department of Transportation
EE/CA	Engineering Evaluation/Cost Analysis
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ER-L	Effects Range Low
ER-M	Effects Range Median
E&S	Erosion and Sedimentation
ft	feet
FS	Feasibility Study
gpm	gallons per minute
HASP	Health and Safety Plan
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HW	Hazardous Waste
IAS	Initial Assessment Study
ICR	Ignitability, Corrosivity, and Reactivity

LIST OF ACRONYMS
(Continued)

IR	Installation Restoration
IT	International Technology Corporation
LANTDIV	Atlantic Division
MCL	Maximum Contaminant Level
MSL	mean sea level
NAVFACENGCOM	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NSC	Naval Supply Center
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste Emergency Response
PCB	Polychlorinated biphenyl
PMCL	Proposed Maximum Contaminant Level
ppm	parts per million
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	Reference Dose
R&D	Research and Development
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SWMF	Solid Waste Management Facility
TBC	To Be Considered
TCA	Trichloroethane
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leachate Procedure
TDS	Total Dissolved Solids

LIST OF ACRONYMS
(Continued)

TNT	Trinitrotoluene
TPH	Total Petroleum Hydrocarbons
tpy	tons per year
TRC	Technical Review Committee
TSCA	Toxic Substances Control Act
USC	United States Code
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
VDEQ	Virginia Department of Environmental Quality
VGS	Virginia Groundwater Standards
VOC	Volatile Organic Compound
VPDES	Virginia Pollutant Discharge Elimination System
VWQS	Virginia Water Quality Standards
WESTON	Roy F. Weston, Inc.
WPNSTA	Naval Weapons Station

SECTION 1
INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) contains a comparative evaluation of removal alternatives for removing various contaminants and debris present at Sites 4, 16, and 21 located at the Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. These sites were included as part of the Round One Remedial Investigation (RI) activities. These sites have undergone extensive soil, sediment, surface water, and groundwater investigations and waste characterization activities. The results of those activities are described in detail in the "Final Round One Remedial Investigation Report for Sites 1-9, 11, 12, 16-19, and 21, Naval Weapons Station, Yorktown, Virginia" (Baker/WESTON, July 1993) and the "Testing Report, Combined Hazardous Waste, Yorktown Project, Contract No. N47408-92-D-3045, Delivery Order 0002" (International Technology Corporation (IT), February 1993).

Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, or Superfund) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) provides that removal actions are part of the response process and are often the first response to a release or threatened release. A removal action is considered appropriate when hazardous substances, pollutants, or contaminants in storage containers, such as drums or barrels, pose a threat of release. Prior to performing a non-time-critical removal action (which means a removal action for a site or sites that has a planning period of 6 months or more), the National Oil and Hazardous Substances Contingency Plan (NCP) requires the lead agency to conduct an EE/CA.

The EE/CA is a brief analysis of removal alternatives for a site or sites, prepared to document the removal action alternative evaluation and selection process. Submittal of this document will fulfill the requirements of the National Environmental Policy Act of 1969 (NEPA) for non-time-critical actions and the requirements defined by CERCLA, SARA, the NCP, and the Superfund Removal Procedures. Non-time-critical removal actions are defined by the U.S. Environmental Protection Agency (EPA) as actions that may be delayed

for 6 months or more before on-site cleanup is initiated (i.e., 6-month planning period). This EE/CA has been prepared in accordance with the "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (EPA Office of Solid Waste Emergency Response (OSWER), August 1993) and "Navy/Marine Corps Installation Restoration Manual" (U.S. Department of the Navy and U.S. Marine Corps, February 1992).

This EE/CA has been prepared by Roy F. Weston, Inc. (WESTON®) under subcontract to Baker Environmental, Inc. (Baker) as part of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program. The Naval Facilities Engineering Command (NAVFACENGCOM), Atlantic Division (LANTDIV) has contracted the Baker Team (Baker/WESTON) to prepare the EE/CA for Sites 4, 16, and 21 at WPNSTA Yorktown.

1.1 OBJECTIVE AND GOALS

The objective of this document is to evaluate removal alternatives for Sites 4, 16, and 21. Individual goals of this EE/CA are to: 1) satisfy environmental review and public relations requirements for removal actions; 2) satisfy administrative record requirements for improved documentation of removal action selection; and 3) provide a framework for evaluating and selecting alternative technologies. The following information is presented within this EE/CA:

- An overall and specific site description, including details of previous studies and analytical data.
- Identification of the removal action objectives for Sites 4, 16, and 21.
- Identification of removal actions and technologies.
- Recommendation of a qualified removal alternative.
- Schedule and estimated cost for the selected removal alternative.

The removal actions and technologies will be compared on a basis of technical feasibility, institutional requirements, human health and environmental issues, and cost to provide a

framework for selecting the appropriate alternative. For the purposes of this document, removal actions are defined as the removal of surface and/or subsurface materials at Sites 4, 16, and 21, which includes visible debris such as drums, batteries, scrap metal, and miscellaneous electrical equipment. Asbestos pipes, which were identified in previous investigations, were removed by WPNSTA Yorktown Public Works personnel in September 1992; therefore, these materials are not included in the scope of this EE/CA. Removal of additional contaminants will be evaluated as part of the WPNSTA Yorktown Feasibility Study (FS) to be conducted upon completion of the RI. The scope of removal actions is discussed further in Section 3 of this EE/CA, entitled "Identification of Removal Action Objectives".

A Remediation Contractor will be selected to perform the removal actions as described in this EE/CA. It will be the responsibility of the Remediation Contractor to: 1) ensure compliance with the applicable regulatory requirements (e.g., preparation of an Erosion and Sedimentation (E&S) Plan) and waste disposal approvals; 2) provide personnel to inspect the material at the sites to determine its potential for recycling and disposal requirements; 3) track and document all removals, sampling and analysis reports, disposal manifests, and restoration activities; 4) develop and implement a Health and Safety Plan (HASP); and 5) maintain the necessary E&S controls following the removal activities for a specified time period.

The administrative record requirements for non-time-critical removals include preparation and approval of the EE/CA, as well as preparation of the Notice of Availability to the Public, a response summary to public comments following the 30-day comment period, and preparation of the Action Memorandum.

SECTION 2
SITE CHARACTERIZATION

2.1 BASE HISTORY/CURRENT MISSION

WPNSTA Yorktown, Virginia (originally named the U.S. Mine Depot), was established in 1918 to support the laying of mines in the North Sea during World War I. The establishment of the depot was the culmination of a search process, begun in 1917 at the request of Congress, to locate an Atlantic coast site for a weapons handling and storage facility. For 20 years after World War I, the depot received, reclaimed, stored, and issued mines, depth charges, and related materials. During World War II, the facility was expanded to include three additional trinitrotoluene (TNT) loading plants and new torpedo overhaul facilities. A research and development (R&D) laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the activity, which included the design and development of depth charges and advanced underwater weapons. On 7 August 1959, the U.S. Mine Depot was redesignated the U.S. Naval Weapons Station. The primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

2.2 INSTALLATION DESCRIPTION

WPNSTA Yorktown is a 10,624-acre facility located in both York and James City Counties, and in the City of Newport News, Virginia, on the York-James Peninsula (see Figure 2-1). The York-James Peninsula occupies an area of approximately 1,752 square miles (of which WPNSTA Yorktown covers approximately 16 square miles). The peninsula is bordered on the southwest by the James River, on the northeast by the York River, and on the southeast by the confluence of the James River and the Chesapeake Bay. At WPNSTA Yorktown, the peninsula is approximately 6 miles wide. The facility is bounded on the northwest by the Naval Supply Center (NSC) Cheatham Annex; on the northeast by the York River and

the Colonial National Historical Parkway; on the southwest by State Route 143 and Interstate 64; and on the southeast by State Route 238 and the community of Lackey.

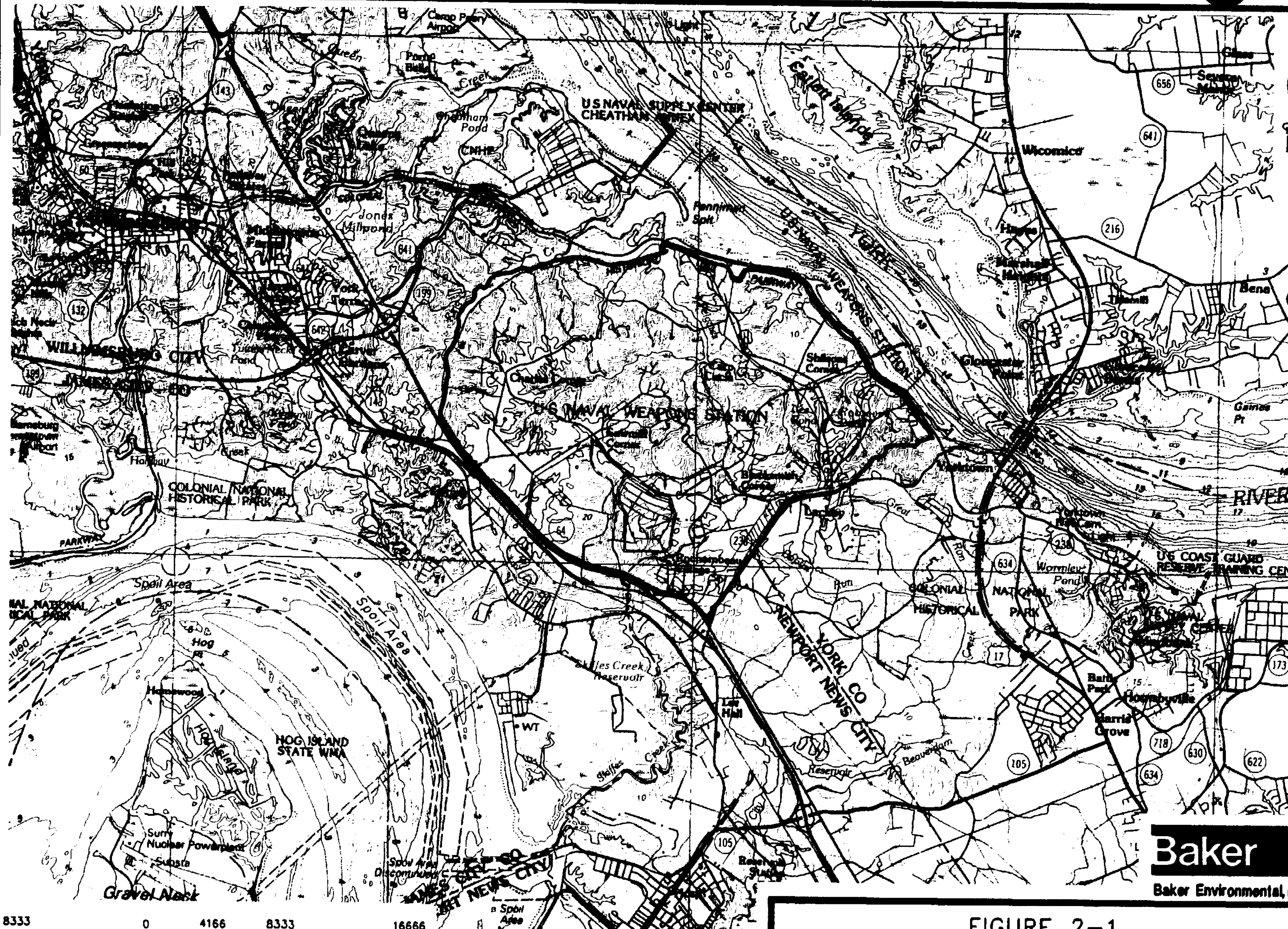
2.2.1 Local Topography at WPNSTA Yorktown

The local terrain is gently rolling and dissected by ravines and stream valleys trending predominantly northeastward toward the York River. Ground elevations at WPNSTA Yorktown range from sea level along the eastern boundary, which borders the York River, to a maximum elevation of approximately 90 feet (ft) above mean sea level (MSL) near the central portions of the York-James Peninsula, roughly coincident with the Old Williamsburg Road. Valleys consisting of 40- to 60-ft ravines with steep slopes (slopes exceeding 10:1 gradient) occur along several of the creeks that drain WPNSTA Yorktown, particularly in the northern section of the installation along the York River.

2.2.2 Local Hydrogeology at WPNSTA Yorktown

The shallow lithology at WPNSTA Yorktown consists of an upper sand, a clay-silt unit, basal gravel/shell, and sediment of the Pliocene and Pleistocene ages. Deposits range in thickness from 20 ft at the western end of the peninsula to approximately 150 ft at the seaward end in the vicinity of WPNSTA Yorktown. The sand and gravel/shell units are both water-bearing and are commonly separated by the clay-silt layer, which may function as a confining or semiconfining unit. Collectively, these units form the shallow aquifer system at WPNSTA Yorktown.

In the shallow aquifer system of York County, Brockman and Richardson (1992) differentiate between the Columbia aquifer and the Cornwallis Cave aquifer based on the presence or absence of artesian conditions. Deep drainages present in the northern part of WPNSTA Yorktown occasionally breach the clay-silt layer of the Cornwallis Cave confining unit and expose the underlying units to atmospheric pressures. Therefore, the sand unit and the lower gravel and shell unit generally exist under water table conditions. The gravel and shell unit may be present as a confined unit in the easternmost part of the station,



8333 0 4166 8333 16666

1 inch = 8333 ft.

209108

SOURCE: U.S.G.S. 1:100,000-SCALE PLANIMETRIC MAP, WILLIAMSBURG, VIRGINIA, 1984.

Baker

Baker Environmental, Inc.

FIGURE 2-1
LOCATION OF NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

consistent with the lithologic description from the boring log for background monitoring well BGGW02A.

The Columbia aquifer is recharged by precipitation. The Cornwallis Cave aquifer is recharged by infiltration from leakage through the clay-silt unit (the Cornwallis Cave confining unit [Brockman and Richardson, 1992]). Some exchange also takes place between surface water in the creeks and ponds and in the Cornwallis Cave aquifer. The direction of groundwater flow across the station is generally to the east-northeast toward the York River, but locally trends toward groundwater discharge zones and appears to coincide with surface streams. The top of the water table generally reflects the topography.

Data from monitoring wells installed throughout WPNSTA Yorktown as part of the Confirmation and RI Studies were used to assess the depth to groundwater within the York County shallow aquifer system. The groundwater levels for summer and fall 1992 indicated depths generally less than 30 ft below ground surface (bgs) throughout upland areas of WPNSTA Yorktown. At areas of WPNSTA Yorktown that are located close to surface water bodies, the depth to the water table is frequently less than 5 ft. The data from the monitoring wells confirmed that the groundwater flow direction within the shallow system is generally toward groundwater discharge zones coincident with surface drainages and streams. The monitoring well data also confirmed that the water level elevations roughly reflect the surface topography. Seasonal variations in groundwater flow direction within the shallow aquifer were not evident based upon the winter 1986 and fall 1987 data.

Surface water from reservoirs supplies the dominant source of domestic (individual home) water in many parts of James City and York Counties, as well as WPNSTA Yorktown.

Four wells at WPNSTA Yorktown, located at Buildings 120, 352, 304, and 28, were completed in the principal artesian aquifer at depths of 445, 470, 480, and 538 ft bgs, respectively. The rated capacity of two of the wells is reportedly 300 gallons per minute (gpm) each. The wells were originally intended as emergency sources of potable water supplies in the event that off-station supplies were inadequate (C.C. Johnson, 1984);

however, based on water quality analysis, water from the wells was not certified as potable by the Virginia State Health Department due to high hardness and elevated amounts of both total dissolved solids (TDS) and fluorides. The wells at Buildings 120, 304, and 352 have been decommissioned, but they still remain accessible for use in groundwater monitoring, if necessary; however, the well at Building 28 has been permanently closed and capped.

The dominant surface water features at WPNSTA Yorktown are the tributaries to the York River, Felgates Creek, Indian Field Creek, and their associated streams. These creeks are tidal and are in communication with the uppermost groundwater system.

2.3 SUMMARY OF PREVIOUS INVESTIGATIONS AND AVAILABLE ANALYTICAL DATA

2.3.1 Previous Investigations

Prior to the most recent (1992) Round One RI activities, an Initial Assessment Study (IAS), a Confirmation Study, and a RI Interim Report were completed at WPNSTA Yorktown. The results of the IAS are summarized in the report entitled "Initial Assessment Study of Naval Weapons Station, Yorktown, Virginia," which was prepared by C.C. Johnson & Associates, Inc. and CH2M Hill in July 1984. The purpose of the IAS was to identify and assess sites posing a potential threat to human health or the environment due to contamination from past operations. A total of 19 potentially contaminated sites was identified based on information from historical records, aerial photographs, field inspections, and personnel interviews. Each site was evaluated for the types of contamination, migration pathways, and pollutant receptors. The IAS concluded that 15 of the 19 sites had the potential to pose a sufficient threat to human health or the environment, and thus warranted Confirmation Studies. An additional site, Site 21, had not yet been discovered during the time of the IAS, but has since been added to the list of sites requiring further investigation. The locations of Sites 4, 16, and 21 in reference to these 16 sites are provided in Figure 2-2.

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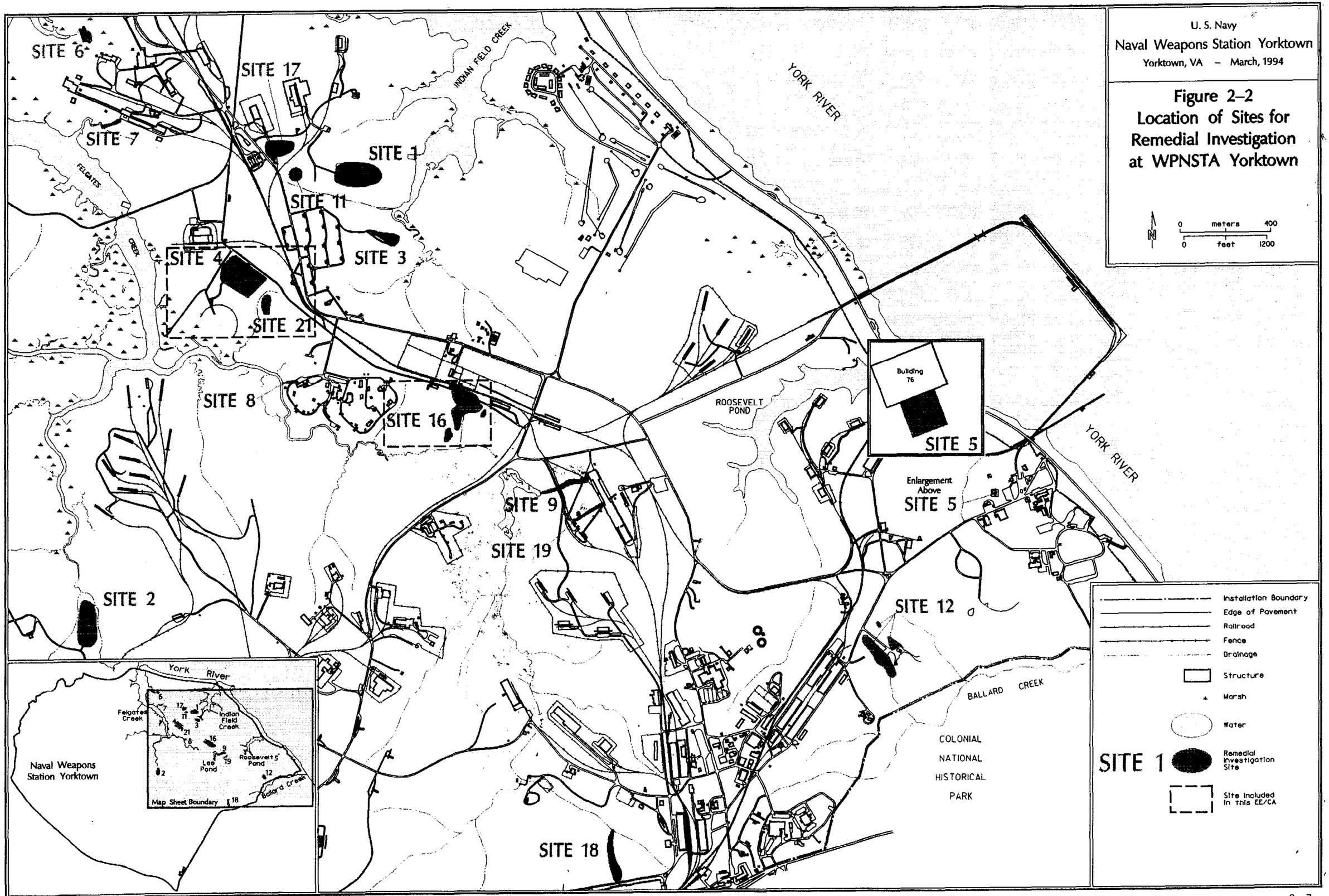
Figure 2–2
Location of Sites for Remedial Investigation at WPNSTA Yorktown



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The Confirmation Studies were conducted by Dames & Moore in two rounds (Round 1 and Round 2). A Draft RI Interim Report prepared by Dames & Moore was submitted to LANTDIV on 24 February 1989. Versar subsequently revised the Draft RI Interim Report to incorporate comments submitted to LANTDIV by the Technical Review Committee (TRC). The TRC is a group comprised of regulatory personnel, academic representatives, and civic leaders. The TRC members may offer suggestions, challenge study methods, and provide additional information to the community. The revised report was submitted on 1 July 1991. The purpose of this report was to summarize available data for each site and, based on these data, provide recommendations for additional efforts to be conducted to complete the RI. Additional RI efforts were recommended for 14 of the 15 sites under Confirmation Study. During November 1990, WPNSTA Yorktown personnel identified an additional site that had not been included in the previous investigations. This was Site 21, the Battery and Drum Disposal Area. A Site Investigation of the area was subsequently conducted in October 1991. Three monitoring wells were installed, and surface and subsurface soil and groundwater samples were collected. The results of this investigation are presented in the report entitled "Draft Final Site Inspection Report Site 21-Battery and Drum Disposal Area Naval Weapons Station, Yorktown, Virginia" (Baker/WESTON, 5 February 1992).

2.3.2 Current Investigations

Round One RI

Soil, sediment, surface water, and groundwater samples were collected and analyzed during the Round One RI, as reported in the Round One RI Report (July 1993). The findings for these sites from the Round One RI are summarized in the ensuing subsections of this EE/CA. (Note: A discussion of the applicable or relevant and appropriate requirements (ARARs), which are referenced in Subsection 2.3.3, is provided in Subsection 3.2.)

As reported in the February 1993 Testing Report, IT conducted an investigation at Sites 4, 16, and 21 to obtain data for a potential removal action. The Testing Report presents the analytical results for samples collected during the investigation and specifies requirements and methods for final disposal of waste materials. Investigation activities included the excavation of test trenches and sampling materials. The results of this investigation are summarized in the ensuing subsections of this EE/CA.

2.3.3 Characterization of Sites 4 and 21

2.3.3.1 Site-Specific Background for Sites 4 and 21

Sites 4 and 21 are located in the north-central area of WPNSTA Yorktown along the eastern branch of Felgates Creek. To the south of Sites 4 and 21 is the explosives burning facility, which is still in use and is currently operated as an interim status facility under the Resource Conservation and Recovery Act (RCRA). Sites 4 and 21 are separated by a distance of approximately 100 ft by a drainage way leading to Felgates Creek. Site 8 is upstream of these two sites along the eastern branch of Felgates Creek, approximately 1,000 ft from Site 21 and 1,300 ft from Site 4. Site 16, also included in this EE/CA, is approximately 3/4-mile upstream of Site 21.

Site 4, the Burning Pad Residue Landfill, consists of a 6-acre area located adjacent to the explosives burning facility south of West Road. Site use began in 1940 and ended in approximately 1975. Carbon-zinc batteries (Leclanche type) from underwater weapons, burning pad residues (possibly containing aluminum, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)), tree stumps, fly ash from coal-fired boilers, mine casings, electrical equipment (possibly telephone poles, line hardware, etc.), and transformers (possibly containing polychlorinated biphenyl (PCB) oils) were reportedly buried at this site. The landfill received an estimated 17 tons per year (tpy) of waste for approximately 35 years, totaling roughly 595 tons of waste disposed (C.C. Johnson, 1984). The landfill is

currently primarily clear, with scrub grasses and small trees; larger trees are present on the outer boundary of the landfill. An ash residue pile is located within the grassy field at the northeast boundary of Site 4.

Geophysical studies conducted as part of the Round One RI activities indicate that the depth of fill in the main fill area is approximately 5 to 10 ft (Baker/WESTON, 1992). A test pit investigation conducted by IT in December 1992 identified a large battery disposal area located in the southeast part of the site. The batteries are approximately 8 to 32 inches bgs. Landfill material, consisting of construction debris, pipe, glass, concrete, bottles, cans, and drums, was also identified at various locations within the site boundary.

During November 1990, WPNSTA Yorktown personnel identified Site 21, the Battery and Drum Disposal Area. Wastes noted and confirmed during a reconnaissance of Site 21 included various sized drums, batteries (Leclanche type), empty solvent containers, and scrap metal. Scattered waste was noted, as well as several areas of concentrated waste dumping (batteries and drums). The amount of material disposed and the method of disposal in this area are unknown. Geophysical studies conducted as part of the Round One RI indicated that the fill area is approximately 200 ft by 200 ft, with well-defined boundaries.

Site 21 was also investigated as part of the test pit study performed by IT in December 1992. This investigation indicated the presence of approximately 5 to 8 inches of topsoil, under which battery fill was present at thicknesses of 2 to 6 ft. The batteries were carbon-zinc dry chemistry-type, consistent with the type observed on the surface.

2.3.3.2 Soil Sampling and Waste Characterization for Site 4

Detailed results of the soil sampling and waste investigation at Site 4 can be found in either the Final Round One RI Report or the Testing Report. Figure 2-3 shows the analytical results from the Round One RI Report. These reports indicate that the Site 4 soils contain:

- Several base/neutral/acid organic (BNA) compounds, with the highest concentrations present in samples 4S01-001, 4S02-001, 4S05-001, and 4S06-001. Bis(2-ethylhexyl)phthalate was present in high concentrations (2,500 to 5,300 micrograms per kilogram (μg/kg)) in all surface soil samples.

- Volatile organic compounds (VOCs): methylene chloride, (86J μg/kg in sample 4S02-001), acetone (8J μg/kg in sample 4S04-001), and 1,1,1-trichloroethane (1,1,1-TCA) (23J μg/kg and 3J μg/kg in samples 4S02-001 and 4S04-001, respectively). Methylene chloride and acetone are common laboratory contaminants.

- Four explosive compounds in one surface soil sample (4S04-001), located adjacent to the ash pile. The highest concentration measured was 2,4,6-TNT, at a concentration of 86,000 μg/kg.

- Aroclor 1254 at concentrations less than 50 μg/kg in two surface soil samples (4S02-001 and 4S06-001).

- Several of the metals concentrations for the surface soils above background levels.

Toxicity Characteristic Leachate Procedure (TCLP) parameters were not detected in drum material composite or rinsate.

Waste materials encountered during the field investigation included batteries, drums containing solidified material, empty drums, trash, burning pad residues, and construction debris. Waste materials were located in four general disposal areas. These areas are shown in Figure 2-4.

Waste characteristics obtained from the Testing Report (and shown in Figure 2-4) include:

- Area 1: Drums, construction debris (concrete, brick, rebar, scrap metal, pipe, glass bottles, cans, and drums). One drum containing liquids was also noted during the IT test pit investigation. The ash pile is located within the boundary of Disposal Area 1.

- Area 2: Crushed drums, wood, glass, and construction debris.

- Area 3: Drums, scrap metal, trash, batteries, and construction debris.

- Area 4: Batteries.

SITE 4

Surface Soil Samples

4S01-001

50 J	Phenanthrene
37 J	Di-n-butylphthalate
92 J	Fluoranthene
61 J	Pyrene
23 J	Butylbenzyl phthalate
41 J	Benzo (a) anthracene
46 J	Chrysene
2900	Bis (2-ethylhexyl) phthalate
56 J	Benzo (b) fluoranthene
38 J	Benzo (k) fluoranthene
45 J	Benzo (a) pyrene
23 J	Indeno (1,2,3-cd) pyrene
18 J	Benzo (g,h,i) perylene
33 J	Aroclor 1254

4S02-001

86 J	Methylene Chloride
23 J	1, 1, 1-Trichloroethane
140 J	Phenanthrene
54 J	Di-n-butylphthalate
190 J	Fluoranthene
140 J	Pyrene
97 J	Benzo (a) anthracene
110 J	Chrysene
2700	Bis (2-ethylhexyl) phthalate
140 J	Benzo (b) fluoranthene
93 J	Benzo (k) fluoranthene
83 J	Benzo (a) pyrene
43 J	Indeno (1,2,3-cd) pyrene
44 J	Aroclor 1254

4S03-001

39 J	Di-n-butylphthalate
25 J	Fluoranthene
21 J	Pyrene
2500	Bis (2-ethylhexyl) phthalate

4S04-001

8 J	Acetone
3 J	1, 1, 1-Trichloroethane
430 J	2,4-Dinitrotoluene
4200	Bis (2-ethylhexyl) phthalate
58000	HMX
47000	RDX
6600	1,3,5-Trinitrobenzene
86000	2,4,6-TNT

4S05-001

22 J	Naphthalene
52 J	Acenaphthene
33 J	Dibenzofuran
41 J	Fluorene
95 J	Pentachlorophenol
770	Phenanthrene
190 J	Anthracene
110 J	Carbazole
50 J	Di-n-butylphthalate
2000	Fluoranthene
1300 J	Pyrene
850 J	Benzo (a) anthracene
940 J	Chrysene
5300	Bis (2-ethylhexyl) phthalate
1400	Benzo (b) fluoranthene
950	Benzo (k) fluoranthene
900	Benzo (a) pyrene
390	Indeno (1,2,3-cd) pyrene
140 J	Dibenzo (a,h) anthracene
340 J	Benzo (g,h,i) perylene

4S06-001

24 J	Acenaphthene
20 J	Dibenzofuran
300 J	Phenanthrene
53 J	Anthracene
29 J	Carbazole
33 J	Di-n-butylphthalate
680	Fluoranthene
450	Pyrene
340 J	Benzo (a) anthracene
350 J	Chrysene
2500	Bis (2-ethylhexyl) phthalate
430	Benzo (b) fluoranthene
340 J	Benzo (k) fluoranthene
270 J	Benzo (a) pyrene
190 J	Indeno (1,2,3-cd) pyrene
60 J	Dibenzo (a,h) anthracene
74 J	Benzo (g,h,i) perylene
19 J	Aroclor 1254

Surface Water Samples

4SW02-001

0.41 J	RDX

4SW03-001

1.4	HMX

4SW04-001

18	HMX
170	RDX
2.6	1,3,5-Trinitrobenzene
0.34	1,3-Dinitrobenzene
0.38 J	Nitrobenzene
8.3	2,4,6-TNT
0.31 J	2,4-Dinitrotoluene

4SW05-001

11	Di-n-butylphthalate
19	HMX
160	RDX
1.5	1,3,5-Trinitrobenzene
0.32 J	1,3-Dinitrobenzene
0.27 J	Nitrobenzene
4.1 J	2,4,6-TNT
0.44 J	2,4-Dinitrotoluene

4SW06-001

1.9	HMX
16	RDX

Sediment Samples

4SD02-001

340 J	Benzo (g,h,i) perylene

4SD02-002

13 J	Methylene Chloride

4SD03-001

5.4 J	4,4'-DDE •
32	4,4'-DDD ••
15 J	4,4'-DDT ••

4SD03-002

3.2 J	4,4'-DDE •
21	4,4'-DDD ••

4SD04-001

12 J	4,4'-DDE •
160	4,4'-DDD ••
5 J	4,4'-DDT •
7.6 J	alpha-Chlordane ••
5.9 J	gamma-Chlordane ••

4SD04-002

6 J	1, 1, 1-Trichloroethane
56 J	4,4'-DDE ••
910	4,4'-DDD ••
9.6	4,4'-DDT ••
40 J	alpha-Chlordane ••
33	gamma-Chlordane ••

4SD05-001

790	Acetone
200 J	2-Butanone
8.9 J	4,4'-DDE •
44 J	4,4'-DDD ••
5 J	alpha-Chlordane •

4SD05-002

3.5 J	4,4'-DDE •
15 J	4,4'-DDD •

4SD06-002

40	Carbon Disulfide

Groundwater Samples

4GW02-001

0.91	RDX

4GW03-001

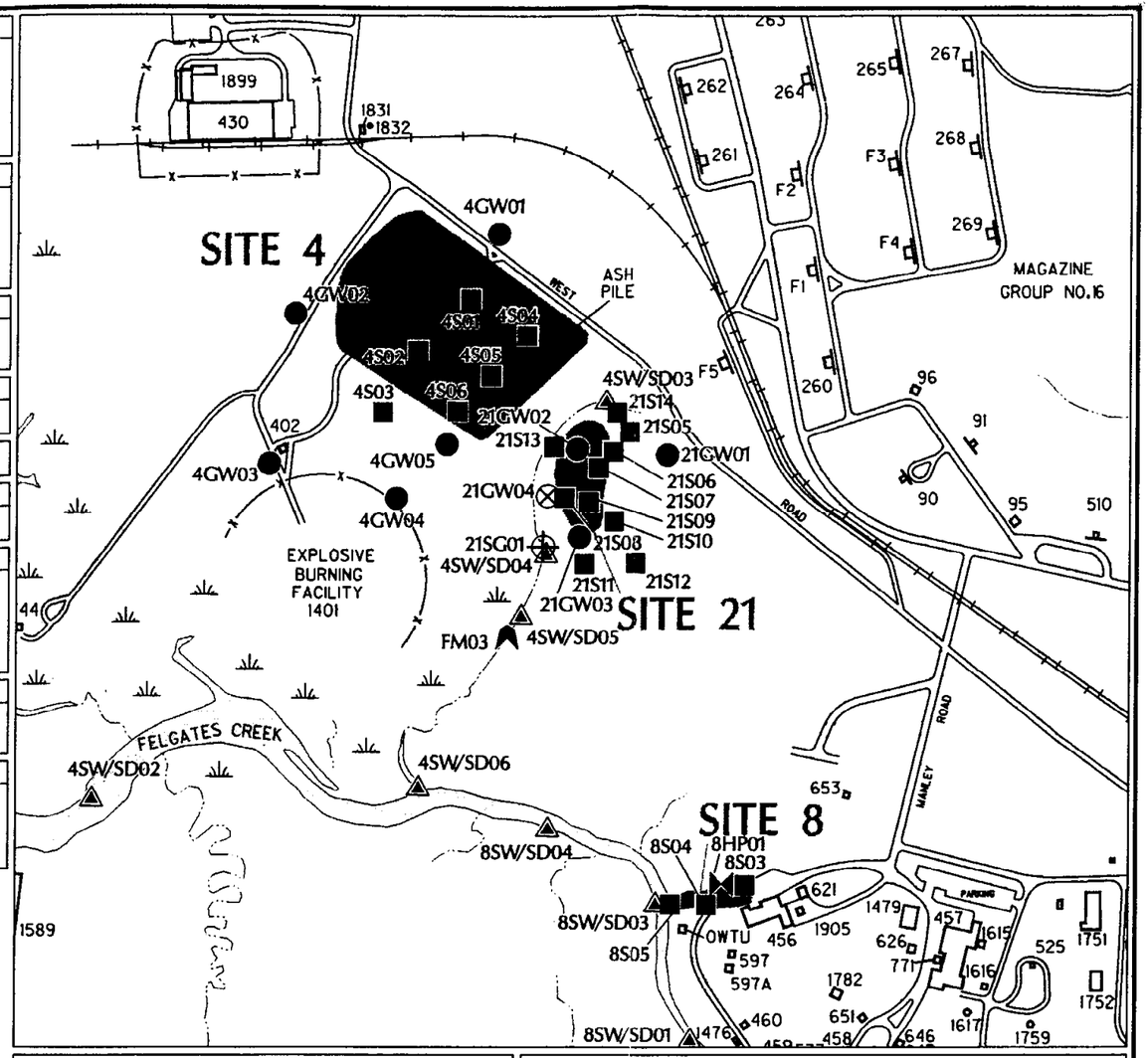
1 J	1, 1-Dichloroethene
2 J	1, 1, 1-Trichloroethane
3 J	Trichloroethene
0.99	HMX
3.3	RDX

4GW04-001

12	1, 2-Dichloroethene
15	Trichloroethene ++

4GW05-001

20	1, 2-Dichloroethene
17	Trichloroethene ++
1.1	HMX
2.8	RDX



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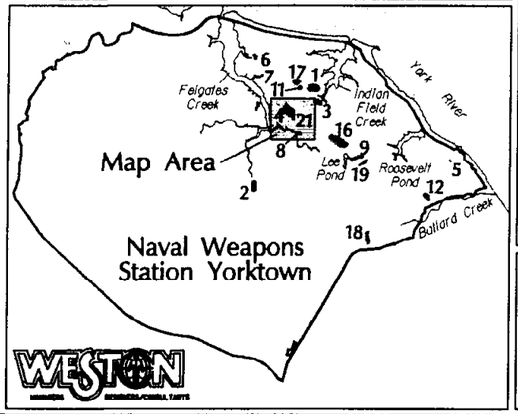


ANALYTICAL PARAMETER COLOR CODING

55 J	VOC (black)
91 J	BNA (cyan)
43 J	Explosive (red)
61 J	Pesticide (green)
43 J	PCB (orange)

1. Detected analytical parameter concentrations noted at left.
2. Analytical results reported in micrograms/Kilogram for sediment and surface soil samples and in micrograms/Liter for surface water and groundwater samples.

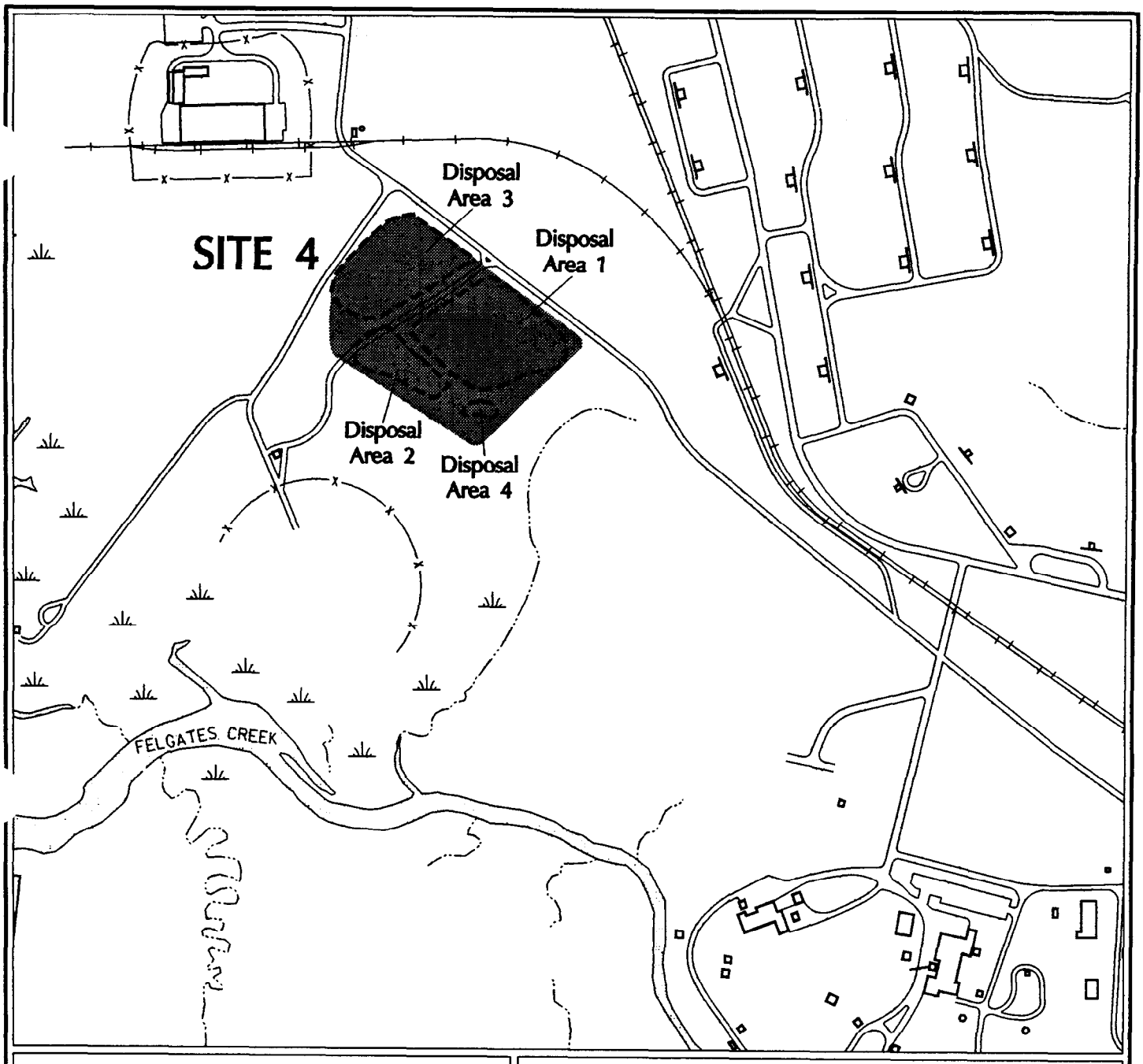
J - Estimated value
• - Meets or exceeds NOAA low effects range criteria
•• - Meets or exceeds NOAA median effects range criteria
++ - Exceeds federal MCL

SITE 4 — Remedial Investigation Site

Sample Location Symbology:
- Existing Monitoring Well
- Round One Monitoring Well
- Round One Surface Water/Sediment
- Round One Surface Soil
- Stream Flow Measurement Station
- HydroPunch™
- Staff Gauge

0 meters 100
0 feet 400
N

Figure 2-3
Site 4
Burning Pad Residue Landfill



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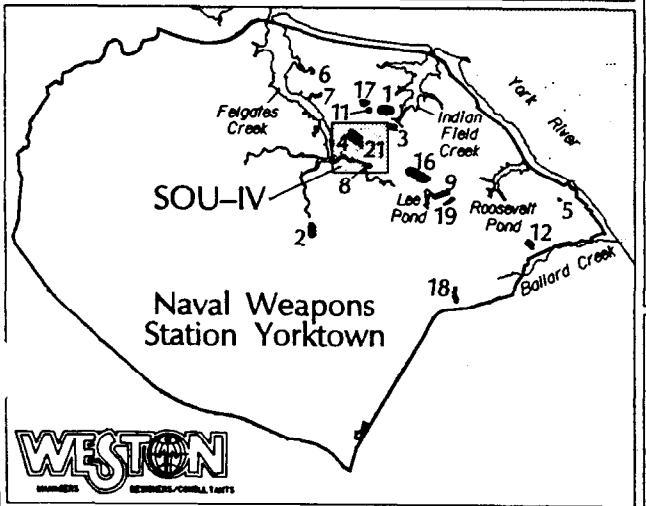

SITE 4 — Remedial Investigation Site

Disposal Area 1 — Limits of Waste Materials

N

0 meters 100

0 feet 400

Figure 2–4
Site 4
Waste Material Boundary

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2.3.3.3 Surface Water and Sediment Sampling for Site 4

Figure 2-3 provides sampling locations and selected analytical results for the surface water and sediment samples collected at Site 4. Explosives were detected in all five surface water samples collected, with the highest concentrations present in the samples along the drainage way east of the explosives burning pad (samples 4SW04 and 4SW05). The only BNA compound detected was di-n-butylphthalate, a common laboratory contaminant, in sample 4SW05. No VOCs or PCBs were detected. Explosives concentrations were higher than those found in studies conducted prior to the Round One RI.

The total metals concentrations in the surface water samples were above applicable regulatory levels for the following samples:

- 4SW02-001: No total metals concentrations exceeded Virginia Water Quality Standards (VWQS) (VR 680-21-00) or Clean Water Act (CWA) standards.
- 4SW03-001: Arsenic, copper, lead, mercury, nickel, and zinc were present in concentrations above the CWA salt water chronic levels. Copper, mercury, nickel, and zinc were also above the VWQS salt water levels. Cadmium concentrations exceeded the VWQS salt water levels.
- 4SW04-001: No metals concentrations exceeded the VWQS or CWA criteria.
- 4SW05-001: Copper, lead, mercury, nickel, and zinc were present at concentrations above the CWA salt water chronic levels. Copper, mercury, nickel, and zinc were also above the VWQS salt water levels.
- The total metals sample collected from 4SW03, the sample directly north of Site 21, contained metals concentrations above background, especially cadmium, mercury, and zinc. These concentrations are probably attributable to the batteries discarded at Site 21. Zinc and mercury were also above station background levels in the total metals sample from 4SW05.

All of the surface water samples analyzed for dissolved metals contained metals concentrations below the above-noted applicable regulatory levels, with the exception of samples 4SW03-001 and 4SW06-001, where nickel concentrations were above both the VWQS and CWA levels.

The sediment samples collected from Site 4 during the Round One RI provided the following information:

- 1,1,1-TCA, acetone, carbon disulfide, methylene chloride, and 2-butanone, the only VOCs detected, were at low concentrations (140 μg/kg or less). Acetone, methylene chloride, and 2-butanone are common laboratory contaminants.

- Benzo(g,h,i)perylene, the only BNA compound detected in any of the sediment samples, was found in sample 4SD02-001, which is also downstream of Sites 8 and 21.

- No explosives or PCBs were detected.

The sediment samples were also analyzed for pesticides. Several pesticides were present in the sediment samples at low concentrations. Pesticide concentrations in sediment samples collected from stations 4SD03, 4SD04, and 4SD05 exceeded National Oceanic and Atmospheric Administration (NOAA) sediment screening criteria. The metals concentrations present in the sediment samples collected from 4SD03 and 4SD05 showed levels of mercury and zinc significantly above station background, probably due to the batteries at Site 21. The zinc concentrations exceeded the NOAA low effects range criteria in all sediment samples collected from Site 4. Five sediment samples contained zinc concentrations above the Apparent Effects Threshold (AET) criteria. Mercury was also above NOAA levels in most of the sediment samples collected from Site 4. These analyses show the same results as the previous investigations.

2.3.3.4 Groundwater Sampling for Site 4

Sampling locations and selected results are available in the Round One RI Report and are summarized in Figure 2-3. Tables containing metals concentrations for groundwater samples collected for the Round One RI and a comparison of contaminants detected in groundwater at WPNSTA Yorktown against potentially applicable federal and state standards are contained in Appendix A of this EE/CA.

Five groundwater samples were collected from the monitoring wells at Site 4. The analytical results obtained from these samples showed:

- Explosives were present in samples 4GW02-001, 4GW03-001, and 4GW05-001; the highest concentrations were detected in 4GW05-001, collected from the downgradient well nearest to the landfill.

- 1,1-dichloroethylene (DCE), 1,1,1-TCA, trichloroethylene (TCE), and 1,2-DCE were detected only in the samples collected from monitoring wells located downgradient of the landfill. The concentrations of TCE in samples 4GW04-001 and 4GW05-001 exceeded the federal regulatory levels.

- No BNAs or PCBs were detected in the groundwater samples.

- Nitrate concentrations in the groundwater at Site 4 ranged from nondetect (4GW02) to 620 μg/L (4GW05), which is well below both federal (10,000 micrograms per liter (μg/L)) and state (5,000 μg/L) regulatory limits.

- The upgradient monitoring well sample, 4GW01-001, contained no VOCs, BNAs, explosives, or PCBs.

The total metals analyses performed on the groundwater samples collected from Site 4 indicated that the following metals were above potentially applicable regulatory levels:

- Sample 4GW01-001: Cadmium, chromium, lead, mercury, and zinc levels exceeded the Virginia Groundwater Standards (VGS). Cadmium and chromium were also present in concentrations above the federal maximum contaminant levels (MCLs). Lead was above the federal action level concentration. Beryllium exceeded the MCL of 4 μg/L.

- Sample 4GW02-001: Chromium and zinc were present above the VGS. Chromium was also above the federal MCL. Lead (at 33.3 μg/L) exceeded the federal action level concentration. Beryllium and nickel were present at concentrations above the federal MCLs.

- Sample 4GW03-001: Cadmium, chromium, and zinc levels exceeded the VGS. Cadmium and chromium were also present at concentrations above the federal MCLs. The lead concentration was above the federal action level. Beryllium and nickel concentrations also exceeded the federal MCLs.

- Sample 4GW04-001: Chromium and zinc were present above the VGS. Chromium also exceeded the federal MCL. The lead concentration was above the federal action level.

- Sample 4GW05-001: Cadmium, chromium, mercury, and zinc exceeded the VGS. Chromium was present at levels above the federal MCL. Lead was detected above the federal action level. Beryllium and nickel concentrations exceeded the federal MCLs.

- The total metals concentrations in all groundwater samples collected from Site 4 were above background metals concentrations.

The total metals concentrations found in the groundwater samples were higher than those detected in previous studies. All of the dissolved metals groundwater samples contained metals at concentrations below the above-referenced applicable regulatory levels.

2.3.3.5 Soil Sampling and Waste Characteristics for Site 21

Analytical results and conclusions can be found in the Final Round One RI, the Testing Report, and the Site Inspection Report for Site 21. Results indicate that the soils at Site 21 (as shown in Figure 2-5) contain the following:

- Low concentrations (<55 μg/kg) of a few VOCs, namely 1,1,1-TCA, toluene, styrene, and xylenes, were detected in the surface soils collected along the southeast side of the site.

- Several BNA compounds, at concentrations of 2.1 mg/kg and less, and total petroleum hydrocarbons (TPH) (nondetect to 12,000 mg/kg) were detected.

- Metals concentrations in surface soils were consistent with the levels detected in the background surface soils, with the exception of cadmium, mercury, and zinc, which were higher than those in background samples.

The metals are probably attributable to the discarded batteries present at the site. These results are similar to those obtained during the Site 21 Site Inspection.

One routine sample and one duplicate sample were collected from the soil boring advanced prior to the installation of monitoring well 21GW04. No BNAs were detected in either sample. Low concentrations of methylene chloride (18J μg/kg), acetone (110J μg/kg), and toluene (4J μg/kg) were detected in duplicate sample 21SB04-101. No VOCs were detected

in the characterization sample. Metals concentrations in these two samples were similar to those found in the Round One RI background soil boring samples.

One main disposal area was identified at Site 21, as described in the Testing Report. The general disposal location of the waste materials is shown in Figure 2-6 of this EE/CA.

Waste characteristics obtained from the Testing Report include:

- Batteries: Dry carbon-zinc chemistry batteries disposed of using trench and fill techniques.
- Drums: Surface drums, located in two piles, are partially buried to a depth of 1 ft. Five- to 55-gallon empty drums are present.
- Electrical Equipment: Surface material, including lighting fixtures and cables.
- Scrap Debris: Metal and trash debris on the surface.

A composite rinsate sample was collected from the surface drums at Site 21. The sample was analyzed for TCLP parameters to determine whether the drums would require decontamination prior to disposal. TCLP parameters were not detected.

2.3.3.6 Surface Water and Sediment Sampling for Site 21

Because of the proximity of Site 21 to Site 4, the surface water and sediment samples collected for Site 4 also represent drainage pathways from Site 21. The results are discussed in Subsection 2.3.3.3 of this EE/CA.

2.3.3.7 Groundwater Sampling for Site 21

Specific results are available in the Final Round One RI Report and the Site Inspection Report for Site 21. Groundwater sampling locations are shown in Figure 2-5.

SITE 21

Surface Soil Samples

21S05–001

62 J	Di-n-butylphthalate
64 J	Fluoranthene
76 J	Pyrene
200 J	Benzo (a) anthracene
520	Chrysene
990	Benzo (b) fluoranthene
540	Benzo (k) fluoranthene
190 J	Benzo (a) pyrene
190 J	Indeno (1,2,3-cd) pyrene
79 J	Dibenzo (a,h) anthracene
170 J	Benzo (g,h,i) perylene
12000	mg/Kg TPH

21S06–001

31 J	Di-n-butylphthalate
140	mg/Kg TPH

21S07–001

14 J	1, 1, 1-Trichloroethane
19 J	Toluene
4 J	Xylene
160 J	Pentachlorophenol
45 J	Di-n-butylphthalate
41 J	Chrysene
51 J	Benzo (b) fluoranthene
33 J	Benzo (k) fluoranthene
170	mg/Kg TPH

21S08–001

4 J	1, 1, 1-Trichloroethane
32 J	Toluene
9 J	Styrene
290 J	Pentachlorophenol
96 J	Phenanthrene
62 J	Di-n-butylphthalate
120 J	Fluoranthene
980	Pyrene
280 J	Benzo (a) anthracene
470	Chrysene
640	Bis (2-ethylhexyl) phthalate
200 J	Benzo (b) fluoranthene
120 J	Benzo (k) fluoranthene
360 J	Benzo (a) pyrene
120 J	Indeno (1,2,3-cd) pyrene
470 J	Benzo (g,h,i) perylene
4100	mg/Kg TPH

21S08–101

53	Methylene Chloride
2 J	1, 1, 1-Trichloroethane
35 J	Toluene
20 J	Styrene
120 J	Pentachlorophenol
82 J	Phenanthrene
63 J	Di-n-butylphthalate
78 J	Fluoranthene
900	Pyrene
200 J	Benzo (a) anthracene
350 J	Chrysene
140 J	Benzo (b) fluoranthene
60 J	Benzo (k) fluoranthene
240 J	Benzo (a) pyrene
370 J	Benzo (g,h,i) perylene
4600	mg/Kg TPH

21S09–001

110 J	Pentachlorophenol
27 J	Di-n-butylphthalate
24	mg/Kg TPH

21S10–001

41 J	Di-n-butylphthalate

21S11–001

2 J	1, 1, 1-Trichloroethane
2 J	Toluene
28 J	Pentachlorophenol
130 J	Di-n-butylphthalate
2100	Bis (2-ethylhexyl) phthalate
33	mg/Kg TPH

21S12–001

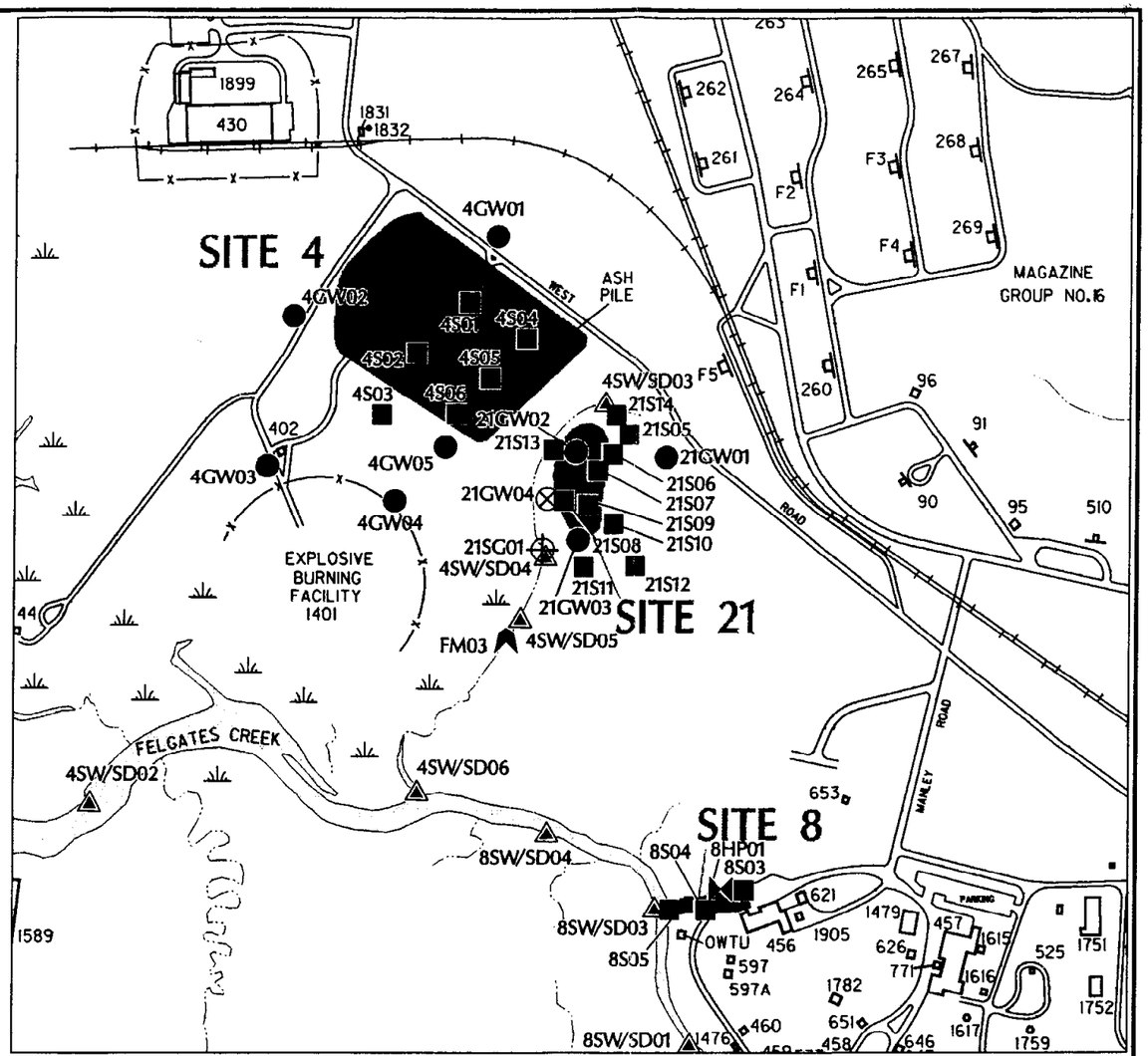
30 J	Di-n-butylphthalate
18	mg/Kg TPH

21S13–001

44 J	Di-n-butylphthalate
110 J	Pyrene
92 J	Benzo (a) anthracene
180 J	Chrysene
690	Bis (2-ethylhexyl) phthalate
120 J	Benzo (b) fluoranthene
180 J	Benzo (a) pyrene
240	mg/Kg TPH

21S14–001

530 J	Bis (2-ethylhexyl) phthalate
11	mg/Kg TPH



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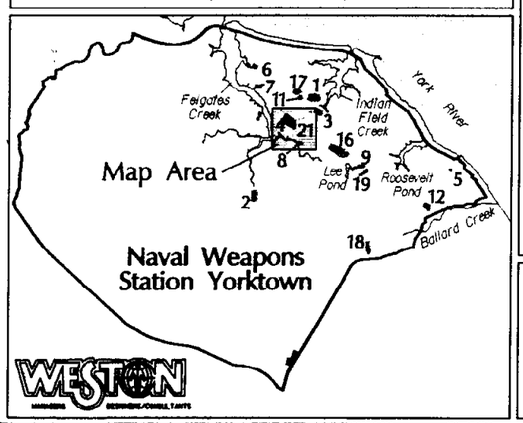


ANALYTICAL PARAMETER COLOR CODING

55 J	VOC (black)
91 J	BNA (cyan)
25 J	TPH (purple)

1. Detected analytical parameter concentrations noted at left.
2. Analytical results reported in micrograms/Kilogram for sediment and surface soil samples and in micrograms/Liter for surface water and groundwater samples.

J - Estimated value

SITE 21 Remedial Investigation Site

Sample Location Symbology:

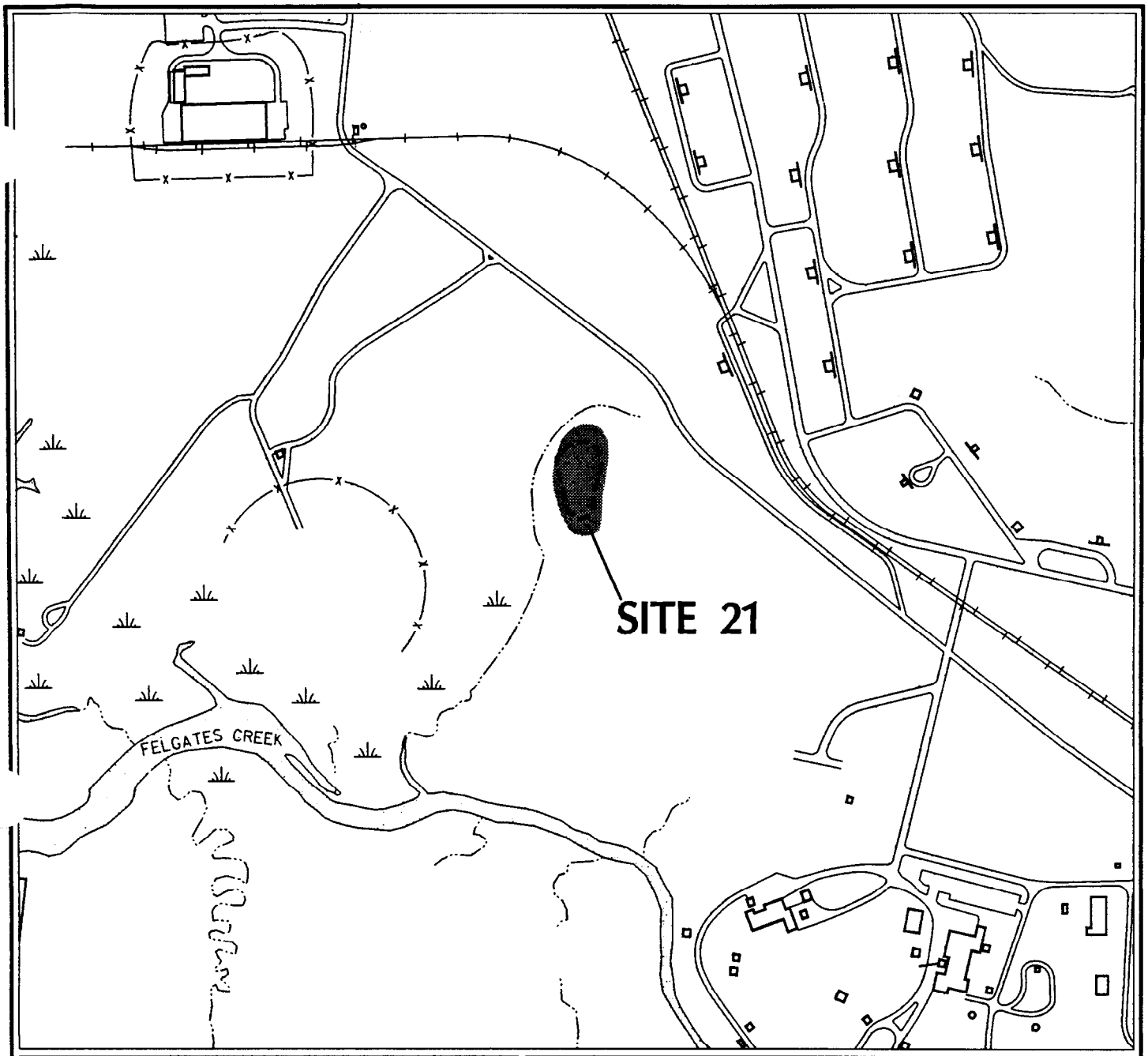
- Existing Monitoring Well
- Round One Monitoring Well
- Round One Surface Water/Sediment
- Round One Surface Soil
- Stream Flow Measurement Station
- HydroPunch™
- Staff Gauge

0 meters 100
0 feet 400

N

Figure 2–5
Site 21
Battery and Drum Disposal Area

17-MAR-1994



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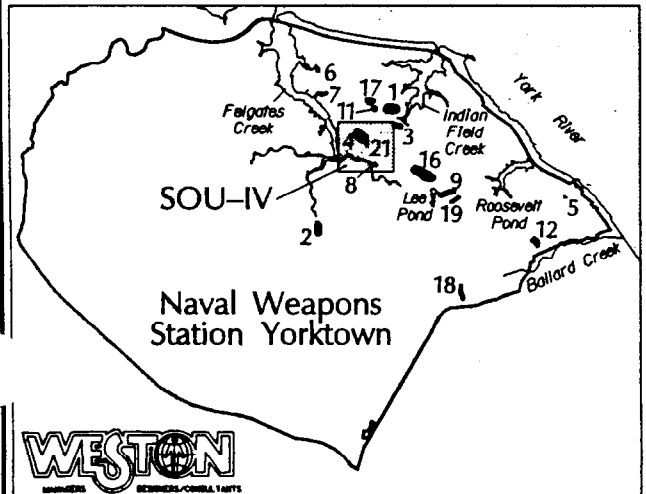


SITE 21 — Remedial Investigation Site

Limits of Waste Materials

N

0 meters 100
0 feet 400

Figure 2–6
Site 21
Waste Material Boundary

17-MAR-1994

Four groundwater samples were collected from the monitoring wells at Site 21. Analyses of these samples showed no detectable concentrations of VOCs, BNAs, or TPH. Nitrate concentrations in the groundwater at Site 21 ranged from 690 to 25,100 μg/L. Groundwater from all monitoring wells except 21GW01 contained concentrations of nitrates that exceeded the VGS of 5,000 μg/L. Monitoring wells 21GW02 and 21GW03 contained levels of nitrates that also exceeded the MCL of 10,000 μg/L. The metals analyses indicated:

- The total metals sample 21GW01-001 contained concentrations of cadmium, chromium, lead, mercury, and zinc from 2 to 10 times in excess of the VGS. The concentrations of cadmium (5.8J μg/L) and chromium (244 μg/L) also exceeded MCLs. The beryllium concentration exceeded the federal MCL. The lead concentration was above the federal action level. All dissolved metals concentrations were below these applicable regulatory levels.

- The levels of cadmium and zinc in the total metals sample 21GW02-001 and duplicate sample 21GW02-101 exceeded the VGS. The cadmium concentration was also above the MCL. Lead concentrations were in excess of the federal action levels. Zinc and cadmium remained above the VGS, and cadmium above the MCL, in the dissolved samples.

- Totals metals concentrations in sample 21GW03-001 exceeded the VGS for cadmium, chromium, lead, mercury, and zinc. The MCLs were exceeded for cadmium and chromium. Lead concentrations were above the federal action level. The concentrations of beryllium and nickel exceeded the federal MCLs. The levels of cadmium and zinc in the dissolved metals samples remained above the applicable regulatory concentrations.

- Chromium and zinc were present in the totals metals sample 21GW04-001 at concentrations above the VGS. The lead concentration also exceeded the federal action level. All dissolved metals concentrations were within applicable regulatory criteria.

- The total metals concentrations in the groundwater collected from Site 21 were higher than those in background samples; zinc, mercury, and cadmium were elevated in the samples collected from 21GW01 and 21GW03, and zinc and cadmium were significantly above background (greater than 100 times) in 21GW02.

These results are consistent with those obtained during previous sampling activities.

Tables containing metals concentrations for groundwater samples collected for the Round One RI and a comparison of contaminants detected in groundwater at WPNSTA Yorktown against potentially applicable federal and state standards are contained in Appendix A of this EE/CA.

2.3.4 Characterization of Site 16

2.3.4.1 Site-Specific Background for Site 16

Site 16 is located in the east-central area of WPNSTA Yorktown. Site 16 is slightly downstream of Lee Pond, which is a manmade impoundment located upgradient of the eastern branch of Felgates Creek. Site 16, the West Road Landfill, is approximately 5 acres in size and is located adjacent to West Road near Indian Field Road. A marsh area and tidal inundation occur directly south of this site along the eastern branch of Felgates Creek. This site was operated from the 1950s to the early 1960s. The site is currently wooded, except for the western end, which is covered with grasses. Landfill boundaries are not evident from visual observation of the area. Wastes that were reportedly landfilled include dry carbon-zinc (Leclanche) batteries, banding materials, pressure transmitting fluid possibly containing PCBs, unknown types of chemicals, and 55-gallon drums (contents unknown). More than 100 tons of waste was estimated to be buried at this site (C.C. Johnson, 1984).

An investigation performed by IT in December 1992 (Testing Report) confirmed the presence of drums, scrap metal, batteries, mine casings, and construction debris in the surface of the landfill. A second waste area was also identified below one of the drum piles during trenching activities. This landfill area, approximately 2 to 9 ft bgs, contained glass containers, cans, and newspapers, which was different from both the reported disposal material and the observed surface wastes. The areal extent of this subsurface disposal area was not assessed. According to the Testing Report, the landfill appears to be distinct from the surface material encountered and was constructed using trench and fill techniques.

2.3.4.2 Soil Sampling and Waste Characteristics for Site 16

The results of soil sampling and waste investigations at Site 16 can be found in either the Final Round One RI Report (and shown in Figure 2-7) or the Testing Report. Reports indicate the following characteristics for the soils at Site 16:

- Metals were not detected above the TCLP regulatory levels.
- Aroclor 1254 and/or Aroclor 1260 were detected in seven of the samples. The highest concentration was 880 μg/kg of Aroclor 1254 in sample 16S05-001.
- VOCs were detected in low concentrations (2J μg/kg, toluene in sample 16S05; 5J μg/kg, styrene in sample 16S06).
- Several BNA compounds were detected in concentrations ranging from 20 to 70 μg/kg.
- Pesticides were detected in surface soil samples 16S01, 16S02, 16S03, and 16S12.
- Nitroexplosives were not detected on the surface of the mine casings sampled by wipe procedures.

Waste materials found in the surface soils included mine casings, drums containing silica desiccant, batteries, banding material, empty drums, fire extinguishers, scrap metal, and construction debris. One composite soil sample was collected and 17 test trenches were excavated to investigate this site.

Waste characteristics obtained from the Testing Report indicated three general waste disposal areas, as shown in Figure 2-8. Waste materials identified included mine casings, batteries (dry carbon-zinc chemistry), drums, sanitary landfill-type materials (glass containers, cans, and newspaper), scrap metal, and construction debris. Specific wastes observed in the individual disposal areas (as shown in Figure 2-8) include:

SITE 16

Surface Soil Samples

16S01-001

1.5 J	4,4'-DDE
2.3 J	4,4'-DDD
1.9 J	4,4'-DDT

16S01-101

1.2 J	4,4'-DDD
1.2 J	4,4'-DDT
0.82 J	4,4'-DDE

16S02-001

35 J	Di-n-butyl phthalate
7.7	Dieldrin

16S03-001

0.40 J	Dieldrin

16S04-001

24 J	Phenanthrene
65 J	Di-n-butylphthalate
61 J	Fluoranthene
57 J	Pyrene
33 J	Benzo (a) anthracene
35 J	Chrysene
700 J	Bis (2-ethylhexyl) phthalate
43 J	Benzo (b) fluoranthene
34 J	Benzo (k) fluoranthene
35 J	Benzo (a) pyrene
550	Aroclor 1254

16S05-001

2 J	Toluene
58 J	Phenanthrene
110 J	Di-n-butylphthalate
150 J	Fluoranthene
130 J	Pyrene
74 J	Benzo (a) anthracene
91 J	Chrysene
590	Bis (2-ethylhexyl) phthalate
120 J	Benzo (b) fluoranthene
83 J	Benzo (k) fluoranthene
66 J	Benzo (a) pyrene
880	Aroclor 1254

16S06-001

5 J	Styrene
96 J	Di-n-butyl phthalate
350	Bis (2-ethylhexyl) phthalate
26 J	Aroclor 1254

16S07-001

140 J	Phenanthrene
44 J	Anthracene
54 J	Carbazole
70 J	Di-n-butylphthalate
280 J	Fluoranthene
200 J	Pyrene
140 J	Benzo (a) anthracene
140 J	Chrysene
330 J	Bis (2-ethylhexyl) phthalate
94 J	Benzo (b) fluoranthene
100 J	Benzo (k) fluoranthene
98 J	Benzo (a) pyrene
64 J	Indeno (1,2,3-cd) pyrene
20 J	Aroclor 1260

16S08-001

66 J	Di-n-butylphthalate
280 J	Bis (2-ethylhexyl) phthalate
13 J	Aroclor 1254

16S09-001

59 J	Di-n-butylphthalate
300 J	Bis (2-ethylhexyl) phthalate
1.4 J	4,4'-DDT

16S10-001

44 J	Di-n-butylphthalate
20 J	Fluoranthene
19 J	Pyrene
220 J	Bis (2-ethylhexyl) phthalate
16 J	Aroclor 1254

Surface Water Samples

16SW03-001

2 J	1,1-Dichloroethylene
5 J	1,1-Dichloroethane
8 J	1,1,1-Trichloroethane
27 J	Phenol
850	4-Methylphenol

Sediment Samples

16SD01-001

570	Di-n-butylphthalate

16SD01-002

77 J	Phenanthrene
21 J	Anthracene
160 J	Di-n-butylphthalate
190 J	Fluoranthene
81 J	Pyrene
74 J	Benzo (a) anthracene
75 J	Chrysene
59 J	Benzo (b) fluoranthene
64 J	Benzo (k) fluoranthene
50 J	Benzo (a) pyrene
42 J	Indeno (1,2,3-cd) pyrene

16SD03-001

410 J	4-Methylphenol
310 J	Di-n-butylphthalate

16SD03-002

160 J	4-Methylphenol
380 J	Di-n-butylphthalate

16SD04-001

1000	4-Methylphenol
59 J	Aroclor 1254 •

16SD04-002

630	Di-n-butylphthalate
25 J	Aroclor 1254

16SD05-001

380 J	Di-n-butylphthalate

16SD05-002

140 J	Di-n-butylphthalate

Groundwater Samples

16GW01-001

1 J	1, 1, 1-Trichloroethane
1.3	RDX

16GW03-001

1 J	1, 1-Dichloroethene
2 J	1, 1-Dichloroethane

16GW03-101

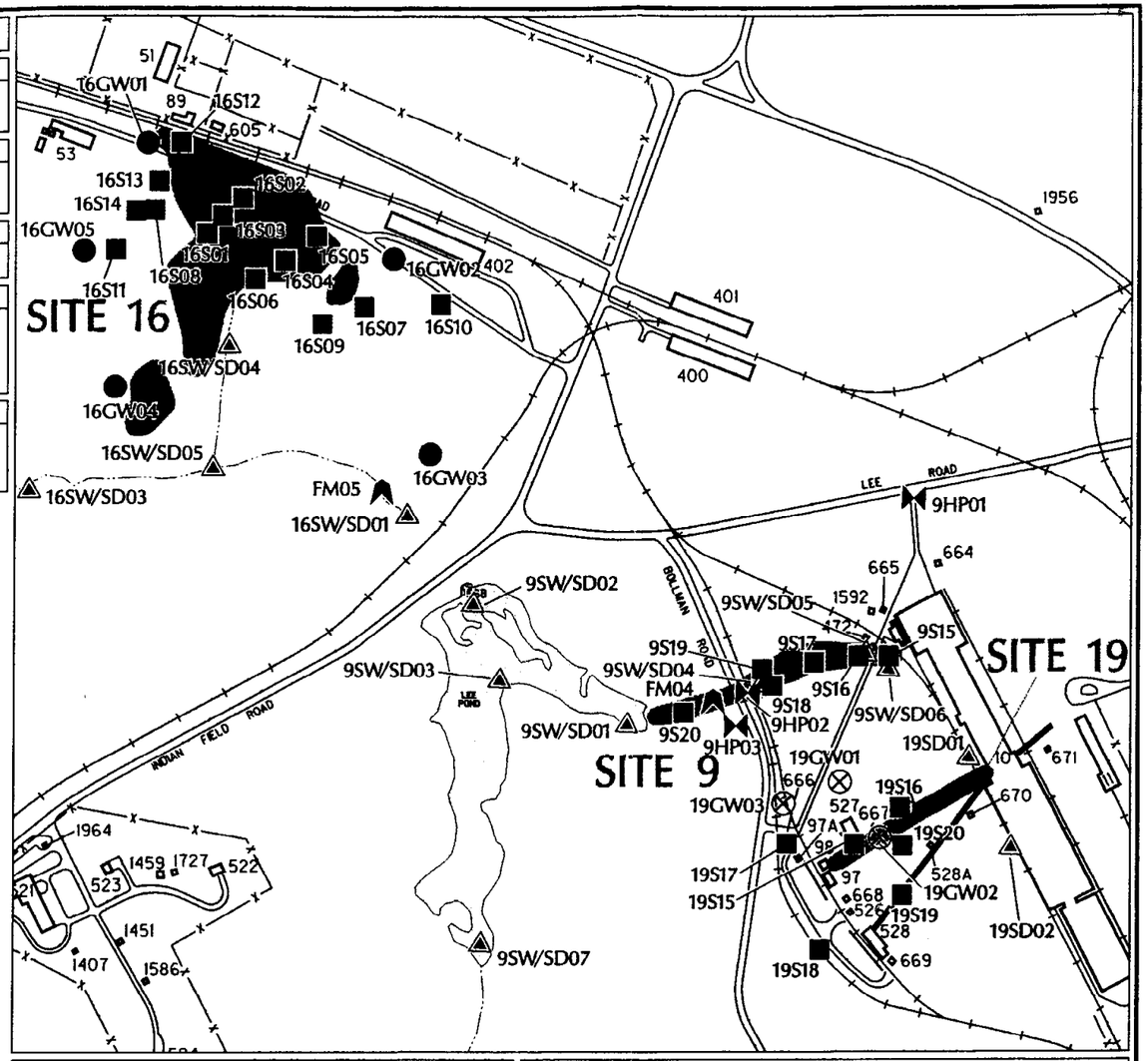
3 J	1, 1-Dichloroethane

16GW04-001

1 J	1, 1-Dichloroethene
1 J	1, 1-Dichloroethane
3 J	1, 1, 1-Trichloroethane
1 J	Phenol

16GW05-001

1 J	1, 1, 1-Trichloroethane
6 J	Chlorobenzene
4 J	1, 4-Dichlorobenzene



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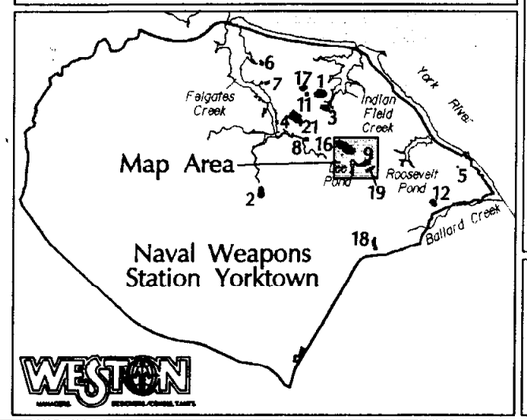


ANALYTICAL PARAMETER COLOR CODING

55 J	VOC (black)
91 J	BNA (cyan)
43 J	Explosive (red)
61 J	Pesticide (green)
43 J	PCB (orange)

1. Detected analytical parameter concentrations noted at left.
2. Analytical results reported in micrograms/Kilogram for sediment and surface soil samples and in micrograms/Liter for surface water and groundwater samples.

J - Estimated value
• - Meets or exceeds NOAA low effects range criteria

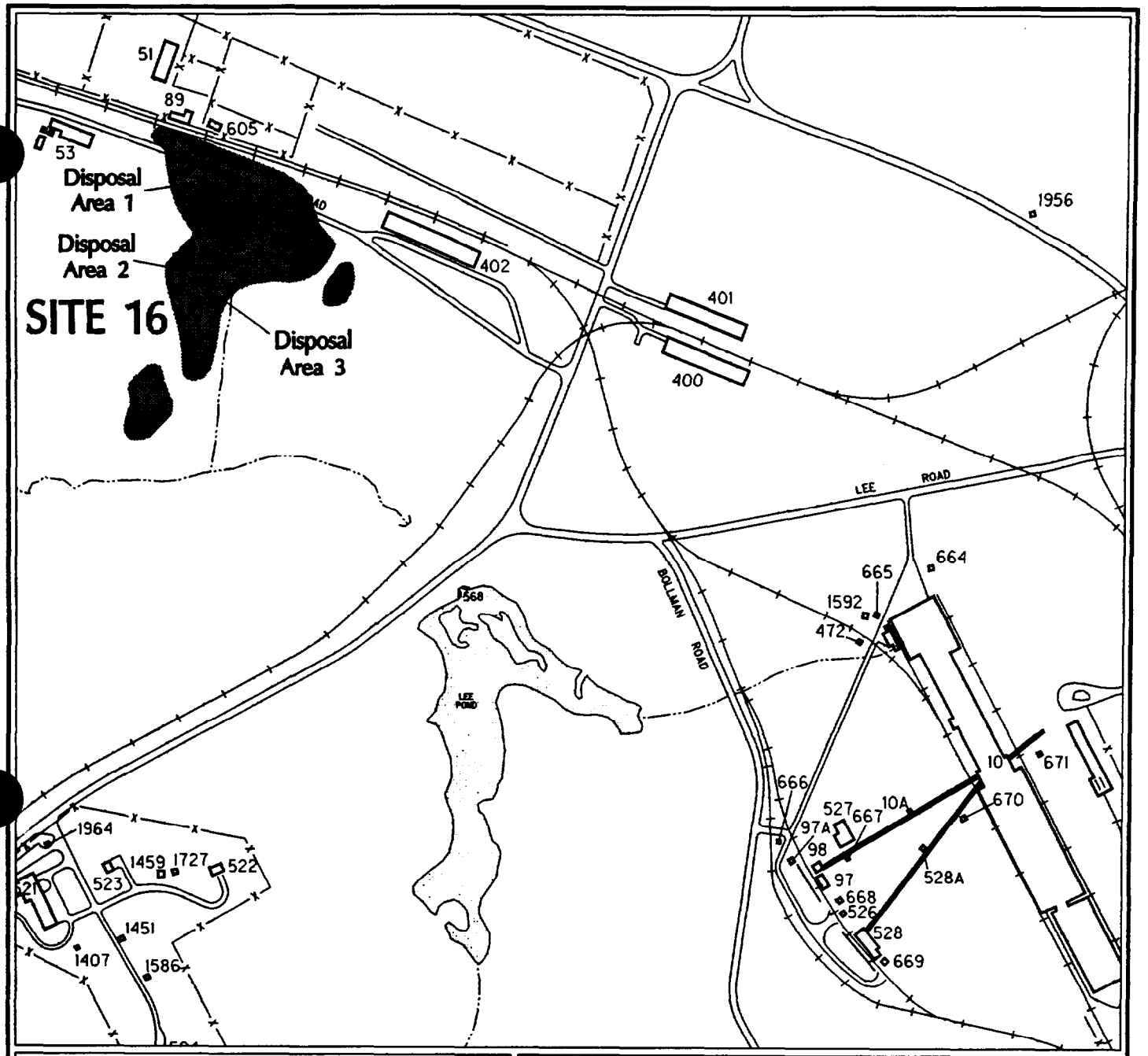
SITE 16 Remedial Investigation Site

Sample Location Symbology:

- Existing Monitoring Well
- Round One Monitoring Well
- Round One Surface Water/Sediment
- Round One Surface Soil
- Stream Flow Measurement Station
- HydroPunch™

0 meters 100
0 feet 400
N

Figure 2-7
Site 16
West Road Landfill



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SITE 16 — Remedial Investigation Site

Disposal Area 1 — Limits of Waste Materials

N

0 meters 100

0 feet 400

Figure 2–8
Site 16
Waste Material Boundary

17-MAR-1994

- Area 1: Scrap metal, fire extinguishers, and metal banding.
- Area 2: Wire, drums, scrap metal, mine casings, cable, and metal containers.
- Area 3: Drums, batteries, scrap metal, aerosol cans, newspaper, bottles, and batteries.

2.3.4.3 Surface Water and Sediment Sampling for Site 16

Figure 2-7 provides selected analytical results for surface water and sediment samples collected at Site 16. The surface water samples collected from Site 16 showed VOCs and BNAs in only one sample. Sample 16SW03, located downstream of the site, showed the presence of 1,1-DCE (2J μg/L), 1,1-dichloroethane (DCA) (5J μg/L), 1,1,1-TCA (8J μg/L), phenol (27J μg/L), and 4-methylphenol (850 μg/L). The metals concentrations found in the surface water samples indicated that no metals concentrations in the total or dissolved metals analysis of samples 16SW01-001 or 16SW05-001 were above the applicable regulatory levels.

Sample 16SW03-001 contained arsenic, copper, mercury, nickel, and zinc above the CWA salt water chronic levels in the total metals sample. Copper, mercury, nickel, and zinc concentrations were also above the VWQS criteria. The cadmium concentration also exceeded the VWQS concentrations. All dissolved metals concentrations were below the VWQS and CWA levels.

The total metals analysis of sample 16SW04-001 showed concentrations of arsenic, copper, lead, mercury, nickel, and zinc at levels above the CWA salt water chronic levels. Cadmium, copper, mercury, nickel, and zinc were also above the VWQS criteria. All dissolved metals analyses were below the VWQS and CWA standards. The surface water total metals concentrations in samples 16SW03-001 and 16SW04-001 were above background for several metals (including copper and zinc). These analyses are consistent with the results obtained during previous investigations.

The sediment samples collected from Site 16 showed few detectable concentrations of contaminants. Station 16SD01, the upstream sampling location, showed the highest concentration of contaminants, indicating the possibility of another source for the contamination found in the tributary to Felgates Creek.

Round One RI results indicate that sediments at Site 16 contain the following:

- Aroclor 1254 was detected in both (shallow and deep) sediment samples collected from sampling station 16SD04, the location closest to the landfill. The concentration of Aroclor 1254 in the shallow sediment sample collected from station 16SD04 exceeded the NOAA low effects range criteria for total PCB concentration.
- No VOCs or explosive compounds were detected in any of the sediment samples.
- The concentrations of metals detected in the sediment samples were typical of concentrations obtained in the background sediment samples. However, the zinc concentration in sample 16SD01-001 (shallow and deep) exceeded the NOAA low effects range criteria.

2.3.4.4 Groundwater Sampling for Site 16

Groundwater samples were collected from five monitoring wells at Site 16; the sampling locations and analytes that were detected in associated samples are depicted in Figure 2-7.

Results indicate the following:

- Low concentrations (6J μg/L or less) of various VOC compounds were detected in all groundwater samples, except 16GW02, where no VOCs were detected above the detection limits.
- The only explosive compound detected was 1.3 μg/L of RDX, found in sample 16GW01.
- BNA compounds were present in the samples collected from 16GW04 (1J μg/L phenol) and 16GW05 (4J μg/L 1,1-dichlorobenzene).

- Nitrate concentrations in the groundwater at Site 16 ranged from nondetect to 2,800 μg/L, which is below the federal (10,000 μg/L) and state (5,000 μg/L) regulatory limits.

- No pesticides, PCBs, or TPH were found in any of the groundwater samples collected at Site 16.

The metals analysis of the groundwater samples collected from Site 16 indicated the following:

- In sample 16GW01-001, the concentrations of chromium, lead, mercury, and zinc were detected above the VGS in the total metals analysis. Chromium was also above the MCL. Lead was above the federal action level. Beryllium was present above the MCL. The dissolved metals analysis showed no concentrations above federal criteria or the VGS.

- No metals concentrations exceeded federal criteria or the VGS in the total or dissolved metals analysis of 16GW02-001 or 16GW05-001.

- The total metals analysis of sample 16GW03-001 showed zinc concentrations above the VGS at a concentration of 116 μg/L. Lead (18.4 μg/L) exceeded the federal drinking water action level. No metals concentrations above these applicable regulatory levels were found in the dissolved metals sample.

- Cadmium, chromium, mercury, and zinc were present above the VGS in the total metals analysis of 16GW04-001. Cadmium and chromium concentrations also exceeded federal MCLs. Lead was detected above the federal action level. Beryllium and nickel concentrations were above MCLs. The dissolved metals analysis showed no metals concentrations above the VGS or federal drinking water criteria.

- The total metals samples from 16GW01, 16GW02, and 16GW04 contained concentrations of several metals that were above background concentrations.

These results are similar to those obtained during previous investigations.

Tables containing metals concentrations for groundwater samples collected for the Round One RI and a comparison of contaminants detected in groundwater at WPNSTA Yorktown against potentially applicable federal and state standards are contained in Appendix A of this EE/CA.

2.4 STREAMLINED RISK EVALUATION

The results of previous investigations indicate that various contaminants, including metals, VOCs, PCBs, and/or BNAs, have migrated to sediments and surface water of drainage ways and groundwater located in the vicinity of Sites 4, 16, and 21. These results indicate that waste materials such as batteries, electrical equipment, and drums, and the ash pile at Site 4, have potentially released contaminants into the environment. This surface debris poses a potential physical hazard to station personnel and ecological receptors through accidental contact. In addition, the potential exists for additional releases, most likely from the surface waste materials and the ash pile located at these sites. The potential for migration of contaminants from these source areas will continue to exist as long as these materials remain in place. In the event of a release, potential ecological receptors include aquatic organisms in surface waters and sediments present downgradient of the sites. Therefore, the elimination of the physical hazards and these potential sources of environmental contamination provided by the activities described herein justifies the removal of the surface and subsurface materials and the ash pile at Site 4.

SECTION 3

IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

This section identifies the objectives for the proposed removal actions at Sites 4, 16, and 21. The potential ARARs developed as part of the RI activities at these sites are presented, along with other criteria specifically applicable to the removals discussed in this EE/CA. The purpose, scope, and scheduling requirements for implementation of the selected removal action alternatives are also described in this section in order to delineate any limits of performance of removal actions described in this EE/CA based upon time, budget, technical feasibility, and relevant criteria and standards.

For the RI/FS activities currently underway at WPNSTA Yorktown, EPA has been identified as the lead regulatory agency, with the Virginia Department of Environmental Quality (VDEQ) and the TRC members playing a major role in directing the RI/FS process. However, the Navy is the lead agency for the removal actions as described in this EE/CA. Therefore, statutory limits regarding the cost and duration of removal actions that are federally driven are not applicable to the removal activities discussed in this EE/CA.

3.1 REMOVAL ACTION OBJECTIVES

The objectives for the removal actions to be performed at Sites 4, 16, and 21 are to:

- Eliminate physical hazards to station personnel and ecological receptors through removal of the surficial debris (e.g., construction debris, drums, scrap metal, wood, mine casings, etc.) present at the three sites.
- Mitigate the potential for environmental contamination due to the continued presence of debris (e.g., ash pile, batteries, drums, etc.).

These objectives will be achieved by conducting the removal actions within the selected time frame and by attaining ARARs to the extent practicable.

3.2 ARARs

SARA mandates in Section 121(d) that site remediation under CERCLA comply with the requirements of all applicable or relevant and appropriate federal and commonwealth environmental and public health laws. For the removal actions to be performed, ARARs will be considered to the extent practicable, as required in NCP 300.415(i). These are known as the ARARs for the site. Applicable requirements are specific to the conditions present on the site for which all jurisdictional prerequisites of the law or requirements are satisfied. Relevant and appropriate requirements are those that do not have jurisdictional authority over the particular circumstances at the site, but that are meant to address similar situations and, therefore, are suitable for use at the site. The determination of applicability or relevance and appropriateness is made by EPA and the responsible commonwealth authority on a case-by-case basis.

ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs are particular to individual contaminants. Location-specific ARARs depend upon the location of the contamination and potential restrictions on activities conducted in these areas (i.e., wetlands, floodplains, etc.). Action-specific ARARs, as the name implies, govern the remedial actions. Action-specific ARARs are usually technology- or activity-based directions or limitations that control actions taken at CERCLA sites.

Chemical-specific requirements set health- or risk-based concentration limits or discharge limitations on various environmental medial for specific hazardous substances, pollutants, or contaminants. These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or indicate a safe level of discharge that may occur during a remedial activity. The chemical-specific water ARARs and To-Be-Considered criteria (TBCs) are presented in Table 3-1. There are no known chemical-specific ARARs for soils that would be relevant to the removal actions under this EE/CA.

Table 3-1

Summary of Chemical-Specific ARARs (μg/L)

Contaminants	Federal						Commonwealth of Virginia			
	Safe Drinking Water Act			Clean Water Act			Water Quality Standards			
	MCL[a]	PMCL[b]	SMCL[c]	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Ingesting Organisms	VGS	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Fish Consumption
Purgeable Organics										
Benzene	5	--	--	--	--	71[1,3]	--	--	--	710
Toluene	1,000	--	--	--	--	200,000[1]	--	--	--	200,000
Ethylbenzene	700	--	30	--	--	29,000[1]	--	--	--	29,000
Carbon Tetrachloride	5	--	--	--	--	4.4[1,3]	--	--	--	45
Chlorobenzene	100	--	--	--	--	21,000[1,7]	--	--	--	990
1,2-Dichloroethane	5	--	--	--	--	99[1,3]	--	--	--	--
1,1,1-Trichloroethane	200	--	--	--	--	**	--	--	--	--
1,1-Dichloroethylene	7	--	--	--	--	3.2[1,3]	--	--	--	--
1,2-Dichloropropane	5	--	--	--	--	--	--	--	--	--
Methylene Chloride	5	--	--	--	--	1,600[1,3]	--	--	--	--
Tetrachloroethylene	5	--	--	--	--	8.85[3]	--	--	--	3,519
Trichloroethylene	5	--	--	--	--	81[3]	--	--	--	807
Vinyl Chloride	2	--	--	--	--	525[3]	--	--	--	5,250
Styrene	100	--	--	--	--	--	--	--	--	--
Xylenes (Total)	10,000	--	20	--	--	--	--	--	--	--
Base/Neutral Extractable Organic Compounds										
Bis(2-ethylhexyl)phthalate	6	--	--	--	--	5.9[1,3]	--	--	--	59
Butyl Benzyl Phthalate	--	100	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	600	--	10	--	--	17,000[1]	--	--	--	17,000
Hexachlorocyclopentadiene	50	--	8	--	--	17,000[1,7]	--	--	--	--
Acid Extractable Organics										
Phenols	--	--	--	--	--	4,600,000[1,7]	1	--	--	--
Explosives										
2,4-Dinitrotoluene	--	--	--	--	--	9.1[3]	--	--	--	91

Table 3-1

Summary of Chemical-Specific ARARs (μg/L) (Continued)

Contaminants	Federal						Commonwealth of Virginia			
	Safe Drinking Water Act			Clean Water Act			Water Quality Standards			
	MCL[a]	PMCL[b]	SMCL[c]	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Ingesting Organisms	VGS	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Fish Consumption
Pesticides/PCBs										
Aldrin	--	--	--	--	--	0.00014[1,3]	0.003	0.3	0.13	0.0014
Gamma-BHC	0.2	--	--	0.08[5]	--	0.063[3]	0.01	0.08	0.01	25
4,4'-DDT	--	--	--	0.001[5]	0.001[5]	0.00059[1,3]	0.001	0.001	0.001	0.0059
Endrin	2	--	--	0.0023[5]	0.0023[5]	0.81[1,7]	0.004	0.0023	0.0023	0.81
Heptachlor	0.4	--	--	0.0038[5]	0.0036[5]	0.00021[1,3]	0.001	0.0038	0.0036	0.0021
Heptachlor Epoxide	0.2	--	--	0.0038[5]	0.0036[5]	0.00011[1,3]	0.001	--	--	--
Chlordane	2	--	--	0.0043[5]	0.004[5]	0.00059[1,3]	0.01	0.0043	0.0040	0.0059
Toxaphene	3	--	--	0.0002	0.0002	0.00075[1,3]	--	0.0002	0.0002	0.0075
PCBs	0.5			.014[5]	.03[5]	.000045[1,3]		0.014	0.030	0.0045
Metals										
Aluminum	--	--	200	--	--	--	--	--	--	--
Antimony	6	--	--	--	--	4,300[1]	--	--	--	--
Arsenic	50	--	--	190[10]	36[10]	0.14[1,3,9]	50	--	--	--
Barium	2,000	--	--	--	--	--	1,000	--	--	--
Beryllium	4	--	--	**	**	*	--	--	--	--
Cadmium	5	--	--	1.1[4,10]	9.3[10]	--	0.4	--	9.3	170
Chromium (Total)	100	--	--	--	--	--	50	--	--	--
Chromium (Hexavalent)	--	--	--	11[10]	50[10]	--	--	11	50	3,400
Copper	1,300*	--	1,000	12[4,10]	2.9[10]	--	1,000	--	2.9	--
Iron	--	--	300	--	--	--	300	--	--	--
Lead	15*	--	--	3.2[4,10]	8.5[10]	--	50	--	--	--
Manganese	--	--	50	--	--	--	50	--	--	--
Mercury	2	--	--	0.012	0.025	--	0.05	0.012	0.025	0.146
Nickel	100	--	--	160[4,10]	8.3[10]	--	--	--	8.3	4,583
Nitrates	10,000	--	--	--	--	--	5,000	--	--	--

Table 3-1

Summary of Chemical-Specific ARARs (μg/L)
(Continued)

Contaminants	Federal						Commonwealth of Virginia			
	Safe Drinking Water Act			Clean Water Act			Water Quality Standards			
	MCL[a]	PMCL[b]	SMCL[c]	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Ingesting Organisms	VGS	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Fish Consumption
Metals (Continued)										
Selenium	50	--	--	5	71[10]	**	10	5.0	71	11,200
Silver	--	--	100	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	100,000	--	--	--
Thallium	2	--	--	--	--	--	--	--	--	--
TPH	--	--	--	--	--	--	1,000	--	--	--
Zinc	--	--	5,000	110[4,10]	86[10]	--	50	--	86	--
Miscellaneous										
Total Cyanides	200	--	--	5.2	1	220,000[1,7]	5.0	5.2	1.0	215,000
pH	--	--	6.5-8.5	--	--	--	6.5-9.0	--	--	--

Notes:

All concentrations presented are in μg/L, except for pH, which is presented in pH units.
[a]MCL - Maximum Contaminant Level.
[b]PMCL - Proposed Maximum Contaminant Level.
[c]SMCL - Secondary Maximum Contaminant Level.
[d]VGS - Virginia Groundwater Standards.
[e]Clean Water Act Ambient Water Quality Criteria - Applicable to Commonwealth of Virginia (56 FR 58442, 19 November 1991).
[f]Water Quality Standards promulgated by the Water Division of the Department of Environmental Quality (VR 680-14-1), effective 27 September 1989.
[1]Criteria revised to reflect current agency reference dose (RfD). The fish tissue bioconcentration factor from the 1980 criteria documents was retained in all cases.
[2]EPA's Office of Research and Development's Environmental Criteria and Assessment Office prepared draft updates of criteria documents for arsenic, copper, and selenium, which are used instead of IRIS for this rulemaking. These documents are included in the record for the Ambient Water Quality Criteria (56 FR58442, 19 November 1991).
[3]Criteria in the matrix based on carcinogenicity (10^{-6} risk).
[4]Freshwater aquatic life criteria for these metals are expressed as a function of total hardness (mg $CaCO_3$/L). Values presented based on a total hardness of 100 mg/L.
[5]Aquatic life criteria for these compounds were issued using the 1980 guidelines for criteria development. The values shown are final acute values.
[6]Applies to methyl mercury.
[7]No criteria for protection of human health from consumption of aquatic organisms (excluding water) were presented in the 1980 criteria or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow calculation of a criterion, even though the results of such a calculation were not shown in the document.
[8]The criteria for 1,2-dichloropropane have been developed using the MCL (56 FR 3526, 30 January 1991).
[9]The criteria refers to the inorganic form only.
[10]Criteria for these metals are expressed as a function of the water effect ratio, as defined in 40 CFR 131.36(c).
*These values are action levels.
**EPA is not promulgating human health criteria for this contaminant.

Location-specific ARARs set restrictions on remedial action activities depending on the characteristics of the site and/or its surrounding environments. Location-specific ARARs may include restrictions on remedial actions occurring within wetlands and floodplains, near locations of known endangered species, or on protected waterways. These restrictions are discussed under "other potential ARARs or guidelines TBC" in Subsection 3.3.

Action-specific ARARs are usually technology- or activity-based requirement or limitations taken with respect to hazardous wastes. WPNSTA Yorktown is required to follow the Navy's Installation Restoration (IR) Program. The Navy's IR Program details some factors that need to be considered in determining the appropriateness of a removal action. Discussion of these factors and how they relate to each removal alternative is contained in Subsections 5.2.2.1 and 5.3.2.1 of this EE/CA. Action-specific ARARs pertinent to the alternatives evaluated are discussed in Section 5 of this EE/CA.

A partial list of potential ARARs is presented in the preamble to the NCP as amended in March 1990. Additional ARARs have been added during a search of federal and commonwealth environmental requirements. The list of chemical-specific ARARs is presented in Table 3-1.

Examples of the potentially applicable federal ARARs for the three sites described in this EE/CA are presented in the following subsections. The Commonwealth of Virginia has adopted many of the federal standards as state-specific standards. Therefore, many of the examples presented here reflect both federal and commonwealth ARARs and TBCs.

3.2.1 Surface Water Quality Criteria and Groundwater ARARs

For the proposed removal actions at Sites 4, 16, and 21, surface water standards are relevant. Specifically, the federal CWA and the Commonwealth of Virginia water quality standards salt water chronic levels pertain to the surface water in these areas, as the removal actions may lessen the migration of contaminants into surface waters adjacent to

these sites. Groundwater ARARs have been included to show the possible impact from the contaminant sources at the sites.

Clean Water Act (CWA)

A Virginia Pollutant Discharge Elimination System (VPDES) Permit (VR 680-14-01) may be required if the remedy includes off-site discharging to surface water. The best available technology (BAT) that is economically achievable must be used.

The provisions of 40 Code of Federal Regulations (CFR) 131 (CWA) state that remedial actions shall attain federal surface water quality criteria where they are relevant and appropriate. Federal surface water quality criteria documents have been published for 65 pollutants listed as toxic under the CWA. These criteria are unenforceable guidelines that may be used by states to set surface water quality standards. Although these criteria were intended to represent reasonable levels of pollutant concentrations consistent with the maintenance of designated water uses, states may appropriately modify these values to reflect local conditions.

Surface water quality criteria are generally provided for different surface water use designations. Concentrations are specified that, if not exceeded, should protect most aquatic life against acute toxicity or chronic toxicity (24-hour average). For many chemical compounds, specific criteria have not been established because of insufficient data.

The Ambient Water Quality Criteria (40 CFR 129) require that the concentration of a toxic pollutant in navigable waters will not result in adverse impact on important aquatic life, or on consumers of aquatic life, after exposure of that aquatic life to the pollutant for a period of time exceeding 96 hours and continuing through at least one reproductive cycle. These federal criteria were adopted, with revisions, by the Commonwealth of Virginia. Both criteria are included in Table 3-1.

Virginia Surface Water Standards

The Commonwealth of Virginia has established its own standards for surface water, which are presented in Table 3-1 along with the EPA CWA criteria.

Safe Drinking Water Act (SDWA)

National Primary Drinking Water Standards (see Table 3-1), MCLs (40 CFR 141), are applicable where the water will be provided to 25 or more people or to 15 or more service connections. When this occurs, the MCLs are the maximum levels allowed at the tap. In other cases, MCLs are relevant or appropriate for comparison to concentrations found in groundwater and, in some cases, surface water if the surface water is used as a source of drinking water.

MCL Goals (40 CFR 141) are the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety.

Secondary Drinking Water Standards, Secondary MCLs (SMCLs) (40 CFR 143), apply to contaminants that primarily affect the aesthetic quality of drinking water and are not federally enforceable.

Virginia Groundwater Standards (VGS)

The Commonwealth of Virginia has established its own standards for groundwater, which are presented in Table 3-1 along with the EPA MCL, the Proposed MCL (PMCL), and the SMCL for most contaminants.

3.2.2 Soil and Air ARARs

Toxic Substances Control Act (TSCA)

Disposal of PCBs (40 CFR 761) is applicable if the remedy involves excavation of soils that contain PCBs.

Resource Conservation and Recovery Act (RCRA)

In general, the applicable solid waste requirements will be action-specific, applying to the remedial activities undertaken. The following are some examples of RCRA requirements (40 CFR 265) that may be applicable or relevant and appropriate:

General Waste Treatment (40 CFR 264 and 265): Although standards do not yet exist for general waste treatment in new facilities, standards do exist for interim status facilities (40 CFR 265, Subpart O) and include specific requirements for ignitable and reactive wastes. The interim status requirements are probably not applicable if the treatment is performed on-site, but they may be relevant and appropriate.

Incineration (40 CFR 265, Subpart O): This subpart includes performance standards for incinerators and monitoring, inspection, and operating requirements.

Land Disposal Restrictions (40 CFR 268): This part describes general requirements that must be met to dispose of a waste at a RCRA landfill.

Storage (40 CFR 265, Subparts I and J): These two subparts include standards for the storage of hazardous waste in containers (Subpart I) and tanks (Subpart J).

Site Closure With Waste In Place (40 CFR 264 and 265, Subpart G): Certain sections of both 40 CFR 264 and 265 may be relevant and appropriate if the waste is to be left in place. This could include capping, installation of slurry walls, grading and covering with vegetation,

or consolidation of substances in one location. Subpart G of both 264 and 265 provides technical requirements for closure and post-closure activities.

Groundwater Monitoring (40 CFR 265, Subpart F): This subpart provides RCRA groundwater corrective action requirements that may be relevant or appropriate at the facility. These requirements include groundwater monitoring and groundwater protection standards.

Virginia Hazardous Waste Management Regulations (VHWMR)

Because Virginia administers an authorized state RCRA program, the Virginia Hazardous Waste Management Regulations (VHWMR) are applicable in lieu of the RCRA regulations covered in 40 CFR 264-265. The Land Disposal Restrictions, 40 CFR 268, are applicable.

Clean Air Act (CAA)

The substantive requirements of a discharge permit (40 CFR 50) would be required to be met if remedial activities have the potential for airborne discharges from the site. The BAT that is economically feasible must be used.

3.3 TBC CRITERIA

In addition to legally binding laws and regulations, federal and state environmental and public health programs issue unenforceable advisories or guidance that are not legally binding. These TBCs are evaluated along with ARARs. TBCs can include health advisories, reference doses and cancer slope factors, proposed rules, guidance materials, or policy documents. When evaluating TBCs, professional judgement is required based upon the latest available information.

The TBC criteria listed below have been identified as being potentially applicable to the sites addressed as part of this EE/CA. Additional TBCs are provided in Subsection 3.3.

Risk-Based Concentrations

EPA Region III has developed risk-based screening levels for various compounds. These values are concentrations of contaminants that have been calculated based upon assumptions as stated in the "Risk Assessment Guidance for Superfund (RAGS), Part A" (EPA, 1989), and equated to either a 10^{-6} excess lifetime cancer risk or a hazard quotient equal to 0.1 for carcinogenic and noncarcinogenic compounds, respectively.

The screening levels will be used as the confirmation sampling criteria for the ash pile excavation to be performed at Site 4. The commercial/industrial exposure scenario was selected because Site 4 lies within the explosive arc of the open burning facility; therefore, this area will not be developed for residential use. Appendix C provides the EPA guidance document that contains the risk-based concentrations that will be applied to the removal of the ash pile at Site 4 under this EE/CA.

National Oceanic and Atmospheric Administration (NOAA)

Sediment screening values have been used as part of the data evaluation at WPNSTA Yorktown, based on the NOAA guidance. These criteria are useful as a preliminary screening of sediments containing concentrations of chemicals whose presence may indicate a potential ecological risk. Three levels of criteria are provided, as shown in Table 3-2. The Effects Range-Low (ER-L) criteria are those concentrations at which 10% of the population would be expected or predicted to show adverse effects. The Effects Range-Median (ER-M) concentrations indicate levels at which approximately half of the population would be expected to show effects. These levels do not necessarily indicate that an ecological risk is present. The ER-L and ER-M guidance concentrations represent the concentrations at which 10% and 50% of a study group showed evidence of adverse impact from these compounds. The overall Apparent Effects Threshold (AET) is the value at and above which adverse biological impacts are always predicted to occur.

Table 3-2

NOAA Sediment Screening Values*

Analyte	ER-L[a] Concentration	ER-M[b] Concentration	AET Concentrations[c]
BNA (µg/kg)			
Acenaphthene	150	650	150
Anthracene	85	960	300
Benzo(a)anthracene	230	1,600	550
Benzo(a)pyrene	400	2,500	700
Chrysene	400	2,800	900
Dibenzo(a,h)anthracene	60	260	100
Fluoranthene	600	3,600	1,000
Fluorene	35	640	350
2-Methylnaphthalene	65	670	300
Naphthalene	340	2,100	500
Phenanthrene	225	1,390	260
Pyrene	350	2,200	1,000
Total PAHs	4,000	35,000	22,000
Pesticides/PCBs (µg/kg)			
Total PCBs	50	368	370
4,4′-DDT	1	7	6
4,4′-DDD	2	20	NSD[d]
4,4′-DDE	2	15	NSD[d]
Chlordane	0.5	6	2
Dieldrin	0.02	8	None
Endrin	0.02	45	NSD[d]
Metals (mg/kg)			
Antimony	2	25	25
Arsenic	33	85	50
Cadmium	5	9	5
Chromium	80	145	None

Table 3-2

NOAA Sediment Screening Values*
(Continued)

Analyte	ER-L[a] Concentration	ER-M[b] Concentration	AET Concentrations[c]
Copper	70	390	300
Lead	35	110	300
Mercury	0.15	1.3	1
Nickel	30	50	NSD[d]
Silver	1	2.2	1.7
Zinc	120	270	260

Notes:

*These values are provided as guidance and do not represent official NOAA standards.
[a]Effects Range - Low.
[b]Effects Range - Median.
[c]Apparent Effects Threshold.
[d]Not sufficient data.

3.4 OTHER POTENTIAL ARARs OR GUIDELINES TBC

Other potential ARARs or guidelines TBC include:

- Virginia Solid Waste Management Regulations (VR 672-20-10) — These regulations govern the classification and disposal requirements for solid waste.

- Groundwater Classification for Aquifers Underlying the Sites (EPA, 1986) — This ARAR is not considered applicable for the current removal actions since none of the removal actions include excavations or other activities that would impact groundwater.

- Occupational Safety and Health Administration (OSHA) Requirements for Hazardous Waste Workers (29 CFR 1910.20) — These regulations provide safety requirements for hazardous waste workers. This regulation is applicable to the removal actions proposed under this EE/CA.

- Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR 107 and 171) — These regulations govern the rules for the transportation of hazardous materials. For the removal actions, the hazardous materials may include solvents, other chemicals, and environmental samples (although they may not be classified hazardous).

- Regulations Pertaining to Activities That Affect the Navigation of Waters of the United States (33 CFR 320-329) — None of the activities to be conducted under the removal actions are anticipated to affect navigable waters.

- Endangered Species Act (50 CFR 81, 225, and 402) — The Endangered Species Act was enacted to protect endangered and threatened species and their habitats, The appropriate state agencies will be contacted to confirm that no federal- or state-listed species have been identified in these areas.

- Fish and Wildlife Conservation Act (50 CFR 83) — The Fish and Wildlife Conservation Act requires the protection of fish and wildlife by limiting actions that will alter or modify streams. The removal actions proposed in this EE/CA do not include modification of streams.

- Wild and Scenic Rivers Act (36 CFR 297) — This act protects the aesthetic quality of rivers. As stated above, no stream-impacting activities are planned as part of the removal actions.

- Drinking Water Health Advisory: Munitions - A Health Advisory on Munitions Chemicals (EPA, 1992) — This document provides laboratory studies of the effects of munitions in drinking water on animals. No drinking water sources will be impacted as part of response actions to be conducted.

- Virginia Wetlands Act (Code of Virginia, Sections 62.1-13.1 et seq.) — This act protects wetlands from being adversely altered or destroyed. The removal actions proposed for Sites 4, 16, and 21 are not anticipated to impact wetlands.

- Virginia Wetlands Regulations (VR 450-01-0051) — As stated above, none of the removals at Sites 4, 16, and 21 are anticipated to require activity in the wetland areas. The Virginia Wetlands Regulations will be referred to for proper compliance.

- Wilderness Act (16 United States Code (USC) 1131 et seq.; 50 CFR 35.1 et seq.) — The Wilderness Act establishes nondegradation maximum restoration, and protection of wilderness areas as primary management principles. These guidelines will be taken into consideration for the restoration of the sites.

- Coastal Zone Management Act (16 USC Section 1451 et seq.). The Coastal Zone Management At requires activities affecting land or water uses in a coastal zone to certify noninterference with coastal zone management through compliance with approved state management programs. The Virginia Coastal Zone Management Office will be contacted to ensure compliance with their established guidelines.

- National Historic Preservation Act (36 CFR 800) — This act requires that the removal actions take into account effects on properties included in or eligible for the National Register of Historic places and to minimize harm to National Historic Landmarks. The proposed removal actions at Sites 4, 16, and 21 are not located on currently listed properties. The State Historic Preservation Office will be contacted by the Navy to obtain a list of historic places to identify any historic landmarks/properties in the vicinity of these sites.

- Chesapeake Bay Preservation Act (Code of Virginia, Sections 10.1-2100 et seq.) — This regulations covers activities that may impact the Chesapeake Bay or its tributaries. The removal action for the three sites will not impact such waters.

- Floodplain Management and Protection of Wetlands (40 CFR Part 6, Appendix A) — These requirements mandate action to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible. All removal actions will include measures to minimize impacts on wetlands.

These additional requirements will be considered in the Work Plan for removal actions described in this EE/CA. Complete development of groundwater ARARs is not applicable for this removal action; however, this will be addressed in the FS.

3.5 REMOVAL ACTION SCOPE AND SCHEDULE

The removal scope for this EE/CA covers Sites 4, 16, and 21. The soils, groundwater, surface water, and sediment at Sites 4, 16, and 21 contain contaminants and waste materials, as previously described in Section 2 of this EE/CA, that, for the most part, are a direct result of past waste disposal practices at WPNSTA Yorktown. Investigation and characterization activities indicate that the waste materials pose a potential threat to human health and the environment.

These waste materials constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to some contaminant migration due to surface runoff; their removal will mitigate this problem. Some of the surface debris at Sites 4, 16, and 21 may have the potential to release contaminants that could migrate to the surface water, sediment, soils, and groundwater. The removal of the surface wastes will permanently eliminate physical threats to human health and the environment posed by the waste and will remove potential sources of environmental contamination. The removal alternative chosen will remove the waste materials as identified in the Testing Report (IT, February 1993), and/or in accordance with the recommended removal alternative. Removal of the waste materials should lessen the threat to human health and the environment within the short-term from further release of contaminants from the debris. Correspondingly, a removal alternative will be developed to satisfy this remedial objective.

The remedial objectives of this EE/CA include the following:

- Removal and final disposal of the surficial/exposed waste materials, which consist of batteries, drums/solvent containers and contents, scrap metal (including mine casings), electrical equipment, construction debris/tree stumps, and transformers (possibly containing PCB lubricants).
- Complete removal of the ash pile located at Site 4.
- Site restoration.

This removal is considered to be a partial site remediation, concentrating on surficial waste materials. Soils, groundwater, sediments, and surface water contamination identified in previous reports and remaining subsurface waste materials/debris will not be addressed at this stage; remediation of these media will be considered further in the WPNSTA Yorktown RI/FS program.

Decommissioning of the mine casings at Site 16 will be conducted by the WPNSTA Explosive Ordnance Disposal (EOD); therefore, this step in the removal and decommissioning of the mine casings will likewise be eliminated from the discussion of the removal alternatives in this EE/CA.

It is the responsibility of the Remediation Contractor to provide a detailed schedule and timeline of each task to WPNSTA personnel, prior to commencing any EE/CA field activities for approval. Approximate durations for the major tasks are included in the discussion of alternative implementability (Subsections 5.2.2.6 and 5.3.2.6 of this EE/CA).

SECTION 4

IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

Based on the objectives developed in the previous section of this EE/CA, removal actions and technologies that are appropriate for addressing the cleanup objectives are identified in this section. These removal actions and/or technologies, termed response actions in the following subsections, are evaluated based on the removal objectives and, if found appropriate, combined to form alternatives in the subsequent section. In identifying response actions, previous experience with the technologies, as well as knowledge of potential uses of the technologies, were considered. Information from previous investigations conducted at Sites 4, 16, and 21 was used to determine whether a particular removal action is suitable to the type, quantity, and location of the waste materials.

Alternatives were eliminated if they did not meet four fundamental characteristics. The following screening factors were considered when evaluating an alternative removal action:

- The feasibility of the technology.
- The acceptability of the technology in light of institutional considerations.
- The human health and environmental protection provided by the technology.
- The ability of the technology to produce the desired results within the short-term.

As noted in Sections 2 and 3 of this EE/CA, there are numerous chemical-, location-, and action-specific concerns relating to human health and environmental issues. It is assumed, for purposes of this EE/CA, that removal (full or partial) of the waste materials will lessen the potential for a contaminant release. Waste materials on the three sites include scrap metal, mine casings, batteries, construction debris, 5- and 55-gallon drums, an ash pile (at Site 4 only), electrical equipment, wire, etc. Therefore, the primary goal of the removal alternative selected is the removal and final off-site disposal of surficial waste materials. For the purpose of this section's response action identification and evaluation, the alternatives were considered to be protective of human health and the environment if the

action resulted in the removal and final disposal of, at a minimum, surficial debris/waste materials at Sites 4, 16, and 21 as identified in the Testing Report.

General response actions have been identified for Sites 4, 16, and 21 based on the information and data presented and discussed in the previous sections of this EE/CA. When removal of "associated soils" from the site is proposed in a response action, it is assumed that these are only the soils disturbed or associated with the removal of the waste materials. Ten general response actions and their expected applicability to the removal of the waste materials at the sites are presented in Table 4-1. According to EE/CA guidance, alternative technologies that have not been proven or developed to the commercial scale are not considered as viable response actions for removals and therefore are not included here.

Response Actions 1 and 2, No Action and Interim Controls and Monitoring, will not be considered for screening because they do not meet the main objective, which is to remove the accessible waste materials from Sites 4, 16, and 21. Likewise, Response Action 7, Long-Term On-Site Storage of Waste Materials, does not correspond with the objective of waste material removal. The remaining seven general response actions are evaluated in the following subsections and are summarized in Table 4-2.

4.1 REMOVAL OF IDENTIFIED SURFICIAL WASTE MATERIALS AND COMPLETE REMOVAL OF THE ASH PILE AT SITE 4

The removal of surficial waste materials and complete removal of the ash pile at Site 4, as identified in the Testing Report, and their associated soils (for both surficial waste and ash) are conducted under this response action. The identified surficial waste materials and ash pile will be removed by hand or heavy equipment. Surficial removal assumes removal of the waste material to a maximum depth of 1 ft bgs. If a large piece of debris is partially buried (i.e., >1 ft bgs), the entire piece of debris will be removed but no further vertical excavation will be conducted even if waste materials are visible below the 1 ft bgs elevation. Precautions will be taken to minimize contaminant releases from punctured

Table 4-1

Identified General Response Actions
Sites 4, 16, and 21
WPNSTA
Yorktown, Virginia

Response Action	Expected Applicability
1. No Action	---
2. Interim Controls and Monitoring	---
3. Removal of Identified[a] Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4	X
4. Complete Removal of Identified[a] Waste Materials	X
5. Selective Removal of Identified[a] Waste Materials	X
6. Containment	X
7. Storage	---
8. Off-Site Disposal	X
9. Off-Site Treatment	X
10. On-Site Treatment	X

Notes:

[a] = Based on Testing Report (IT, February 1993).
X = Applicable.
--- = Not applicable.

Table 4-2

Response Action Summary
Sites 4, 16, and 21
WPNSTA
Yorktown, Virginia

Response Action	Associated Technology
Removal Alternatives	
1. Removal of Identified* Surficial Waste Materials and the Ash Pile at Site 4	• Partial Excavation of Surficial Waste Materials and Associated Soils, Complete Removal of the Ash Pile at Site 4, Interim E&S Controls
2. Complete Removal of Identified* Waste Materials	• Full Excavation and Complete Removal of all Waste Materials, Including Batteries and the Ash Pile at Site 4, Interim E&S Controls
3. Selective Removal of Identified* Waste Materials	• Partial Excavation and Separation of Surficial Waste Materials, Complete Removal of the Ash Pile at Site 4 and Batteries at all Three Sites, Interim E&S Controls
Treatment Alternatives	
4. Off-Site Disposal	• Secure Landfill
5. Off-Site Treatment	• Incineration, Recycling
6. On-Site Treatment	• Incineration, In Situ Bioremediation
7. Containment	• Soil Covers/Capping

Note:

*Based on Testing Report (IT, February 1993).

drums, batteries, or electrical equipment during removal activities. This alternative includes the removal of all identified surficial waste materials with little or no separation of the waste materials from the associated soils. This removal response action would result in a time benefit since little or no separation of the two is required. Removals under this alternative are in accordance with the following guidelines and restrictions:

- The ash pile at Site 4 and a minimum of 6 inches of the underlying natural soil will be completely removed under this selective removal action. The initial excavation boundaries, for complete ash pile removal, will continue to a depth and width to be determined visually in the field. Prior to backfilling the excavated disposal area, soil sampling will be conducted. The confirmation samples will be analyzed for VOCs, BNAs, metals, cyanide, explosives, pesticides/PCBs, and TPH. The analytical results will be compared to EPA risk-based concentrations. The goal of the removal action is to meet these criteria, but the practicality of achieving these levels will have to be evaluated with respect to actual site conditions and cost-effectiveness. A sample of the excavated ash material will also be collected and analyzed for hazardous waste (HW) characteristics and other analysis as required by the selected landfill for disposal approval. Any water that enters the excavation will be pumped, temporarily stored, and sampled for HW characteristics and other analyses required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums, located on the surface of each of the sites, will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Any liquids that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed accordingly. Drums found containing nonsolidified materials will be flushed; all rinsate will be collected in a new (i.e., clean drum designated for these types of liquids) liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the surficial identified waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results. The drum removal is a surficial removal only. Surficial removal limits are based on results contained in the Testing Report and on field observations.

- The remaining surficial waste materials (i.e., batteries, scrap metal, wood, construction debris, electrical equipment, mine casings, etc.) with associated soils will be removed from the surface of the three sites to a depth not to exceed 1 ft bgs. Confirmatory samples will be collected to provide information on the residual soils. Surficial removal limits are based on results contained in the Testing Report and on field observations.

- Separation of the waste materials from the associated soils will not be conducted. All soils displaced during removal activities will be disposed with the appropriate waste materials. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen.

During removal activities at the three sites, E&S controls, such as diversion ditches, berms, hay bales, and/or silt fencing, will be installed and maintained. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface. The ash pile excavation will be backfilled using a fill material capable of supporting vegetative cover.

Complete waste removal of the ash pile at Site 4 effectively eliminates the potential for additional contamination of the soils, groundwater, sediment, and surface water from the ash pile contamination. Partial (surficial) removal of the drums and the remaining waste materials also reduces the potential for further contamination of the surrounding environment as well as the likelihood of station personnel coming in contact with any harmful debris scattered on the surface of these sites. Partial removal provides an immediate benefit to human health, as well as an achievable removal goal within the short-term. Further removal or treatment of the contaminated groundwater, soils, sediment, and surface water will be addressed at the sites during the WPNSTA Yorktown RI/FS program.

Based on the above discussion, the removal of identified surficial waste materials and complete removal of the ash pile at Site 4 will be retained for further consideration.

4.2 COMPLETE REMOVAL OF IDENTIFIED WASTE MATERIALS

The complete (surface and subsurface) removal of waste materials, including the ash pile at Site 4, batteries, drums, construction debris, mine casings, scrap metal, etc., identified in the Testing Report and their associated soils is conducted under this response. The identified waste materials and associated soils will be removed by hand or heavy equipment. Precautions will be taken to minimize releases from punctured drums, batteries, or electrical equipment during removal activities. Since the exact condition and quantity of waste

materials present at the sites have not been fully realized at this stage of WPNSTA Yorktown's RI/FS program, it is uncertain how extensive a removal action would be required. In addition, extensive scheduling and planning for long-term removal activities are required for this response. Removal will be conducted in accordance with the following guidelines:

- All surficial and subsurface waste materials (i.e., scrap metal, construction debris, etc.), including the entire ash pile at Site 4 (with 6 inches of the underlying soil) and the batteries, both surface and subsurface, at all three sites, are completely removed under this selective removal action. Initial excavation boundaries, for complete removal, will continue to a depth and width to be determined visually in the field. Prior to backfilling the excavated ash pile area, soil sampling will be conducted, and the results will be compared against the EPA risk-based cleanup criteria provided in Appendix C. A sample of the excavated ash material will be collected and analyzed for HW characteristics and other analyses as required by the landfill for disposal approval. Any water that enters the excavation will be pumped, temporarily stored, and sampled for HW characteristics and other analyses required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums located at or below the surface of each of the sites will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Any liquids that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed accordingly. Drums found containing nonsolidified materials will be flushed; all rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the identified waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results.

- Separation of the waste materials from the associated soils will not be conducted. The soils displaced during debris removal will be disposed appropriately with the waste materials. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen. Confirmatory soil sampling is included for the waste material excavations under this alternative.

Removal activities will continue until complete removal has been verified by field personnel. The complete removal response action includes testing and sampling of the soils,

groundwater, surface water, and sediment prior to backfilling the excavations. Tests may include the use of metal detectors and trenching. Sampling analysis will be based on contaminant levels detected during the previous characterization and investigation activities conducted at the sites. If results from this sampling show a need for further action, stabilization alternatives or additional excavation may be reviewed and implemented.

During removal activities at the three sites, E&S controls, such as diversion ditches, berms, hay bales, and silt fencing, will be installed and maintained. All excavations will be backfilled using a fill material compatible with the surrounding soils.

The complete removal of waste materials and associated soils provides a benefit to human health and the environment. However, this response action would not be an attainable objective at this time because the sites have not yet been fully characterized and the volume and extent of contaminated soils, groundwater, surface water, and sediment, as well as waste materials below the surface, are unknown. In addition, time and cost for complete removal with verification sampling cannot be accurately estimated at this stage of the RI/FS program.

Based on the considerations of time, cost, and the need for human health benefits in the short-term, the complete removal response action will not be retained for further consideration. Further removal of the contaminated groundwater, soils, sediment, and surface water along with the remaining waste materials will be considered at the sites during RI/FS activities.

4.3 SELECTIVE REMOVAL OF IDENTIFIED WASTE MATERIALS

For this response action, the extent of the removal (partial versus complete) of the identified waste materials is based on the specific material(s) in question. For purposes of this response action, surficial removal assumes removal of the waste material to a maximum depth of 1 ft bgs. If a large piece of debris is partially buried (i.e., >1 ft bgs), the entire piece of debris will be removed, but no further vertical excavation will be conducted even

if waste materials are visible below the 1 ft bgs elevation. Removal of the specific wastes will continue in accordance with the following guidelines and limitations:

- The entire ash pile at Site 4 (with a minimum of 6 inches of underlying natural soil) and the batteries, both surface and subsurface, at all three sites will be completely removed under this selective removal action. Initial excavation boundaries, for complete ash and battery removal, will continue to a depth and width to be determined in the field. Prior to backfilling these excavated disposal areas, tests will be conducted to ensure complete removal. Testing will include the use of metal detectors for the battery area excavations and sampling for the ash pile excavation. The results of the ash pile samples will be compared against EPA risk-based concentrations. Any water that enters the excavation will be pumped, temporarily stored, and sampled for HW characteristics and other analyses required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums, located on the surface of each of the sites, will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Any liquids that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed accordingly. Drums found containing nonsolidified materials will be flushed; all rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the surficial identified waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results. The drum removal is a surficial removal only. Surficial removal limits are based on results contained in the Testing Report and on field observations.

- The remaining surficial waste materials (i.e., scrap metal, wood, construction debris, electrical equipment, mine casings, etc.) will be removed from the surfaces of the three sites to a depth not to exceed 1 ft bgs.

- Separation of the waste materials from the associated soils will be conducted. The soils displaced during debris removal will be sampled and disposed based on the analytical results. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen. Confirmation sampling will be conducted to provide information on the residual soils. Surficial removal limits are based on the results contained in the Testing Report, topographical surveys, and field observations.

During removal activities at the three sites, E&S controls, such as diversion ditches, berms, hay bales, and silt fencing, will be installed and maintained. Waste materials will be removed by hand or heavy equipment. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface waste materials. The ash pile and battery disposal excavations will be backfilled using a fill material capable of supporting vegetative cover.

Complete waste removal of the ash pile and battery disposal areas effectively eliminates the potential for additional contamination of the soils, groundwater, sediment, and surface water from these waste materials; this option also mitigates the physical hazard associated with these materials through disposal of the wastes and associated contaminated soils at an appropriate off-site disposal facility. In addition, partial (surficial) removal measures of the drums and remaining waste materials also reduces the potential for further contamination of the surrounding environment, as well as the likelihood of station personnel coming in contact with any harmful debris scattered on the surface of these sites. Partial removal provides an immediate benefit to human health, as well as an achievable removal goal within the short-term.

Based on the above considerations, the selective removal response action will be retained for further consideration. Further removal or treatment of the contaminated groundwater, soils, sediment, surface water, and remaining wastes will be addressed at the sites during the WPNSTA Yorktown RI/FS program.

4.4 OFF-SITE DISPOSAL

Off-site disposal includes the transportation and disposal of the contaminated materials to a secure landfill. Waste materials may need to be separated, depending on the contaminant(s) present.

4.4.1 Secure Landfill

Sanitary landfills are permitted to accept various waste materials, including ash, commercial waste, construction waste, debris, demolition waste, discarded material, scrap metal, and nonregulated hazardous waste, by specific approval only. If the landfill is not permitted to accept specific materials, a special waste request must be submitted to the landfill and to VDEQ for approval prior to disposal of such materials. Sanitary landfills are not allowed to accept free liquids, regulated hazardous waste, and drums that have not been emptied and properly cleaned. There are five permitted sanitary landfills located near WPNSTA Yorktown.

Industrial landfills are generally permitted for the disposal of specific industrial wastes or wastes that are the by-product of a production process. Hazardous wastes, as defined by the Virginia Hazardous Waste Management Regulations, are not accepted.

Any wastes encountered (i.e., drum liquid and ash pile) that may be considered a hazardous waste will be sampled to determine whether disposal under RCRA is required.

Off-site disposal in a secure landfill provides for protection of human health and the environment from the threat of additional releases from the waste materials and will be retained for further consideration.

4.4.2 Disposal Requirements

Analytical results must be submitted to the landfill(s) and a waste characterization form prepared prior to disposal of wastes generated during the removals described in this EE/CA. The waste characterization form generally includes a description of the waste, the waste quantity, and the TCLP ignitability, corrosivity, and reactivity (ICR) results. As discussed below, VDEQ must approve the disposal of any special wastes into sanitary landfills. The approval process normally takes approximately 6 weeks.

The Virginia solid waste management facility (SWMF) designations are as follows:

- Sanitary Landfill: Sanitary landfills are permitted to accept various waste materials, including ash, commercial waste, construction waste, debris, demolition waste, discarded material, scrap metal, and nonregulated hazardous waste, by specific approval only. If the landfill is not permitted to accept specific materials, a special waste request must be submitted to both the landfill and to VDEQ for approval prior to disposal of such materials. Sanitary landfills are not allowed to accept free liquids, regulated hazardous wastes, and drums that have not been emptied and properly cleaned.

  The disposal of special wastes requires approval by VDEQ. Special wastes include asbestos waste, PCBs (>50 parts per million (ppm)), liquids, and drums. Other special wastes include discarded chemicals that are not regulated as hazardous wastes and hazardous materials associated with site cleanups. A listing of permitted private sanitary landfills near WPNSTA that are permitted to accept special wastes is presented below:

  - Bethel Landfill (Permit No. 299) in Hampton, Virginia.
  - BFI Landfill (Permit No. 129) in Richmond, Virginia.
  - Chambers Landfill (Permit No. 531) in Richmond, Virginia.

- Construction/Demolition/Debris Landfill: These landfills can only accept construction wastes that are produced during the construction of structures, including lumber, wire, sheetrock, broken brick, shingles, glass, pipes, and concrete. Paints, coatings, solvents, asbestos, liquids, and garbage cannot be disposed at a construction debris landfill. Given the analytical results and the regulatory requirements, materials at Sites 4, 16, and 21 cannot be disposed at a construction debris landfill.

- Industrial Waste Disposal Facility: Industrial waste landfills are generally permitted for the disposal of specific industrial wastes or wastes that are the by-product of a production process. Hazardous wastes, as defined by the Virginia Hazardous Waste Management Regulations, are not accepted. First Piedmont Landfill (Permit No. 65) in Chatham, Virginia, is an industrial landfill permitted to accept special wastes.

4.5 OFF-SITE TREATMENT

Off-site treatment methods that can be used as an alternative to off-site disposal include incineration, composting, stabilization, biological treatment, and recycling. Descriptions of these treatment technologies are presented in the subsections that follow.

4.5.1 Incineration

Incineration is a controlled process that uses combustion to convert a waste to a less bulky and/or less toxic material. Contaminated soils are excavated and combined with additives (if necessary), which in turn are heated in a rotary kiln or a multiple-hearth furnace. The incineration system includes the waste feed system, the kiln or furnace where combustion occurs, the auxiliary fuel feed system, an afterburner that destroys gaseous products produced within the incinerator, and air pollution control systems. The anticipated operating temperature for these units is approximately two-thirds as high as the contaminants' melting temperature. The noncombustible by-product is expected to exhibit extremely low leachability and remain stable in the environment. Incineration is a high-temperature process that has been proven to be effective in destroying even the most difficult to burn organic compounds.

This response action requires separation of the materials in the field during excavation. Applicable materials are then sent to an off-site permitted incinerator. Off-site incineration is a commercially available, practical method for removing some contaminants from soils and waste materials. As such, this response action will be retained for further consideration, particularly for contaminants that are banned from land disposal by EPA regulations (applicable if drums containing unknown liquids or land-banned contaminants are encountered).

4.5.2 Composting

Composting is a treatment technology is which contaminated soils are excavated and then degraded using a naturally occurring microbial process. Composting is a proven technology for achieving accelerated biodegradation of select industrial and municipal wastes under controlled conditions. Generally, there are three categories of compost systems: windrow, static pile, and in-vessel. In the windrow method, which is the most commonly used method, the mixture to be composted is piled in long rows (windrows) that are periodically turned by mechanical means to increase exposure of organic matter to oxygen. The static pile

(forced aeration) approach utilizes a blower to aerate the mixture to be composted. The mixture is placed on a base of wood chips or other suitable material in which a network of aeration pipes has been constructed. Oxygen is then introduced by blowing or drawing air through the pile. In-vessel composting, which is currently being developed, occurs in closed containers where environmental conditions can be controlled.

The process flow is similar for all three composting systems. The material to be composted is mixed with a bulking agent or agents such as wood chips, straw, horse manure, sawdust, leaves, or paper. The bulking agent can serve as a source of carbon, nutrients, or microbes. In addition, it increases porosity and aeration. Once the mixture to be composted is in place, it undergoes a self-heating process caused by microbial activity. After composting, the treated material is usually cured for approximately 30 days. During this period, additional decomposition as well as stabilization, pathogen destruction, and degassing take place.

Studies have shown that the majority of nitroaromatic and organic compounds can be biologically degraded by composting. Composting requires that separation of soils from their associated wastes be completed in the field during excavation. The composting technology is not appropriate for the waste materials (i.e., construction debris batteries, scrap metal, drums, etc.). Composting could only be used on the soils separated from the waste materials at the sites. The effectiveness of composting would first need to be verified by bench-scale and/or pilot-scale treatability studies. These studies can be costly and time consuming. Composting may also significantly increase the volume of material requiring final disposal. For these reasons, composting will not be retained for further consideration.

4.5.3 Stabilization

Stabilization is a treatment process used to immobilize waste constituents in a solid matrix through mixing with additives and binders (e.g., cement, lime, or thermosetting polymer). Application at Sites 4, 16, and 21 would involve the excavation and separation of contaminated soils from their associated waste materials and conversion of these soils into

a solid mass that would immobilize leachable contaminants. Stabilization is a partial remedial measure. Stabilized materials must be properly disposed in an off-site permitted landfill that complies with applicable regulations.

Stabilization has been used successfully to immobilize waste materials; however, certain binding materials are sensitive to wastes containing organic compounds. Typically, wastes exhibiting organic compound concentrations in the 10% to 20% range are unsuitable for stabilization. Laboratory bench-scale and/or pilot-scale tests would be required to confirm the feasibility of stabilization and to determine the optimum binding materials for site soils. Stabilization may also increase the final volume of material requiring disposal due to the addition of binding materials.

Because of the adverse effect that organic materials in the site soils may have on the effectiveness of stabilization and the significant increase in volume of waste materials for disposal, stabilization will not be retained for further consideration.

4.5.4 Biological Treatment

Biological treatment is an innovative technology that, in recent years, has attracted much attention as a potentially inexpensive and efficient remediation alternative for many hazardous wastes sites. The technology can be applied to both aqueous and soil matrices that have been contaminated with organic compounds. Biological treatment centers around biological degradation of the target compounds by microorganisms such as bacteria and fungi. Typically, the target compounds are used as a carbon and/or energy source by these microorganisms, and in the process, are effectively degraded and removed from the contaminated matrix. This technology, also known as bioslurry treatment, could be performed off-site in a treatment vessel.

The application of bioremediation to hazardous wastes is complex. Not all organic compounds are susceptible to biological degradation and metals cannot be treated by this method. Careful characterization of the contaminated material, including bench-scale and

pilot-scale treatability studies, must be conducted to identify the target compounds. Treatability studies can be costly and time consuming. Biological treatment has been documented as effective in some remedial activities; however, it only addresses the contaminants in the soil/sediment/groundwater at the site and not the identified waste materials (i.e., drums, scrap metal, batteries, etc.). Base on the objective of this EE/CA, namely removal of surficial waste materials at Sites 4, 16, and 21, biological treatment will be eliminated from further consideration.

4.5.5 Recycling

Many of the waste materials identified at the three sites, as discussed previously, are recyclable. Various types of scrap metal are candidates for some type of recycling process. The recycling response option requires that the recyclable materials be separated from other debris and soil prior to shipment to the recycling facility.

Sampling (wipe or chip) of the recyclable materials may be necessary. The Navy will determine if sampling is required, based upon the requirements of the recycling facility. The recyclable materials will also be cleared of any material (i.e., soil) adhering to the surfaces.

This response action will be retained for further consideration.

4.6 ON-SITE TREATMENT

On-site treatment would not be conducted until after the waste materials are removed from the soils. The wastes would be separated and, if necessary, contained until the on-site treatment is scheduled. The on-site treatment technologies considered under this response action include incineration, composting, stabilization, and biological treatment. These technologies are described in the subsections that follow.

4.6.1 Incineration

Incineration for off-site treatment was described in Subsection 4.5.1. On-site incineration would be a similar process, but incineration would be performed at the site using a mobile or transportable incinerator. Mobile incinerators are transported intact to the site. Transportable systems are delivered to the site and assembled. Mobile and transportable incinerators rely on the same technologies as a commercial, stationary incinerator. However, the treatment capacities of mobile and transportable incinerators may be somewhat smaller than those of stationary incinerators.

For on-site incineration, a suitable location and pad would be required for the incinerator unit. Trial burns would also be required. Incineration would only be applicable to the soils associated with the waste materials or to solidified materials or liquids from drums. Waste materials (i.e., batteries, scrap metal, weapons casing, drums, etc.) could not be incinerated. The small size of the mobile and transportable systems would also demand that the feed soil be screened with a relatively small maximum permissible solids diameter. Due to the on-site time required for test burns, the additional area and pad required for the treatment unit, and the decreased capacity of on-site systems, on-site incineration will not be retained for further consideration.

4.6.2 Composting

Off-site composting was described in Subsection 4.5.2. On-site composting would use the same processes as off-site composting. An on-site composting facility would require a treatment area, preferably near the excavation area. The most commonly used composting method, windrow composting, requires a large tract of land. Treatability studies and treatment time for composting would also require a significant amount of on-site time. For these reasons and for those reasons specified in Subsection 4.5.2, on-site composting will not be retained for further consideration.

4.6.3 Stabilization

On-site stabilization, similar to off-site stabilization described in Subsection 4.5.3, would be performed at WPNSTA Yorktown. The disadvantages associated with off-site stabilization also apply to on-site stabilization. These disadvantages include the unsuitability of stabilization when organic materials are present in the soil, the need for treatability studies, and the increase in the volume of material requiring final disposal. Therefore, on-site stabilization will not be retained for further considerations.

4.6.4 Biological Treatment

On-site biological treatment relies on the same processes as off-site biological treatment, which are described in Subsection 4.5.4. On-site biological treatment can be performed prior to removing the contaminated soil, or aboveground using the bioslurry process following the removal of contaminated soil. When performed on soil still in place, nutrients and oxygen (if necessary) are delivered to the soils through injection wells or an infiltration system. Soil and groundwater characteristics can greatly affect the results of this method. A treatability study on the contaminated soil and its ability to be remediated using on-site bioremediation would be required prior to full-scale treatment. Because of the uncertainties associated with on-site biological treatment and its applicability to the waste and soil at Sites 4, 16, and 21 at WPNSTA Yorktown, this technology will not be retained for further consideration.

4.7 CONTAINMENT

No removal actions are implemented under the containment response. However, mechanisms such as soil capping would be installed to prevent direct access to the contaminants and reduce the infiltration of contaminants into the groundwater. Periodic monitoring and analysis of groundwater are also included in this response action. If, in the event that groundwater monitoring data indicate an adverse impact on the groundwater, an alternative response action may be implemented.

Containment measures such as soil capping or other types of covers are practical alternatives; however, much of the debris is scattered on the surface or is protruding from the surface; as such, it would be difficult to construct an effective cap or cover and maintain the integrity of such a cap given these site conditions. Therefore, based on the above statement and the fact that containment does not address the objective of removing the surficial waste, this technology will be eliminated from further consideration.

4.8 SUMMARY

Table 4-3 summarizes the removal limitations under each of the removal response actions. Based upon the evaluation conducted in this section, the following response actions have been retained for further consideration:

- Removal of Identified Surficial Waste Materials and the Ash Pile at Site 4.
- Selective Removal of Identified Waste Materials.
- Off-Site Disposal.
- Off-Site Treatment.

Table 4-3

Removal Response Actions Summary

Waste Material	Removal Response Actions		
	Removal of Identified Surficial Wastes and Complete Removal of the Ash Pile at Site 4	**Complete Removal of Waste Materials**	**Selective Removal of Waste Materials**
Ash pile	Complete removal[a] of ash pile, associated soils, and a minimum of 6 inches of underlying natural soil	Complete removal of ash pile, associated soils, and a minimum of 6 inches of underlying natural soil	Complete removal of ash pile, associated soils, and a minimum of 6 inches of underlying natural soil
Batteries	Surficial removal[b]	Complete removal	Complete removal
Construction debris	Surficial removal	Complete removal	Surficial removal
Scrap metal	Surficial removal	Complete removal	Surficial removal
Electrical equipment, wire, miscellaneous debris	Surficial removal	Complete removal	Surficial removal
5- and 55-gallon drums	Surficial removal	Complete removal	Surficial removal
Mine casings (only present on the surface)	Complete removal	Complete removal	Complete removal

Notes:

[a]Complete removal assumes removal to whatever depth is necessary to removal all of the waste material present.
[b]Surficial removal assumes removal of the waste material to a maximum depth of 1 ft bgs. If a large piece of debris is partially buried (i.e. >1 ft bgs), the entire piece of debris is removed, but no further vertical excavation is conducted, even if waste materials are visible below the 1 ft bgs elevation.

Sampling is included for all three removal response actions.

SECTION 5
ANALYSIS OF REMOVAL ACTION ALTERNATIVES

5.1 INTRODUCTION

In this section, a detailed analysis of the response actions developed in Section 4 of this EE/CA that satisfy the objectives stated in Section 3 is presented. This analysis facilitates a comparison of the alternatives based on the action-specific ARARs followed by a four-step analysis of each alternative. Relevant and applicable environmental standards and generally accepted engineering practices were considered in determining suitable actions or technologies. The response actions presented in Section 4 that met the necessary criteria are the following:

- Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4.
- Selective Removal of Identified Waste Materials.
- Off-Site Disposal.
- Off-Site Treatment.

The above response actions are combined in this section, forming two different removal alternatives for final analysis in this EE/CA. The two removal alternatives are: 1) Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal; and 2) Selective Removal of Identified Waste Materials With Off-Site Treatment or Disposal. These removal alternatives will be subjected to a more detailed analysis in order to select the appropriate alternative for implementation. The following criteria were used to evaluate these alternatives:

- Technical feasibility.
- Effectiveness.
- Implementability.
- Cost.

Expanded descriptions of these criteria are provided below. Specific evaluation of the two alternatives based upon these criteria is provided in Subsections 5.2 and 5.3.

5.1.1 Technical Feasibility

The technical feasibility criterion addresses critical objectives in the evaluation of potential removal actions. These objectives include performance (effectiveness and useful life), reliability, implementation, compliance with ARARs, and safety. The evaluation of each removal action alternative is based on its ability to achieve the following technical goals:

- Performance — Two aspects of removal actions determine their desirability on the basis of performance: effectiveness and useful life. Effectiveness refers to the degree to which an action will prevent or minimize substantial danger to human health, welfare, or the environment. Useful life is the length of time that this level of effectiveness can be maintained.

- Reliability — To be reliable, a potential removal action alternative should incorporate proven technologies that have a demonstrated and dependable record of use, and should be capable of accomplishing the desired corrective results over the planned life of the remedial action. In addition, the frequency and complexity of necessary operations and maintenance (O&M) should be considered in evaluating the reliability of alternatives.

- Implementation — Additional important aspects of a removal alternative include its ability to be implemented, its relative ease of installation, and the time required to achieve a given level of response. The time requirements can generally be classified as the time required to implement a technology and the time required before results are actually realized.

- Compliance With ARARs — Chemical-specific ARARs, as discussed in Section 3 of this EE/CA, are not directly applicable to this EE/CA's waste material removal objective since no groundwater sampling is conducted as part of a response action. However, discussion of the Navy's IR Program and action-specific ARARs is relevant to this type of removal and is discussed further in this section in relation to this alternative's removal limits.

- Safety — Each removal alternative can be evaluated with regard to safety. This evaluation can include short-term threats to the safety of nearby communities, to the environment, or to workers during implementation.

5.1.2 Institutional Requirements

Institutional factors can be critical to the overall ability to select and implement an effective removal action program. These criteria are used to evaluate the acceptability of each technology to local, state, and federal agencies, as well as the potential for compliance with existing or future regulatory policies. As a result of such factors, ancillary equipment and approvals (i.e., E&S plan approvals, pre-acceptance at a disposal facility, etc.) may be required prior to implementation of the removal action. All applicable state and federal requirements must be met and all plans must be approved by the regulatory agencies. The Remediation Contractor is responsible for compliance with the applicable regulatory approvals.

This evaluation criterion includes:

- Short-term impacts during construction, including odors, dust, truck traffic, and noise.
- Federal, state, and local government acceptance and regulatory permits.
- Local resident and community perceptions.
- WPNSTA Yorktown IR Program requirements.
- Long-term management and operational requirements.
- State and federal DOT regulations for the handling, shipping, and manifesting of wastes.

5.1.3 Human Health and Environmental Issues

The removal alternative selected must adequately protect human health and the environment. The alternatives are evaluated for their effectiveness in mitigating the existing or potential contaminant exposure to station personnel.

Documentation that the alternative protects humans and adequately controls both the long-term effects of the residual contamination and the short-term effects caused by implementation of the removal action is required. Applicable health and environmental standards (i.e., ARARs) are used to evaluate each alternative.

The overall goal of the selected removal alternative is to mitigate the existing environmental threats without creating additional adverse effects. The environmental effectiveness evaluation criterion focuses on the key environmental contaminants. The factors to be incorporated into the environmental effectiveness evaluation include:

- The likelihood of on-site source control or off-site removal actions being effective in mitigating and/or minimizing the threat to human health, welfare, and the local environment.
- The prevention of additional environmental (soil, surface water, and groundwater) contamination.
- The potential for adverse environmental effects resulting from the alternative or its implementation.

During the evaluation and implementation of waste material removal actions at the site, worker health and safety must also be considered. Any measures that have the potential for worker contact or release of hazardous substances must conform to OSHA requirements.

5.1.4 Cost Analysis

A removal alternative should be implemented and operated in a cost-effective manner and must mitigate the environmental concerns at the site. This requires ensuring that the results of a particular alternative cannot be achieved by less costly methods. In considering the cost-effectiveness of the various alternatives, costs are considered as follows:

- Capital costs.
- O&M costs.
- Post-removal (E&S controls) costs.

The present worth value method is typically used to evaluate the total cost of a removal alternative's strategy, including the post-closure period. Thus, the cost-effectiveness of the various alternatives is compared based on total present worth. However, for Sites 4, 16, and 21, the removal actions are designed to be completed within 1 year. In general, the cash flow discounting method to determine present worth is not necessary with the exception of maintenance of E&S controls, and the total costs are appropriate for use in comparing the alternatives.

The cost analysis presented in this EE/CA represents cost estimates for the developed removal alternatives based on the existing data presented herein.

5.2 ALTERNATIVE 1: REMOVAL OF IDENTIFIED SURFICIAL WASTE MATERIALS AND COMPLETE REMOVAL OF THE ASH PILE AT SITE 4 WITH OFF-SITE DISPOSAL

As detailed in Subsection 4.1 of this EE/CA, Alternative 1: Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4, entails the removal of surficial waste materials and complete removal of the ash pile at Site 4 as identified in the Testing Report and as previously summarized in Table 4-3. All soils associated with removal of surficial waste materials and the ash pile at Site 4 will be removed and disposed with the appropriate waste material. Confirmational sampling is conducted under this alternative in the surficial excavation areas. Following removal from the sites, the surficial waste materials, ash pile, and associated soils will be disposed off-site at the appropriate permitted landfill.

The surficial waste materials and the ash pile at Site 4 will be removed by hand or heavy equipment. Precautions will be taken to minimize contaminant releases from punctured drums, batteries, or electrical equipment during removal activities. This alternative includes the removal of all identified surficial waste materials and the ash pile at Site 4 with little or no separation of the waste materials from the associated soils. Surficial waste materials, including tree stumps, mine casings, electrical equipment (including power lines, poles, and hardware), scrap metal, batteries (dry carbon-zinc type and those from weapons), banding

material, construction debris, and 5- to 55-gallon drums, will be removed from the three sites. For the purposes of this EE/CA, it is assumed that no transformers or light ballasts (possibly containing PCBs) exist at the surface or will be encountered within the 1 ft bgs excavation depth.

Site 4 covers approximately 6 acres of area, 75% of which is a flat, open space. The remaining 25% is comprised of a dense, wooded area. Surficial waste materials can be found throughout the cleared area as well as scattered within the wooded lot. Figure 2-4 of this EE/CA depicts the approximate disposal areas of the surficial waste materials.

Site 16 is approximately 5 acres in size. This site is mostly wooded and contains debris scattered throughout. Figure 2-8 of this EE/CA shows the approximate boundaries of the surface materials.

Site 21 encompasses an area of approximately 1 acre and is contained in an entirely wooded area. Waste materials are dispersed over the entire area. Figure 2-6 of this EE/CA shows the approximate boundaries of the surficial waste materials.

During removal activities at the sites, E&S controls, such as diversion ditches, berms, hay bales, and/or silt fencing, will be installed and maintained. Staging of the removed material and associated soils may be necessary depending on the disposal facility requirements. A staging area will be set up to temporarily hold the waste materials prior to final off-site disposal. Following removal of the waste materials, any surface excavations will be backfilled with a clean, low-permeability fill material.

5.2.1 Process Description

The removal/excavation and final off-site disposal of the surficial waste materials and associated soils at the three sites consists of the following process steps:

- Excavation/removal.

- Separation/staging.
- Sampling/analysis (of the ash pile at Site 4, waste excavation areas, excavation waters, and/or of unknown materials in drums, if encountered).
- Off-site disposal.
- Site restoration.

These steps are briefly described in the following subsections.

5.2.1.1 Excavation of Surficial Waste Materials and Ash Pile

The surficial removal limits of the waste materials and the ash pile at Site 4 will be based on the areas previously identified in the Testing Report, topographic surveys, and field observations. Vertical removal limits will be determined in the field, but will not exceed 1 ft bgs. If materials are visible below the 1 ft bgs limit, the location and material description will be noted for action in future RI/FS activities. Drums, located on the surface of each of the sites, will be emptied, if necessary, opened on both ends, and crushed prior to disposal. The drum removal is a surficial removal only. The ash pile at Site 4 and a minimum of 6 inches of underlying natural soil will be completely excavated. Excavation boundaries, for complete ash pile removal, will continue to a depth and width to be determined in the field, based on analytical sample results.

Due to the wooded areas on all of the sites, special care will be taken to cause as little disturbance as possible to the natural environment or habitats present at the sites. It is anticipated that nearby streams and wetlands will not be disturbed by removal activities. Heavy mechanical equipment may not be able to access some of the more remote waste material areas. Hand excavation will be conducted in these circumstances. Conventional, readily available excavation equipment and hauling vehicles will be utilized.

E&S control measures, which typically include the installation of silt fences and the construction of surface water diversions, will be implemented prior to commencement of materials handling at the sites and maintained during the removal project.

5.2.1.2 Separation/Staging

During removal of the surficial waste materials, the ash pile at Site 4, and associated soils, separation of the ash, batteries, and their associated soils from the other wastes and soil is required due to disposal requirements. This separation will be conducted using the available mechanical equipment and by hand, if necessary. Efforts relating to the removal of trees, grubbing, reseeding, etc., should be coordinated with the Special Assistant, Natural Resources Management, Code 09C-3 at WPNSTA Yorktown. All appropriate health and safety measures will be implemented. In addition, separation of certain drums may be required for testing purposes. Two staging areas will be set up in open, vehicle-accessible areas: one between Sites 4 and 21, and one at Site 16, to facilitate hauling to the appropriate off-site disposal facilities. The wastes and associated soils will be staged separately, on lined, bermed staging areas that will be designed and installed to prevent contamination of the staging area.

5.2.1.3 Sampling

Under this alternative, confirmation sampling will be performed to characterize the surface soils in the removal areas. The samples will be analyzed for VOCs, BNAs, explosives, metals, cyanide, pesticide/PCBs, and TPH. While it is not anticipated that these compounds will be present at every site, the extensive analyses will be used to support future RI/RS activities at these sites (i.e. ecological/baseline risk assessments).

Prior to backfilling the excavated ash pile disposal area, confirmation soil sampling will be conducted. Excavation will continue until soil sample results meet the risk-based concentrations (unless it is determined that this is not achievable) as provided in Appendix C of this EE/CA. A sample of the excavated ash material will be taken and analyzed for HW characteristics and other analyses required by the disposal facility. Any water that enters the excavation will be pumped, temporarily stored, and sampled for HW characteristics and other analyses required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or disposal state's) regulations.

Samples will be taken of any drum liquids and analyzed for HW characteristics to determine what disposal option is appropriate. Sample results are known for the soils underlying or surrounding most of these waste materials. These sampling results were used in determining appropriate disposal alternatives for the waste materials. Drums found containing nonsolidified materials will be rinsed and crushed prior to disposal. All rinsate will be collected in a clean liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after the surficial identified waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results.

In addition, samples will be taken from excavated materials (i.e., batteries, wastes, and soils), as necessary, and analyzed for TCLP and ICR characteristics to determine the appropriate disposal method.

5.2.1.4 Off-Site Treatment/Disposal

Waste materials, including ash, batteries, drums, construction debris, etc., and their associated soils removed from the sites will be transported from the staging areas directly to a disposal facility. Sanitary, industrial, or RCRA-approved landfills may be utilized depending on the nature and quantity of waste materials and associated soils. The disposal information applicable to Alternative 1 for the specific surficial waste materials most likely to be encountered is presented in the following paragraphs.

All waste material will be manifested in accordance with Virginia DOT regulations. Copies of the manifest will be kept on-site by WPNSTA Yorktown. All attempts will be made to limit dust resulting from this operation.

Drums

All drums will be emptied into an intact drum, opened on both ends, and crushed prior to disposal. Sampling will be conducted as discussed in Subsection 5.2.1.3. No separation of the drums from the soil is required under this alternative, with the exception of those drums

that require emptying and dismantling. All emptied and crushed drums, removed solidified material, and associated soils will be disposed at a permitted landfill. Material from drums that cannot be disposed in a sanitary or RCRA landfill will be sent for off-site treatment/disposal as discussed in Subsection 5.3.1.4.

Batteries

Under this alternative, all batteries, as identified in the Testing Report, will be excavated/ removed to the limited depth stated previously (1 ft bgs) and disposed at a landfill. On 9 April 1993, the currently proposed disposal facility placed a request with VDEQ to dispose of the batteries as a special waste. Based on the information received, VDEQ stated that "...the batteries do not possess hazardous characteristics and are not a listed hazardous waste," and gave approval to dispose of the batteries in a sanitary waste landfill in a letter dated 5 May 1993.

However, for the purposes of costing the alternatives presented in this EE/CA, the batteries and associated soils have been assumed to be disposed at a hazardous waste landfill. The confirmatory sampling to be performed during the field activities will determine the actual disposal methods.

Miscellaneous Debris/Scrap Metal

All miscellaneous debris, including scrap metal and associated soils, will be excavated/ removed and disposed at an off-site sanitary landfill. Mine casings, after decommissioning and inspection by EOD personnel, will also be disposed at the sanitary landfill.

Electrical Equipment/Construction Debris

All electrical equipment and construction debris (i.e., power lines, poles, broken brick, shingles, glass, lumber, etc.) on the surface of the three areas will be removed and disposed at a sanitary or industrial landfill. No additional separation of the soils unearthed during removal of the electrical equipment will be conducted. As stated previously, it is assumed,

for purposes of this EE/CA, that no transformers or light ballasts, possibly containing PCBs, will be encountered at the surface or within the 1 ft bgs excavation depth.

5.2.1.5 Site Restoration

All excavations resulting from the removal of the waste materials and their associated soils will be backfilled prior to demobilization. A low-permeability fill material will be placed in all surficial excavations (less than 1 ft bgs) to inhibit the infiltration of surface water into the subsurface waste materials. The ash pile excavation will be backfilled using a fill material compatible with the surrounding soils. Seeding and mulching will also be conducted following placement of the fill material in the ash pile.

5.2.2 Technical Considerations

The factors used to evaluate the technical feasibility of Alternative 1 include:

- Compliance with the ARARs.
- Effectiveness.
- Useful life.
- O&M.
- Demonstrated performance.
- Implementability.
- Safety.

These factors, as applied to Alternative 1, are discussed in the following subsections.

5.2.2.1 Compliance With the ARARs

The objective of this EE/CA, as stated previously, is the removal of the identified surficial waste material at Sites 4, 16, and 21. These sites contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to surface runoff and potential leaching; their removal will mitigate this problem.

Chemical-specific ARARs, as discussed in Section 3 of this EE/CA, are not directly applicable to this EE/CA's waste material removal objective since no groundwater sampling is conducted as part of a response action. However, the risk-based screening levels provided in this document in Appendix C are TBCs that are being applied as confirmation sampling criteria for the ash pile excavation at Site 4. In addition, discussion of the Navy's IR Program and action-specific ARARs is relevant to this type of removal; these items are discussed further in this subsection in relation to this alternative's removal limits. ARARs relevant to this EE/CA removal action are discussed in detail in Section 3 of this EE/CA.

WPNSTA Yorktown's IR Program considers the following factors in determining the appropriateness of a removal action: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants in soil largely at or near the surface that may migrate due to exposure or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

This alternative successfully addresses these IR factors. The entire ash pile at Site 4 will be removed, which effectively eliminates: 1) the actual exposure of nearby human populations and animals from the ash waste; and 2) the potential for the ash material to migrate on the surface, which, in effect, eliminates the concern for surface water contamination from this source. In addition, all surficial waste, including batteries, metal debris, 5- to 55-gallon drums, mine casings, etc., are removed, significantly reducing: 1) the potential threat of exposure to station personnel and animal populations; 2) the potential for the waste material to migrate; and 3) the threat of hazardous substances, pollutants, or contaminants in drums or other containers (i.e., batteries) to be released onto the surface. This surficial removal, in turn, also reduces the concern for surface water contamination from these sources.

Waste materials remaining below the surface will be addressed during the FS. All disposal and transportation requirements under VDEQ, VDOT, and RCRA (if necessary) will be implemented and enforced under this alternative.

5.2.2.2 Effectiveness

The effectiveness of a removal action alternative is dependent on the alternative's ability to perform the intended functions and comply with the ARARs, as discussed in Subsection 5.2.2.1.

Excavation techniques are: 1) proven technologies for conventional applications; 2) often used for removal actions; and 3) involve few technical concerns. For separation/staging of the ash pile and the batteries from the other waste materials, health and safety measures will be implemented to limit field personnel from personal exposure with the waste materials and soils. Mechanical separation will be conducted, whenever possible.

Off-site disposal in a secure, permitted landfill is technically viable because the design of the landfill is based on standard engineering practices. Whether the material is sent to a sanitary, industrial, or RCRA-approved hazardous waste landfill, measures are installed at the landfills to ensure the reliability of the technology and the security of the material in the landfill.

5.2.2.3 Useful Life

The excavation and off-site disposal of the waste materials and associated soils alternative is a permanent, irreversible solution for Sites, 4, 16, and 21 because the surficial waste materials, associated soils, and entire ash pile will be removed from the three sites. The operating time for this alternative, after design and permitting, is currently estimated at 5 to 6 months.

5.2.2.4 O&M

The O&M anticipated for this alternative is in conformance with the desired time limits (i.e., short-term). The necessary hauling and excavation equipment will be in operation for approximately 6 months. Conventional, readily available excavation equipment and hauling vehicles will be utilized. E&S controls will be maintained in all areas during removal activities.

5.2.2.5 Demonstrated Performance

As noted previously, excavation and off-site disposal techniques are proven technologies for conventional applications that are often used for removal actions.

5.2.2.6 Implementability

The approximate time required for excavation and off-site disposal is as follows:

- Permit issues/approvals (related to construction and off-site disposal of drums with solidified material): 1 to 2 months.
- Preparation of specifications and subcontractor selection: 2 to 3 months.
- Field preparation: 1 month.
- Excavation and disposal: 4 to 6 months.

5.2.2.7 Safety

All applicable safety precautions (i.e., dust control measures) and devices (i.e., air monitoring equipment), including a HASP, are required during removal activities. It is the responsibility of the Remediation Contractor to develop and implement a HASP.

5.2.3 Institutional Considerations

The institutional considerations associated with the excavation and off-site disposal of the identified surficial waste materials, ash pile, and associated soils are listed below:

- Removal issues associated with the IR Program are addressed (see Subsection 5.2.2.1).
- Prior to all on-site activities, permission for construction may be required to comply with WPNSTA Yorktown regulations.

- During excavation activities, E&S controls and dust controls will be implemented.

- Prior to the disposal of drums, any solidified materials will be removed and disposed in a sanitary landfill; a permit or approval may be required from VDEQ for sanitary landfill disposal.

- Prior to off-site disposal, VDEQ may be required to approve the off-site disposal location (i.e., appropriate landfill) for batteries and associated soils.

- During operations, all applicable OSHA regulations must be enforced.

- DOT requirements must be met for the transportation of all materials/soils removed from Sites 4, 16, and 21. State Hazardous Waste Manifests, permits, or licenses may also be required.

- Long-term liability remains in the event of failure of the disposal facility.

5.2.4 Human Health and Environmental Considerations

The following human health and environmental issues are associated with this alternative:

- All of the identified surficial waste materials, associated soils, and the ash pile at Site 4 will be excavated and disposed off-site. This action can be expected to effectively reduce/eliminate: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants associated with debris and in soil largely at or near the surface that may migrate via ground/surface water due to exposure and/or weather conditions or may potentially leach into the ground surface; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

- With the proper installation and implementation of dust control measures and temporary staging areas, the local environment would not be impacted by the excavation activities.

- There are few local human health or environmental impacts associated with off-site disposal because the waste materials would be removed from the sites to a more secure/final location. In the case of landfill facility failure, the possibility exists for impact to the area surrounding the facilities.

5.2.5 Cost Analysis

The total cost of implementation for Alternative 1 is estimated at $3,475,450 and consists of capital and O&M costs (present worth), as outlined in Table 5-1. Backup material detailing this cost estimate is contained in Appendix B of this EE/CA.

5.3 ALTERNATIVE 2: SELECTIVE REMOVAL OF IDENTIFIED WASTE MATERIALS WITH OFF-SITE TREATMENT OR DISPOSAL

For Alternative 2: Selective Removal of Identified Waste Materials With Off-Site Treatment or Disposal, the extent of the removal (partial or complete) of the identified waste materials is based on the specific material(s) in question. Waste materials at the three sites, as previously described in Section 4, include batteries, the ash pile at Site 4, 5- and 55-gallon drums, construction debris, scrap metal, electrical equipment (including power lines, poles, and hardware), mine casings, etc. Removal limits for the waste materials will be in accordance with the guidelines and limitations summarized in Table 4-3. Removal activities include: 1) full removal of the ash pile at Site 4 with a minimum of 6 inches of the underlying natural soils; 2) full removal of all batteries, both surface and subsurface, from all three sites; 3) removal of surficial drums; and 4) removal of remaining surficial waste materials to a depth not to exceed 1 ft bgs. For the purposes of this EE/CA, it is assumed that no transformers or light ballasts (possibly containing PCBs) exist at the surface or will be encountered within the 1 ft bgs excavation depth. The waste materials will be located in the field based on the findings in the Testing Report, topographical surveys, and field observations.

All soils disturbed or associated with the removal actions at all three sites will be removed and disposed based on the results of the sampling. Following removal, separation, and/or segregation activities, the waste materials will be treated (i.e., recycling) or disposed off-site at an appropriate permitted facility.

Table 5-1

Estimated Costs for Alternative 1
Sites 4, 16, and 21
Removal of Identified Surficial Waste Materials and
Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal

Cost Item	Quantity	Unit Cost ($)	Amount ($)
Capital Costs			
• Mobilization/Demobilization and Construction Facilities		Lump Sum	77,500
• Clearing and Grubbing		Lump Sum	28,600
• E&S Controls		Lump Sum	20,622
• Site Access Road and Staging Area		Lump Sum	82,757
• Removal/Grading/Restoration of Disturbed Areas (Staging Area/Site Access Road)		Lump Sum	31,000
• Removal/Loading/Preparation/Backfill			447,250
- Removal of Ash Pile	1,138 yd^3	16.57 per yd^3	
- Backfill Ash Pile (with low-permeability soils)	854 yd^3	16.71 per yd^3	
- Removal of Surficial Batteries and Associated Soils	2,101 yd^3	84.07 per yd^3	
- Backfill Battery Excavations (with low-permeability soils)	1,575.80 yd^3		
- Removal of Surficial Drums (no on-site soil separation)	1,200 yd^3	26.88 per yd^3	
- Remove Materials from Drums and Crush Drums	1,200 yd^3	105.18 per yd^3	
- Backfill Drum Excavations (with low-permeability soils)	900 yd^3	16.71 per yd^3	
- Removal of Surficial Waste Materials (no on-site soil separation)	625 yd^3	16.57 per yd^3	
- Backfill Surficial Waste Excavations (with low-permeability soils)	469 yd^3	16.71 per yd^3	
- Removal of 44 Mine Casings	Lump Sum	19,460	
• Transportation and Disposal			1,782,196
- Scrap Metal and Miscellaneous Debris (to Sanitary Waste Landfill)	625 yd^3	62.50 per yd^3	
- Batteries and Associated Soils (to Hazardous Waste Landfill)	2,101 yd^3	340 per yd^3	
- Ash Pile and Soils (to Hazardous Waste Landfill)	1,138 yd^3	340 per yd^3	

Table 5-1

Estimated Costs for Alternative 1
Sites 4, 16, and 21
Removal of Identified Surficial Waste Materials and
Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal
(Continued)

Cost Item	Quantity	Unit Cost ($)	Amount ($)
• Transportation and Disposal (Continued)			
- Drums (to Hazardous Waste Landfill)	840 yd^3	340 per yd^3	
- Drums (to Sanitary Waste Landfill)	360 yd^3	62.50 per yd^3	
- Transport of Mine Casings to EOD	44	135/casing	
- Sampling and Decon of Mine Casings (following EOD decommissioning)	44	1,630/casing	
- Disposal of Mine Casings	44	125/casing	
- Soils Sampling	130	1,711/sample[b]	
- Sampling/Excavation of Stained Soils Associated with Staging Areas	Lump Sum	840.70	
- Sampling of Disposal Materials (TCLP/ICR)	7	1,624/sample	
- Sampling of Decon Water and Collected Runoff Water	Lump Sum	2,250	
- 10,000-Gallon Water Holding Tank	Lump Sum	13,725	
• Permitting Fees/Equipment for Construction/Separation Activities		Lump Sum	4,000
• Permit for Drums With Solidified Material		Lump Sum	10,000
• Disposal Contingency for Unknown Liquids in Drums (and Land Ban Materials)		Lump Sum	4,000
O&M Costs (Present Worth)			
• Drum Sampling (Unknown Liquids)			
- Labor	40 hours	60/hr	2,400
- Analytics (TCLP, ICR)[a]	10 each	1,150/sample	11,500
• E&S Controls Maintenance (Based on 3 Years, at 6% Interest)	3 years		16,650
Subtotal (Rounded)			2,518,450
Administrative and Construction Services (20%)			503,700
Contingency (15%) [on subtotal plus admin]			453,300
Total (Rounded)			$3,475,450

Notes: Costs incurred by WPNSTA EOD for decommissioning mine casings not included.
[a]Toxicity Characteristic Leachate Procedure (TCLP), and Ignitability, Corrosivity, and Reactivity (ICR).
[b]Sample cost assumes full analysis (VOCs, BNAs, metals, cyanide, TPH, pesticides/PCBs, and explosives) with data validation costs.

Removal of the waste materials will be executed using hand and mechanical equipment. Precautions will be taken to minimize contaminant release from punctured drums, batteries, or electrical equipment during removal activities.

As previously stated in the discussion of Alternative 1, Site 4 covers approximately 6 acres of area, 75% of which is a flat, open space. The remaining 25% is comprised of a dense, wooded area. Surficial waste materials can be found throughout the cleared area as well as scattered within the wooded lot. Figure 2-4 depicts the approximate boundaries of the surficial waste materials.

Site 16 is approximately 5 acres in size. This site is mostly wooded and contains debris scattered throughout. Figure 2-8 shows the approximate boundaries of the surficial waste materials.

Site 21, which covers an area approximately 1 acre, is contained in an entirely wooded area. Waste materials are dispersed over the entire area. Figure 2-6 shows the approximate boundaries of the surficial waste materials.

Staging and separation of the selected materials and/or associated soils will be necessary for this alternative. Two staging areas will be set up in open, vehicle-accessible areas: one located between Sites 4 and 21, and the other at Site 16, to facilitate hauling to the appropriate off-site recycling or disposal facility.

5.3.1 Process Description

The removal and excavation and final off-site treatment or disposal of the waste materials on the three sites consists of the following process steps:

- Excavation/removal.
- Separation/staging of soils, batteries, and scrap metal.
- Backfilling of separated soils.

- Sampling of batteries, excavations, and the ash pile at Site 4 (and unknown materials in drums, if encountered).
- Off-site treatment (i.e., recycling)/disposal.
- Site restoration.

These steps are briefly described in the following subsections.

5.3.1.1 Excavation/Removal of Waste Materials

The entire ash pile at Site 4 (with a minimum of 6 inches of underlying natural soil) and the batteries, both surface and subsurface, at all three sites will be completely removed under this selective removal alternative. Excavation boundaries, for complete ash and battery removal, will be based on areas identified in the Testing Report and will continue to a depth and width to be determined in the field based on analytical results. Drums, located on the surface at each of the sites, will be emptied, if necessary, opened on both ends, and crushed prior to disposal. The drum removal is surficial only. The remaining surficial waste materials (i.e., scrap metal, wood, construction debris, electrical equipment, mine casings, etc.) will be removed from the surface of the three sites to a depth not to exceed 1 ft bgs. Removal of the surficial waste materials is based on results from the Testing Report, topographical surveys, and field observations.

If materials are visible below the 1 ft bgs limit, it will be noted for action in the FS. Separation of the unearthed/disturbed soils, scrap metal, and batteries from the other waste materials will be conducted as part of this alternative. All soils disturbed during the removal of the surficial waste materials will be staged in the immediate vicinity of the excavation. Following removal of the identified surficial waste materials, the staged soils will be sampled and properly disposed based on the analytical results.

Due to the wooded areas present at all of the sites, special care will be taken to cause as little disturbance as possible to the natural environment or habitats present at the sites. It is anticipated that nearby streams and wetlands will not be disturbed during removal

activities. Heavy mechanical equipment may not be able to access some of the more remote waste material areas. Hand excavation will be conducted in these circumstances. Conventional, readily available excavation equipment and hauling vehicles will be used.

E&S control measures, which typically include the installation of silt fences and the construction of surface water diversions, will be implemented prior to commencement of materials handling at the sites.

5.3.1.2 Separation/Staging

Following removal of the waste materials, separation of the ash, batteries, soils, and recyclable scrap metals and mine casings will be required. Soils associated with the excavations will be disposed based on the analytical results. This separation will be conducted using the available mechanical equipment and by hand, if necessary. All appropriate health and safety measures will be implemented to minimize field personnel exposure to the materials. Mechanical equipment will be used, whenever possible. Two staging areas will be set up in open, vehicle-accessible areas: one located between Sites 4 and 21, and the other at Site 16, to facilitate hauling to the appropriate off-site recycling or disposal facility.

5.3.1.3 Sampling

Under this alternative, confirmation sampling will be performed to characterize the surface soils in the removal areas. The samples will be analyzed for VOCs, BNAs, explosives, metals, cyanide, pesticides/PCBs, and TPH. While it is not anticipated that these compounds will be present at every site, the extensive analyses will be used to support future RI/RS activities at these sites (i.e. ecological/baseline risk assessments).

Prior to backfilling the ash pile at Site 4, tests will be conducted to ensure complete removal. Testing will include confirmation sampling for the ash pile excavation. Samples taken in the ash pile excavation will be analyzed for the parameters stated above.

Excavation will continue until soil sample results are below the risk-based concentrations (unless it is determined that this is not achievable), as provided in Appendix C of this EE/CA. A sample of the excavated ash material will be taken and analyzed for HW characteristics and other analyses required by the disposal facility. Any water that enters the excavation will be pumped, temporarily stored, and sampled for HW characteristics and other analyses required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or disposal state's) regulations.

Samples of any drum liquids will be taken and analyzed for HW characteristics to determine what disposal option is appropriate. Sample results are known for the soils underlying or surrounding most of these waste materials. These sampling results were used in determining appropriate disposal alternatives for the waste materials. For this option, all drums found will be rinsed and crushed prior to disposal. All rinsate will be collected in a clean liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled after all of the surficial identified waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results.

5.3.1.4 Off-Site Treatment/Disposal

Two treatment options are applicable to the waste materials removed from the surface of these sites, as previously discussed in Subsection 4.5. These options include incineration and recycling. Implementation of Alternative 2 includes use of both off-site treatments. If a waste material is encountered that is not applicable to either treatment option (i.e., batteries, ash material, miscellaneous debris, etc.), it will be disposed at an appropriate off-site approved disposal facility. The following is a discussion of both off-site treatment methods and landfill disposal as they pertain to the specific waste materials.

All waste material will be manifested in accordance with Virginia DOT regulations. Copies of the manifest will be kept on-site by WPNSTA Yorktown. All attempts will be made to limit dust resulting from this operation.

5.3.1.4.1 Incineration

This treatment method will be utilized for materials (e.g., contaminated soils or drum contents) that cannot be disposed in a sanitary or RCRA-approved landfill (i.e., contaminants that fall under the Land Ban restrictions). Applicable waste materials removed from the sites will be transported from the staging areas directly to an incineration facility. The particular wastes are required to be received at the incinerator in specific quantities (i.e., fiber pack). Samples of the waste material will be sent to the incinerator in advance so that the off-site incinerator can perform the necessary test burns and/or analyses at their facility.

Drums

All drums will be emptied, as discussed in Subsection 5.3.1.3, into an intact drum, opened on both ends, and crushed prior to disposal. Under this alternative, drum contents that cannot be disposed in a RCRA-approved landfill will be disposed of at a permitted incineration facility. Any other liquids encountered during removal activities may be sampled and disposed in the same method.

5.3.1.4.2 Recycling

Applicable waste materials (i.e., scrap steel and aluminum metal) will be removed from the sites and transported to a permitted recycling facility. Recyclable waste materials must be separated from soils and other debris during or immediately following removal from the sites. These materials will be staged in separate holding containers (i.e., roll-off boxes) prior to transportation to the recycling facility.

Scrap Metal

Under this alternative, all identified surficial scrap metals will be excavated, removed from the surface, and separated from the soils and/or any other debris encountered during the

removal. Mine casings may also be recycled following inspection by EOD. The Remediation Contractor's personnel, under guidance by the recycling facility, will be responsible for evaluating the condition of the scrap metal for the recycling option. The grade and condition of the scrap metal will determine its value as recyclable material. Some scrap metal may not be of recyclable quality and will have to be disposed in a sanitary landfill. For the purpose of costing Alternative 2, was assumed that 25% of the surficial waste materials will be of recyclable quality.

Batteries

The potential applicability of recycling the batteries removed from these sites is currently under review. While recycling would be the disposal alternative of choice, the technical and financial feasibility of this option appears to be limited, based on the condition of the batteries and the chemical composition. In the event that recycling is deemed to be a viable option, this treatment alternative will be re-evaluated. As stated previously, the batteries and associated soils have been costed as a hazardous waste. The actual disposal method will be determined through analytical sampling to be performed during the field activities.

5.3.1.4.3 Off-Site Disposal

Waste materials (including drums, batteries, ash pile, surface debris, etc.) will be removed from the sites and then transported from the staging areas directly to a disposal facility. Sanitary, industrial, or RCRA-approved landfills may be used depending on the nature and quantity of waste material.

Ash Pile

The entire ash pile at Site 4 with a minimum of 6 inches of underlying natural soil is completely removed under this selected removal alternative. The ash material and associated soils will be staged separately and then taken directly from the staging area to the appropriate permitted disposal facility.

Drums

As stated previously, all drums will be emptied into an intact drum, opened on both ends, and crushed prior to disposal. Drums that are already emptied will be opened and crushed. All drums will be separated from any soils disturbed during the drum removal. All emptied and crushed drums and solidified material will be disposed at a permitted landfill. Material from drums that cannot be disposed in a sanitary or RCRA landfill will be sent for off-site treatment, as discussed in Subsection 5.3.1.4.1.

Batteries

Under this alternative, all batteries and associated soils, as identified in the Testing Report, will be fully excavated/removed as stated previously. On 9 April 1993, the currently proposed disposal facility placed a request with VDEQ to dispose of batteries as a special waste. Based on the information received, VDEQ stated that "...the batteries do not possess hazardous characteristics and are not a listed hazardous waste," and gave approval to dispose of batteries in a sanitary waste landfill in a letter dated 5 May 1993.

However, for the purposes of costing the alternatives presented in this EE/CA, the batteries and associated soils have been assumed to be disposed as a hazardous waste. The confirmatory sampling to be performed during the field activities will determine the actual disposal methods.

Electrical Equipment/Construction Debris

All electrical equipment and construction debris (i.e., power lines, poles, broken brick, shingles, glass, lumber, fire extinguishers, etc.) on the surface of the three areas will be removed and disposed at a sanitary landfill. Separation of the soils unearthed during removal of the electrical equipment and other debris will be conducted. As stated previously, it is assumed that no transformers or light ballasts, possibly containing PCBs, will be encountered at the surface or within the 1 ft bgs excavation depth.

5.3.1.5 Site Restoration

All surface excavations resulting from the removal of the waste materials and their associated soils will be backfilled prior to demobilization. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials to inhibit the infiltration of surface water into the subsurface waste materials. The ash pile and battery excavations will be backfilled using a fill material compatible with the surrounding soils. Seeding and mulching will also be conducted following placement of the fill material in the ash pile excavation.

5.3.2 Technical Considerations

The factors used to evaluate the technical feasibility of Alternative 2 include:

- Compliance with the ARARs.
- Effectiveness.
- Useful life.
- O&M.
- Demonstrated performance.
- Implementability.
- Safety.

These factors, as applied to Alternative 2, are discussed in the following subsections.

5.3.2.1 Compliance With the ARARs

The objective of the EE/CA, as stated previously, is the removal of the identified surficial waste material at Sites 4, 16 and 21. These sites contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to surface runoff and potential leaching; their removal will mitigate this problem.

Chemical-specific ARARs, as discussed in Section 3 of this EE/CA, are not directly applicable to this EE/CA's waste material removal objective since no groundwater sampling is conducted as part of a response action. However, the risk-based screening levels provided in Appendix C are TBCs that are being applied as confirmation sampling criteria for the ash pile excavation at Site 4. In addition, discussion of the Navy's IR Program and action-specific ARARs is relevant to this type of removal; these items are discussed further in this subsection in relation to this alternative's removal limits. ARARs relevant to this EE/CA removal action are discussed in detail in Section 3 of this EE/CA.

As stated previously in Subsection 5.2.2.1, WPNSTA Yorktown's IR Program considers the following factors in determining the appropriateness of a removal action: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants in soil largely at or near the surface that may migrate due to exposure or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

Under this alternative, the ash pile at Site 4 and the batteries at all three sites are completely removed, which effectively eliminates: 1) the actual exposure of nearby human populations and animals from the battery and ash waste; and 2) the potential for the ash material to migrate on the surface, which, in effect, eliminates the potential for surface water contamination and leaching from these sources. In addition, all surficial waste, including metal debris, 5- to 55-gallon drums, mine casings, etc., are removed, significantly reducing: 1) the potential threat of exposure to station personnel and animal populations; 2) the potential for the waste material to migrate; and 3) the threat of hazardous substances, pollutants, or contaminants in drums or other containers to be released onto the surface. This surficial removal, in turn, also reduces the concern for surface water contamination from these sources.

Waste materials remaining below the surface and contamination of other medium (i.e., soil, groundwater, sediment, etc.) will be addressed during the FS. All disposal and

transportation requirements under VDEQ, VDOT, and RCRA (if necessary), as discussed in Subsection 3.2, are implemented and enforced under this alternative.

5.3.2.2 Effectiveness

The effectiveness of a removal action alternative is dependent on the alternative's ability to perform the intended functions and comply with the ARARs, as discussed in Subsection 5.3.2.1.

Excavation techniques are: 1) proven technologies for conventional applications; 2) often used for removal actions; and 3) involve few technical concerns. For separation/staging of the waste materials, measures will be taken to limit/eliminate field personnel from personal contact with the waste materials and soils.

Both treatment technologies, incineration and recycling, are proven, widely used options for final elimination of waste materials. Various types of incineration systems have been documented as effective for the destruction and disposal of the organic portion of hazardous wastes.

Off-site disposal in a secure, permitted landfill is technically viable because the design of the landfill is based on standard engineering practices. Whether the material is sent to a sanitary, industrial, or RCRA-approved landfill, measures are installed at the landfills to ensure the reliability of the technology and the security of the material in the landfill.

5.3.2.3 Useful Life

The excavation and off-site treatment/disposal of the waste materials alternative is a permanent, irreversible solution for Sites 4, 16, and 21 in that the batteries, ash pile, and surficial waste will be removed from the three sites. In addition, the soils associated with the removal of the ash and battery disposal areas will also be removed and permanently

disposed or recycled off-site. The operating time for this alternative, after design and permitting, is currently estimated at 5 to 6 months.

5.3.2.4 O&M

The O&M anticipated for this alternative is in conformance with the desired time limit (i.e., short-term). The necessary hauling and excavation equipment will be in operation for approximately 6 months. Conventional, readily available excavation equipment and hauling vehicles will be used. E&S controls will be maintained in all areas during removal activities.

5.3.2.5 Demonstrated Performance

As noted previously, excavation and off-site disposal or treatment techniques are proven technologies for conventional applications that are often used for removal actions.

5.3.2.6 Implementability

The approximate time required for excavation and off-site disposal or treatment of the selected waste materials is as follows:

- Permit issues/approvals (related to construction): 1 to 2 months.
- Preparation of specifications and subcontractor selection: 2 to 3 months.
- Field preparation: 1 month.
- Excavation, separation, and disposal: 4 to 8 months (this option will be more labor-intensive due to the additional separation/segregation of wastes/debris).

5.3.2.7 Safety

All applicable safety precautions (i.e., dust control measures) and devices (i.e., air monitoring equipment), including a HASP, are required during removal activities. It is the responsibility of the Remediation Contractor to develop and implement a HASP.

5.3.3 Institutional Considerations

The institutional considerations associated with the excavation and off-site disposal or ttreatment of the selected waste materials are listed below:

- Removal issues associated with the IR Program are addressed (see Subsection 5.2.2.1).
- Prior to all on-site activities, permission for construction, if necessary, may be required to comply with Installation regulations.
- During excavation activities, E&S controls and dust controls will be implemented.
- Prior to the disposal of drums, any solidified materials will be removed and disposed in a sanitary landfill; a permit or approval may be required from VDEQ for sanitary landfill disposal.
- Prior to the disposal of batteries, approval may be required from VDEQ regarding the disposal location (i.e., appropriate landfill) based on analytical results.
- During operations, all applicable OSHA regulations must be enforced.
- DOT requirements must be met for the transportation of all materials/soils removed from Sites 4, 16, and 21. State Hazardous Waste Manifests, permits, or licenses may also be required.
- Long-term liability remains in the event of failure of the treatment/disposal facility.

5.3.4 Human Health and Environmental Considerations

The following human health and environmental issues are associated with this alternative:

- All of the batteries, ash, and remaining identified surficial waste materials will be excavated and disposed/treated off-site. This action can be expected to effectively reduce/eliminate: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants associated with wastes/debris largely at or near the surface that

may migrate via ground/surface water or leaching due to exposure and/or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

- With the proper installation and implementation of dust control measures and temporary staging areas, the local environment would not be impacted by the excavation activities.

- There are few local human health or environmental impacts associated with off-site disposal/treatment because the waste materials would be removed from the sites to a more secure location. In the case of landfill facility failure, the possibility exists for impact to the areas surrounding the facility.

5.3.5 Cost Analysis

The total cost of implementation for Alternative 2 is estimated at $5,542,450 and consists of capital and O&M costs, as outlined in Table 5-2. This alternative considers the potential cost recovery for recycling, which requires additional labor costs for the separation/ segregation of wastes. In addition, a much greater volume of waste material (i.e., batteries and soils) is removed under this alternative. Backup spreadsheets detailing the costs in Table 5-2 are contained in Appendix B of this EE/CA.

Table 5-2

Estimated Costs for Alternative 2
Sites 4, 16, and 21
Selective Removal of Identified Waste Materials
With Off-Site Treatment or Disposal

Cost Item	Quantity	Unit Cost ($)	Amount ($)
Capital Costs			
• Mobilization/Demobilization and Construction Facilities		Lump Sum	77,500
• Clearing and Grubbing		Lump Sum	28,600
• E&S Controls		Lump Sum	20,622
• Site Access Road and Staging Area		Lump Sum	82,757
• Removal/Grading/Restoration of Disturbed Areas (Staging Area/Site Access Road)		Lump Sum	31,000
• Removal/Loading/Preparation/Backfill			789,297
- Removal of Ash Pile	1,138 yd^3	16.57 per yd^3	
- Removal of All Batteries and Associated Soils	5,545 yd^3	84.07 per yd^3	
- Backfill Battery Excavations (with low-permeability soils)	4,158.80 yd^3	16.71 per yd^3	
- Backfill Ash Pile (with low-permeability soils)	854 yd^3	16.71 per yd^3	
- Removal of Surficial Drums (on-site soil separation required)	1,200 yd^3	31.26 per yd^3	
- Remove Materials from Drums and Crush Drums	1,200 yd^3	105.18 per yd^3	
- Removal of Surficial Waste Materials (on-site soil separation required)	625 yd^3	23.13 per yd^3	
- Backfill Drum Excavations (with low-permeability soils)	900 yd^3	16.71 per yd^3	
- Backfill Surficial Waste Excavations (with low-permeability soils)	469 yd^3	16.71 per yd^3	
- Removal of 44 Mine Casings	Lump Sum	19,460	
• Transportation and Disposal			2,937,891
- Scrap Metal and Miscellaneous Debris (to Sanitary Waste Landfill)	469 yd^3	62.50 per yd^3	
- Batteries and Associated Soils (to Sanitary Waste Landfill)	5,545 yd^3	340 per yd^3	
- Ash Pile and Soils (to Hazardous Waste Landfill)	1,138 yd^3	340 per yd^3	
- Recycle of Scrap Metal	156.30 yd^3	0.00	

Table 5-2

Estimated Costs for Alternative 2
Sites 4, 16, and 21
Selective Removal of Identified Waste Materials
With Off-Site Treatment or Disposal
(Continued)

Cost Item	Quantity	Unit Cost ($)	Amount ($)
• Transportation and Disposal (Continued)			
- Recycle of Mine Casings	44	0.00	
- Drums (to Hazardous Waste Landfill)	840 yd^3	340 per yd^3	
- Drums (to Sanitary Waste Landfill)	360 yd^3	62.50 per yd^3	
- Transport of Mine Casings to EOD	44	135/casing	
- Sampling and Decon of Mine Casings (following EOD decommissioning)	44	1,630/casing	
- Soils Sampling	130	1,711/sample[b]	
- Sampling/Excavation of Stained Soils Associated with Staging Areas	Lump Sum	840.70	
- Sampling of Disposal Materials (TCLP/ICR)	7	1,624/sample	
- Sampling of Decon Water and Collected Runoff Water	Lump Sum	2,250	
- 10,000-Gallon Water Holding Tank	Lump Sum	13,725	
• Permitting Fees/Equipment for Construction/ Separation Activities		Lump Sum	4,000
• Permit for Drums With Solidified Material		Lump Sum	10,000
• Disposal Contingency for Unknown Liquids in Drums (and Land Ban Materials)		Lump Sum	4,000
O&M Costs (Present Worth)			
• Drum Sampling (Unknown Liquids)			
- Labor	40 hours	60/hr	2,400
- Analytics (TCLP, ICR)[a]	10 each	1,150/sample	11,500
• E&S Controls Maintenance (Based on 3 Years, at 6% Interest)	3 years		16,650
Subtotal (Rounded)			4,016,250
Administrative and Construction Services (20%)			803,300
Contingency (15%) [on subtotal plus admin]			722,900
Total (Rounded)			$5,542,450

Notes: Costs incurred by WPNSTA EOD for decommissioning mine casings not included.
[a]Toxicity Characteristic Leachate Procedure (TCLP), and Ignitability, Corrosivity, and Reactivity (ICR).
[b]Sample cost assumes full analysis (VOCs, BNAs, pesticides/PCBs, explosives, TPH, metals, and cyanide) with data validation costs.

SECTION 6
COMPARATIVE ANALYSIS OF REMOVAL ALTERNATIVES

In this section, information from the previous section is used to discuss and compare the alternatives on the basis of technical feasibility, environmental effectiveness, institutional requirements, human health considerations, and cost. The purpose of this comparative analysis is to identify the strengths and weaknesses of each alternative relative to each other so that the most appropriate alternative can be selected. The two alternatives that have been developed are: Alternative 1: Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal; and Alternative 2: Selected Removal of Identified Surficial Waste Materials With Off-Site Treatment or Disposal.

6.1 ENVIRONMENTAL EFFECTIVENESS

Alternatives that result in the destruction of hazardous substances, or in the reduction of the toxicity, mobility, or volume of the waste and have been proven reliable in the field under similar conditions on the same waste materials are preferred. Also preferred are alternatives that are widely demonstrated to be effective, have permanent and irreversible useful lives, and will perform under all possible environmental conditions at the site. Alternatives that are unproven, relatively ineffective, unreliable, short-term, or susceptible to adverse site conditions are rejected.

In Alternative 1: Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal, the off-site disposal of surficial waste materials, the ash pile, and associated soils removed from the identified areas does not result in the total reduction of the toxicity of the waste materials or soil; however, the mobility and volume of the affected waste materials and soil are dramatically reduced through off-site disposal. This alternative successfully achieves the objective of this EE/CA by removing the identified surficial waste materials (i.e., scrap metals, construction debris, batteries, drums, mine casings, etc.) and the entire ash pile and disposing of them off-site.

Removal and off-site disposal of the soils associated with the removal of these waste materials is also included under this alternative. These sites contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to surface runoff and leaching; their removal will mitigate this problem. This action is not necessarily permanent, but relies on the integrity of the landfill to which the affected waste materials and soils are transferred.

Alternative 2: Selective Removal of Identified Waste Materials With Off-Site Treatment or Disposal, recommends the removal and disposal of the ash pile at Site 4, all batteries (surface and subsurface), and remaining surficial waste materials at a permitted landfill or treatment (i.e., recycling) facility. Alternative 2 is a permanent, irreversible solution for Sites 4, 16, and 21 because the batteries, ash pile, and surficial waste will be completely removed from the sites. In addition, the soils associated with the removal of the ash and battery disposal areas are also removed and permanently disposed off-site based on the analytical results.

Disposal at a permitted landfill does not reduce the toxicity of the waste materials, but does achieve the main objective of this removal action, i.e., the removal and off-site disposal of the selected identified waste materials. A treatment facility also accomplishes this objective while reducing toxicity and providing an effective alternative to off-site disposal at a landfill. Both of these options have been proven effective in past removal actions.

These sites contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to surface runoff and leaching. The removal (surface and subsurface) of the ash pile and battery disposal areas effectively mitigates the potential for further migration of the various identified contaminants through sediment and surface water runoff.

Alternative 2 provides for recycling of the scrap metal and mine casings, incineration of the drum liquids, and reliable disposal of the remaining waste materials to landfills. This off-site disposal or treatment option is efficient in meeting the objectives of this EE/CA; these options have also been documented to be reliable in past removal projects.

6.2 TECHNICAL FEASIBILITY

A comparison of the technical feasibility of the alternatives is presented in Table 6-1.

6.3 INSTITUTIONAL REQUIREMENTS

The institutional considerations associated with the excavation and off-site disposal and/or treatment of the identified waste materials (surface and/or subsurface), as stated in Subsections 5.2.3 and 5.3.3 of this EE/CA, are listed below:

- The removal objective is completed in the short-term.
- Removal issues associated with the Navy's IR Program are addressed (see Subsections 5.2.2.1 and 5.3.2.1 of this EE/CA).
- Prior to all on-site activities, permission for implementation and construction may be required to comply with Installation regulations. Alternative 2 may require additional permit(s) for separation/recycling. Both alternatives may require a permit to dispose of solidified materials from drums.
- During excavation activities, E&S controls and dust controls will be implemented.
- During operations, all applicable OSHA regulation must be enforced.
- DOT requirements must be met for the transportation of all materials/soils removed from Sites 4, 16, and 21. State Hazardous Waste Manifests, permits, or licenses may also be required.
- Long-term liability remains in the event of failure of the treatment/disposal facility.

Table 6-1

Technical Feasibility Comparison

Criteria	Alternative No.1: Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal	Alternative No.2: Selective Removal of Identified Waste Materials With Off-Site Treatment or Disposal
Effectiveness	Proven effective in various field removal actions, involves few technical concerns.	Proven effective in various field removal actions, involves separation technical concerns.
Useful Life	Permanent, irreversible	Permanent, irreversible
Maintenance Requirements	Little/no long-term maintenance requirements. E&S controls during and following removal operations.	Little/no long-term maintenance requirements. E&S controls during and following removal operations.
Construction Capability	Conventional and readily available equipment and hauling vehicles	Conventional and readily available equipment and hauling vehicles. Separation equipment will be required.
Implementation Time	Approximately 8 to 10 months	Approximately 1 year; separation/segregation of wastes may be encountered and may cause extensions/ delays.
Beneficial Results Time Frame	Long-term	Long-term
Community Health and Safety	Not threatened - beneficial	Not threatened - beneficial
Worker Health and Safety	Minimal concern with proper OSHA enforcement	Minimal concern with proper OSHA enforcement

Both alternatives comply with the required institutional considerations. Alternative 1 reduces the threat of contaminant migration in the surface soils (to 1 ft bgs only) associated with the waste materials since, aside from the ash pile at Site 4, the removal is surficial only. Alternative 2 requires a slightly longer on-site operation time; however, the selective removal of contaminated waste materials (i.e., the ash pile and batteries from all three sites) effectively removes a greater volume of waste material. In addition, the use of off-site treatment (i.e., recycling) provides a viable option to total landfill disposal.

6.4 HUMAN HEALTH CONSIDERATIONS

It is not anticipated that implementation of either alternative will adversely impact the health of the surrounding community when properly implemented. Removal of the identified surficial waste materials and/or soils lessens the threat to the human population at WPNSTA Yorktown and to the sensitive ecosystem in the area. Alternative 2 provides an additional benefit in that a greater volume of the waste material is removed and disposed at permitted treatment or landfill facilities.

6.5 COST CONSIDERATIONS

The costs for Alternatives 1 and 2 are detailed in Tables 5-1 and 5-2. Although the costs for several items are similar, the overall cost for Alternative 2 is greater due to the larger removal and disposal volumes and separation of materials involved. There is no profit shown for recycling of the scrap metal and mine casings in Alternative 2 due to the level of difficulty in assessing the value derived (if any) from recycling the scrap metal present at the sites. However, if the grade of metals is high and the quantity of the recyclable scrap metal is greater than estimated, a profit may be realized from the recycled material.

SECTION 7
RECOMMENDED REMOVAL ACTION ALTERNATIVE

Two removal alternatives have been developed and evaluated for Sites 4, 16, and 21: Alternative 1: Removal of Identified Surficial Waste Materials and Complete Removal of the Ash Pile at Site 4 With Off-Site Disposal; and Alternative 2: Selective Removal of Identified Waste Materials With Off-Site Treatment or Disposal. The two alternatives have both advantages and disadvantages that were noted in Section 6 of this EE/CA.

Based on an examination of the information presented in this report, Alternative 2 is recommended for implementation at Sites 4, 16, and 21. This alternative meets the EE/CA's removal objective: to remove the surficial debris and dispose of it off-site. Alternative 2 allows for complete removal of the battery disposal areas across all three sites and the entire ash pile at Site 4. This extensive removal effectively eliminates a primary potential source of some of the identified contamination at these sites. This alternative also entails removal of the surficial waste materials, including 5- to 55-gallon drums, mine casings, scrap metal, construction debris, electrical hardware, etc., which contributes to mitigating some potential contaminant migration due to surface runoff and leaching.

The combination of complete ash and battery removal with surficial removal of the remaining waste materials provides for a significant decrease in potential sources of contamination at the three sites. This removal alternative also surpasses the removal objective, with the removal of a greater volume of waste materials (i.e., subsurface batteries), thus providing a decrease in both the physical hazards and the health and environmental hazards associated with direct contact with the waste materials.

Alternative 2 was analyzed with respect to the four criteria (technical feasibility, institutional considerations, human health and environmental consideration, and cost) used to evaluate the alternatives throughout Sections 4, 5, and 6 of this EE/CA. This analysis confirmed that the selective removal of the waste materials with off-site disposal and treatment (i.e., recycling and/or incineration) was the most appropriate combination of response actions.

Removal under this alternative, as summarized in the following paragraphs, provides both an effective solution to the removal objective and an increased benefit to human health and the environment while being a documented and proven removal action.

In accordance with Alternative 2: Selective Removal of Identified Waste Materials With Off-Site Treatment or Disposal, removal will be conducted under the following guidelines:

- The entire ash pile at Site 4 (with a minimum of 6 inches of underlying natural soil) and the batteries, both surface and subsurface, at all three sites will be completely removed under this selective removal action. Excavation boundaries, for complete ash and battery removal, will continue to a depth and width to be determined in the field based on sampling results. Prior to backfilling these excavated disposal areas, tests will be conducted to ensure complete removal. Testing will include the use of metal detectors for the battery area excavations and sampling for the ash pile excavation. The samples collected from the ash pile excavation will be compared against the risk-based concentrations in the guidance document provided in Appendix C. Any water that enters the excavation will be pumped, temporarily stored, and sampled for HW characteristics and other analyses required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums, located on the surface of each of the sites, will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Samples will be taken of any unidentifiable drum liquids and analyzed for HW characteristics to determine what disposal option is appropriate. Drums found containing nonsolidified materials will be rinsed; all rinsate will be collected in a clean liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the surficial identified waste materials have been removed from the site. The drummed rinsate will be disposed of appropriately, based on analytical results. The drum removal is a surficial removal only. Surficial removal limits are based on results contained in the Testing Report and on field observations.

- The remaining surficial waste materials (i.e., scrap metal, wood, construction debris, electrical equipment, mine casings, etc.) will be removed from the surface of the three sites to a depth not to exceed 1 ft bgs.

- Separation of the waste materials from the associated soils will be conducted. The soils displaced during debris removal will be sampled and disposed of based on the sampling results. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen (i.e.,

recycling versus landfill). Confirmatory sampling will be conducted for the waste material excavations. Surficial removal limits are based on results contained in the Testing Report and on field observations.

- Identified waste materials will be removed by hand or heavy equipment. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials to inhibit the infiltration of surface water into the subsurface waste materials. The ash pile and battery disposal excavations will be backfilled using a fill material capable of sustaining a vegetative cover. Where applicable, regrading will be performed to limit the amount of fill that may need to be removed during the final remedial action.

The cost for the chosen removal alternative is greater than that of Alternative 1; however, Alternative 2 provides a more extensive removal action (i.e., complete removal of battery disposal areas) as summarized in the previous paragraphs with an alternative disposal option, off-site treatment (i.e., recycling of scrap metal), that can be implemented in a relatively short time period.

It will be the responsibility of the Remediation Contractor to: 1) ensure compliance with the applicable regulatory requirements (i.e., E&S Plan) and waste disposal approvals; 2) provide personnel to inspect the material at the sites to determine its recyclable quality and disposal requirements; 3) track and document all removals, sampling and analysis reports, disposal manifests, and restoration activities; 4) develop and implement a HASP; and 5) maintain the necessary E&S controls following the removal activities for a specified time period.

APPENDIX A

GROUNDWATER SAMPLING TABLES

NOTES FOR APPENDIX A TABLES

J = Estimated concentration. Compound is present below the established detection limit, but above the instrument detection limit.

UJ = Analyte nondetect; estimated detection limit assigned by data validators due to QC difficulties.

U = Compound is not detected above the reported detection limit.

Groundwater data are presented in units of micrograms per liter.

* = Compound is present at a concentration greater than twice the maximum background concentration detected in the samples collected as part of the Round One RI field activities.

Shaded cell indicates metal concentration exceeds one or more ARARs.

(a) Exceeds VGS only.
(b) Exceeds federal MCL only.
(c) Exceeds federal SMCL only.
(d) Exceeds federal MCL and VGS.
(e) Exceeds SMCL and VGS.

** = Federal criteria for copper and lead are action levels.

Contaminants Detected in Groundwater at WPNSTA Yorktown
Compared Against Potentially Applicable Federal and State Standards
August 1990
(Concentrations in μg/L)

Chemical	Location Detected	Concentration	MCL
1,1-Dichloroethene	6GW01-001 6GW01-101 7HP01-001 7HP01-101	15 16 160 89J	7
Trichloroethene	6GW01-001 6GW01-101 12GW01-001 12GW02-001 4GW04-001 4GW05-001 8HP01-001 1GW12-001	370 380 55 20 15 17 15 18,000	5
1,1,1-Trichloroethane	7HP01-001 7HP01-101	9,900 9,700	200
Tetrachloroethene	1GW12-001	7J	5

Note:

J = Estimated value.

Table A-1
Metals and Nitrates Concentrations for Groundwater Samples Collected During Round One RI Activities for Sites 4, 16, and 21 at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	4GW01-001	4GW02-001	4GW03-001
ANALYTE	MCL	SMCL				
Aluminum		200		53,700 J (c) *	34,300 J (c) *	70,800 J (c) *
Aluminum (dissolved)				150 J	35.00 UJ	58.00 UJ
Antimony	6			44.00 U	44.00 U	44.00 U
Antimony (dissolved)				44.00 U	44.00 U	44.00 U
Arsenic	50		50	20.60	5.00	2.00 U
Arsenic (dissolved)				2.00 U	2.00 U	2.00 U
Barium	2,000		1,000	250 *	174 *	253 *
Barium (dissolved)				6.60 U	26.60 U	24.80 U
Beryllium	4			7.20 (b) *	5.90 (b) *	16.30 (b) *
Beryllium (dissolved)				1.00 U	1.00 U	1.00 U
Cadmium	5		0.04	5.20 J (d)	4.00 UJ	5.20 J (d)
Cadmium (dissolved)				4.00 UJ	4.00 UJ	4.00 UJ
Calcium				52,900	231,000 *	839,000 *
Calcium (dissolved)				41,300	133,000	152,000
Chromium	100		50	174 (d) *	150 (d) *	286 (d) *
Chromium (dissolved)				8.00 U	8.00 U	8.00 U
Cobalt				80.40 *	42.00 U	59.10 *
Cobalt (dissolved)				6.00 U	6.00 U	6.00 U
Copper	1,300**	1,000	1000	31.70 U	28.70 U	28.60 U
Copper (dissolved)				5.00 UJ	5.00 UJ	5.00 UJ
Iron		300	300	158,000 J (e) *	121,000 J (e) *	228,000 J (e) *
Iron (dissolved)				449 J (e)	19.00 U	19.00 U
Lead	15**		50	54.80 (d) *	33.30 (b) *	36.50 (b) *
Lead (dissolved)				2.00 U	2.00 U	2.00 U
Magnesium				10,700 J *	13,700 *	25,900 J *
Magnesium (dissolved)				2,150 J	2,360 J	3,410 J
Manganese		50	50	1,290 (e) *	1,070 (e) *	2,200 (e) *
Manganese (dissolved)				11.50	26.90	2.00 U
Mercury	2		0.05	0.18 (a)	0.10 U	0.10 U
Mercury (dissolved)				0.10 U	0.10 U	0.10 U
Nickel	100			94.70	113 (b)	206 (b)
Nickel (dissolved)				18.00 U	18.00 U	18.00 U
Potassium				5,220 U	8,900 *	18,300 *
Potassium (dissolved)				970 U	2,350 U	970 U
Selenium	50		10	2.00 UJ	2.00 UJ	20.00 UJ
Selenium (dissolved)				2.00 UJ	2.00 UJ	2.00 UJ
Silver		100		6.00 UJ	6.00 UJ	6.00 UJ
Silver (dissolved)				6.00 UJ	6.00 UJ	6.00 UJ
Sodium			100,000	4,790	6,140	11,700 *
Sodium (dissolved)				4,870	5,990	7,820
Thallium	2			2.00 UJ	2.00 U	2.00 U
Thallium (dissolved)				2.00 U	2.00 U	2.00 U
Vanadium				136 *	97.80 *	201 *
Vanadium (dissolved)				6.00 U	6.00 U	6.00 U
Zinc		5,000	50	375 (a) *	326 (a) *	735 (a) *
Zinc (dissolved)				10.30	12.60	13.30
Nitrates	10,000		5,000	250	100 U	220

Table A-1
Metals and Nitrates Concentrations for Groundwater Samples Collected During Round One RI Activities for Sites 4, 16, and 21 at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	4GW04-001	4GW05-001	16GW01-001
ANALYTE	MCL	SMCL				
Aluminum		200		26,000 J (c) *	54,000 J (c) *	102,000 J (c) *
Aluminum (dissolved)				35.00 UJ	88.00 UJ	54.70 UJ
Antimony	6			44.00 U	44.00 U	48.30 (b)
Antimony (dissolved)				44.00 U	45.70 (b)	44.00 U
Arsenic	50		50	13.30	4.70	10.60
Arsenic (dissolved)				2.00 U	2.00 U	2.00 U
Barium	2,000		1,000	102	287 *	241 *
Barium (dissolved)				22.00 U	77.10 *	23.60 U
Beryllium	4			3.30 *	20.20 (b) *	5.10 (b) *
Beryllium (dissolved)				1.00 U	1.00 U	1.00 U
Cadmium	5		0.04	4.00 UJ	4.80 J (a)	4.00 UJ
Cadmium (dissolved)				4.00 UJ	4.00 UJ	4.00 UJ
Calcium				465,000 *	127,000,000 *	14,200
Calcium (dissolved)				140,000	322,000 *	5,160
Chromium	100		50	154 (d) *	203 (d) *	313 (d) *
Chromium (dissolved)				8.00 U	8.00 U	8.00 U
Cobalt				29.10 U	82.10 *	30.30 U *
Cobalt (dissolved)				6.00 U	6.00 U	6.00 U
Copper	1,300**	1,000	1000	16.80 U	17.70 U	58.40 J *
Copper (dissolved)				5.00 UJ	5.00 UJ	5.00 UJ
Iron		300	300	99,300 J (e) *	162,000 J (e) *	94,500 J (e) *
Iron (dissolved)				19.00 U	19.00 U	20.80 U
Lead	15**		50	49.20 (b) *	41.70 (b) *	56.00 (d) *
Lead (dissolved)				2.00 U	2.00 U	2.00 U
Magnesium				13,300 J *	31,900 J *	12,300 J *
Magnesium (dissolved)				2,820 J	11,900 J *	1,000 J
Manganese		50	50	404 (e) *	3,140 (e) *	97.20 (e)
Manganese (dissolved)				3.90	239 (e) *	4.60
Mercury	2		0.05	0.10 U	0.19 (a)	0.20 (a)
Mercury (dissolved)				0.10 U	0.10 U	0.10 U
Nickel	100			63.60	209 (b)	30.70
Nickel (dissolved)				18.00 U	18.00 U	18.00 U
Potassium				10,200 *	16,800 *	11,900 *
Potassium (dissolved)				970 U	3,220 U	2,010 U
Selenium	50		10	2.00 UJ	20.00 UJ	20.00 UJ
Selenium (dissolved)				2.00 UJ	2.00 UJ	2.00 UJ
Silver		100		6.00 UJ	6.00 UJ	6.00 UJ
Silver (dissolved)				6.00 UJ	7.50 J	6.00 UJ
Sodium			100,000	7,110	9,140	3,410
Sodium (dissolved)				5,080	5,820	3,050
Thallium	2			2.00 U	2.00 U	2.00 U
Thallium (dissolved)				2.00 U	2.00 U	2.00 U
Vanadium				132 *	132 *	195 *
Vanadium (dissolved)				6.00 U	6.00 U	9.10
Zinc		5,000	50	246 (a) *	547 (a) *	233 (a) *
Zinc (dissolved)				17.70	22.60	28.70
Nitrates	10,000		5,000	110	620	2000

Table A-1
Metals and Nitrates Concentrations for Groundwater Samples Collected During Round One RI Activities for Sites 4, 16, and 21 at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	16GW02-001	16GW03-001	16GW03-101	16GW04-001
ANALYTE	MCL	SMCL					
Aluminum		200		2,460 J (c)	4,580 J (c) *	3,920 J (c) *	77,700 J (c) *
Aluminum (dissolved)				65.70 UJ	35.00 UJ	79.60 UJ	105.00 J
Antimony	6			44.00 U	44.00 U	44.00 U	44.00 U
Antimony (dissolved)				44.00 U	44.00 U	44.00 U	44.00 U
Arsenic	50		50	2.00 U	3.10	2.70	17.80
Arsenic (dissolved)				2.00 U	2.00 U	2.90 J	2.00
Barium	2,000		1,000	65.10	53.10	53.10	362 *
Barium (dissolved)				56.50	23.90 U	37.50 U	30.70 U
Beryllium	4			1.00 U	1.00 U	1.00 U	7.80 (b) *
Beryllium (dissolved)				1.00 U	1.00 U	2.20	1.00 U
Cadmium	5		0.04	4.00 UJ	4.00 UJ	4.00 UJ	5.70 J (d)
Cadmium (dissolved)				4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ
Calcium				128,000	91,500	91,200	83,600
Calcium (dissolved)				134,000	88,800	85,000	62,700
Chromium	100		50	14.30	15.40	16.10	234 (d) *
Chromium (dissolved)				8.00 U	8.00 U	8.80	8.00 U
Cobalt				6.00 U	6.00 U	6.00 U	91.20 *
Cobalt (dissolved)				6.00 U	6.00 U	6.00 U	6.00 U
Copper	1,300**	1,000	1000	5.00 UJ	23.70 U	22.80 U	43.50 U
Copper (dissolved)				5.00 UJ	5.00 UJ	5.60 U	5.00 UJ
Iron		300	300	3,090 J (e)	8,270 J (e)	7,330 J (e)	137,000 J (e) *
Iron (dissolved)				33.20 U	21.60 U	42.60 U	105 U
Lead	15**		50	2.00 U	18.40 (b)	20.00 (b)	43.50 (b) *
Lead (dissolved)				2.00 U	2.00 U	2.00 U	2.00 U
Magnesium				2,260 J	2,500 J	2,460 J	16,600 J *
Magnesium (dissolved)				2,310 J	1,810 J	1,990 J	1,820 J
Manganese		50	50	23.40	54.00 (e)	62.40 (e)	857 (e) *
Manganese (dissolved)				3.80	15.30	14.30	87.20 (e) *
Mercury	2		0.05	0.10 U	0.10 U	0.10 U	0.25 (a)
Mercury (dissolved)				0.10 U	0.10 U	0.10 U	0.10 U
Nickel	100			18.00 U	18.00 U	20.10	167 (b)
Nickel (dissolved)				18.00 U	18.00 U	23.00	18.00 U
Potassium				2,310 U	999 U	970 U	14,300 *
Potassium (dissolved)				2,250 U	1,060 U	1,240 U	970 U
Selenium	50		10	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
Selenium (dissolved)				2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
Silver		100		6.00 UJ	6.00 UJ	6.00 UJ	6.00 UJ
Silver (dissolved)				6.00 UJ	6.00 UJ	6.00 UJ	6.00 UJ
Sodium			100,000	4,130	5,280	5,340	4,950
Sodium (dissolved)				4,250	4,840	5,240	4,470
Thallium	2			2.00 U	2.00 U	2.00 U	2.00 UJ
Thallium (dissolved)				2.00 U	2.00 U	2.00 U	2.00 U
Vanadium				6.00 U	12.40	7.90	241 *
Vanadium (dissolved)				7.50	6.00 U	11.30	6.00 U
Zinc		5,000	50	19.90	116 (a)	110 (a)	376 (a) *
Zinc (dissolved)				12.00	17.10	21.70	10.80
Nitrates	10,000		5,000	440	110	100 U	100 U

Table A-1
Metals and Nitrates Concentrations for Groundwater Samples Collected During Round One RI Activities for Sites 4, 16, and 21 at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	16GW05-001	21GW01-001	21GW02-001	21GW02-101
ANALYTE	MCL	SMCL					
Aluminum		200		779 J (c)	53,700 J (c) *	10,300 J (c) *	11,600 J (c) *
Aluminum (dissolved)				58.00 UJ	35.00 UJ	35.00 UJ	35.00 UJ
Antimony	6			44.00 U	44.00 U	44.00 U	44.00 U
Antimony (dissolved)				44.00 U	44.00 U	44.00 U	44.00 U
Arsenic	50		50	2.00 U	2.70	5.80	3.30
Arsenic (dissolved)				2.10 J	2.00 U	2.00 U	2.00 U
Barium	2,000		1,000	57.10	193 *	225 *	222 *
Barium (dissolved)				51.70	3.00 U	147 *	159 *
Beryllium	4			1.00 U	18.10 (b) *	3.10 *	2.90 *
Beryllium (dissolved)				1.00 U	1.00 U	1.00 U	1.00 U
Cadmium	5		0.04	4.00 UJ	5.80 J (d)	53.20 (d)	52.10 (d)
Cadmium (dissolved)				4.00 UJ	4.00 UJ	29.40 J (d)	38.40 J (d)
Calcium				19,200	45,200	99,700	92,700
Calcium (dissolved)				21,300	19,800	111,000	115,000
Chromium	100		50	13.20	244 (d) *	35.70	36.40
Chromium (dissolved)				8.00 U	8.00 U	8.00 U	8.00 U
Cobalt				6.40 U	148 *	202 *	202 *
Cobalt (dissolved)				6.00 U	6.00 U	6.00 U	9.90 U
Copper	1,300**	1,000	1000	5.00 UJ	27.70 U	52.40 U	47.50 U
Copper (dissolved)				5.00 UJ	5.00 UJ	5.00 UJ	5.00 UJ
Iron		300	300	29,200 J (e)	398,000 J (e) *	21,600 J (e)	23,000 J (e)
Iron (dissolved)				878 J (e)	29.10 U	127 U	19.00 U
Lead	15**		50	10.40	83.00 (d) *	40.40 (b) *	46.90 (b) *
Lead (dissolved)				2.00 UJ	2.00 U	2.00 U	2.00 U
Magnesium				2,960 J	9,640 J *	10,500 J *	10,300 J *
Magnesium (dissolved)				3,320 J	2,820 J	8,880 J *	9,180 J *
Manganese		50	50	45.60	3,090 (e) *	7,590 (e) *	7,870 (e) *
Manganese (dissolved)				40.10 *	5.40	796 (e) *	836 (e) *
Mercury	2		0.05	0.10 U	0.25 (a)	0.10 U	0.10 U
Mercury (dissolved)				0.10 U	0.10 U	0.10 U	0.10 U
Nickel	100			18.00 U	93.30	58.30	59.20
Nickel (dissolved)				18.00 U	18.00 U	18.00 U	33.40
Potassium				4,180 U	3,920 U	6,750 *	5,770 U
Potassium (dissolved)				2,000 U	1,460 U	3,360 U	4,350 U
Selenium	50		10	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
Selenium (dissolved)				2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
Silver		100		6.00 UJ	6.00 UJ	6.00 UJ	6.00 UJ
Silver (dissolved)				6.00 UJ	6.00 UJ	6.00 UJ	6.00 UJ
Sodium			100,000	4,360	3,480	4,240	4,260
Sodium (dissolved)				4,560	5,580	4,410	4,480
Thallium	2			2.00 U	2.00 U	2.00 U	2.00 U
Thallium (dissolved)				2.00 U	2.00 U	2.00 U	2.00 U
Vanadium				6.00 U	394 *	38.10 *	43.50 *
Vanadium (dissolved)				6.00 U	6.00 U	6.00 U	7.90
Zinc		5,000	50	28.40	462 (a) *	10,100 (e) *	10,200 (e) *
Zinc (dissolved)				13.20	8.00	8,070 (e)	8,300 (e)
Nitrates	10,000		5,000	2800	690	25100 (d)	24300 (d)

Table A-1

Metals and Nitrates Concentrations for Groundwater Samples Collected During Round One RI Activities for Sites 4, 16, and 21 at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	21GW03-001	21GW04-001
ANALYTE	MCL	SMCL			
Aluminum		200		80,300 J (c) *	28,900 J (c) *
Aluminum (dissolved)				35.00 UJ	35.00 UJ
Antimony	6			44.00 U	44.00 U
Antimony (dissolved)				44.00 U	44.00 U
Arsenic	50		50	5.40	2.00 U
Arsenic (dissolved)				2.00 U	2.00 U
Barium	2,000		1,000	412 *	110
Barium (dissolved)				112 *	17.30 U
Beryllium	4			8.40 (b) *	2.30
Beryllium (dissolved)				1.00 U	1.00 U
Cadmium	5		0.04	145 (d)	4.00 UJ
Cadmium (dissolved)				99.80 (d)	4.00 UJ
Calcium				59,200	151,000
Calcium (dissolved)				45,100	125,000
Chromium	100		50	168 (d) *	84.40 (a) *
Chromium (dissolved)				8.00 U	8.00 U
Cobalt				93.50 *	25.30 U
Cobalt (dissolved)				29.70 U	6.00 U
Copper	1,300**	1,000	1000	45.50 U	16.80 U
Copper (dissolved)				5.00 UJ	5.00 UJ
Iron		300	300	180,000 J (e) *	72,200 J (e) *
Iron (dissolved)				1,960 J (e)	19.000 U
Lead	15**		50	56.30 (d) *	19.60 (b)
Lead (dissolved)				2.00 U	2.00 UJ
Magnesium				13,700 J *	8,210 J *
Magnesium (dissolved)				4,230 J *	4,670 J *
Manganese		50	50	4,740 (e) *	288 (e) *
Manganese (dissolved)				3,630 (e) *	71.40 *
Mercury	2		0.05	0.25 (a)	0.10 U
Mercury (dissolved)				0.10 U	0.10 U
Nickel	100			117 (b)	27.30
Nickel (dissolved)				33.00	18.00 U
Potassium				11,200 *	3,530 U
Potassium (dissolved)				6,030 U	970 U
Selenium	50		10	2.00 UJ	2.00 UJ
Selenium (dissolved)				2.00 UJ	2.00 UJ
Silver		100		6.00 UJ	6.00 UJ
Silver (dissolved)				6.00 UJ	6.00 UJ
Sodium			100,000	6,130	5,490
Sodium (dissolved)				5,620	4,950
Thallium	2			2.00 UJ	2.00 U
Thallium (dissolved)				2.00 UJ	2.00 U
Vanadium				172 *	98.60 *
Vanadium (dissolved)				6.60	6.00 U
Zinc		5,000	50	30,800 (e) *	263 (a) *
Zinc (dissolved)				2,490,000 (e)	24.50
Nitrates	10,000		5,000	11100 (d)	5500 (a)

APPENDIX B

COST ANALYSIS BACKUP SPREADSHEETS

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W.O. NO. :06629-001-012-3000-00
LOCATION :YORKTOWN WEAPONS STATION, YORKTOWN, VA.
ESTIMATE :CONCEPTUAL/PRELIMINARY
ESTIMATOR :NGA
DATE : 10-Dec-93 09:07 AM

ESTIMATE ACCURACY: +30% TO -15%

FILENAME: LANTDIV2.WK1

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21 PROJECT SUMMARY										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES				65,500.00		7,000.00		0.00	5,000.00	77,500.00
2	CLEARING AND GRUBBING				0.00		0.00		0.00	28,600.00	28,600.00
3	EROSION AND SEDIMENTATION CONTROLS				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS				22,000.00		4,800.00		1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS				143,834.00		298,916.28		0.00	4,500.00	447,250.28
7	TRANSPORTATION AND DISPOSAL				11,440.70		15,960.00		6,325.00	1748470.50	1,782,196.20
8	PERMITTING FEES	1.0	LS								4,000.00
9	PERMIT FOR DRUMS WITH SOLIDIFIED MATERIAL	1.0	LS								10,000.00
10	DISPOSAL CONTINGENCY FOR UNKNOWN LIQUIDS IN DRUMS (AND LAND BAN MATERIALS)	1.0	LS								4,000.00
	SUBTOTAL										2,487,900.00
11	OPERATIONS AND MAINTENANCE COSTS: (PRESENT WORTH)										
	DRUM SAMPLING LABOR	40.0	HRS			60.00					2,400.00
	ANALYTICS	10.0	EA							1150.00	11,500.00
	EROSION AND SEDIMENTATION CONTROLS MAINTENANCE (3 YEARS DURATION; INTEREST @ 6%)	3.0	YRS								16,650.00
	PROJECT SUBTOTAL										2,518,450.00
12	ADMIN. AND CONSTRUCTION SERVICES @ 20%										503,700.00
13	CONTINGENCY @ 15%										453,300.00
	TOTAL (ROUNDED)										3,475,450.00

SHEET NO. 1

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES										
1A	MOBILIZATION AND DEMOBILIZATION - ALLOWANCE	1.0	LS	5000.00	5,000.00	4200.00	4,200.00	0.00	0.00	3,500.00	12,700.00
1B	CONSTRUCTION FACILITIES										
	TEMPORARY FACILITIES REQUIRED FOR SUPPORT OF FIELD ACTIVITIES										
	APPROXIMATE DURATION	6.0	MO								
	MONTHLY ALLOWANCE FOR TEMPORARY FACILITIES										
	ALLOW $9,500.00 PER MONTH	1.0	MO	9500.00	57,000.00	0.00	0.00	0.00	0.00	0.00	57,000.00
	ALLOWANCE FOR INSTALLATION/SETUP	1.0	LS	3500.00	3,500.00	2800.00	2,800.00	0.00	0.00	1,500.00	7,800.00
	SUBTOTAL				65,500.00		7,000.00		0.00	5,000.00	77,500.00
2	CLEARING AND GRUBBING										
	SITE 4	4.0	ACRE								
	SITE 16	1.0	ACRE								
	SITE 21	0.5	ACRE								
	TOTAL AREA	5.5	ACRE	0.00	0.00	0.00	0.00	0.00	0.00	28,600.00	28,600.00
3	EROSION AND SEDIMENTATION CONTROLS										
	SILT FENCING	4960.0	LF	1.35	6,696.00	0.56	2,777.60	0.00	0.00	0.00	9,473.60
	ROCK CHECK DAMS	35.0	EA	28.75	1,006.25	63.00	2,205.00	0.00	0.00	0.00	3,211.25
	STAKED HAYBALES	180.0	EA	3.75	675.00	5.84	1,050.30	0.00	0.00	0.00	1,725.30
	TIRE CLEANERS	6.0	EA	57.50	345.00	94.50	567.00	0.00	0.00	0.00	912.00
	MAINTENANCE	1.0	LS	2500.00	2,500.00	2800.00	2,800.00	0.00	0.00	0.00	5,300.00
	NOTE: FOR COMBINED SITES 4, 16 AND 21										
	SUBTOTAL				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA										
4A	SITE ACCESS ROAD										
	GRADING, GEOTEXTILE AND CRUSHED STONE	4388.9	SY	4.87	21,373.94	1.08	4,740.01	0.00	0.00	0.00	26,113.96
	NOTE: FOR COMBINED SITES 4, 16 AND 21										
4B	STAGING AREA(S)										
	NOTE: FOR COMBINED SITES 4 AND 16										
	GRADING	2222.2	SY	0.80	1,777.76	0.50	1,111.10	0.00	0.00	0.00	2,888.86
	GEOTEXTILES	4444.4	SY	1.89	8,399.92	0.15	666.66	0.00	0.00	0.00	9,066.58
	HDPE MEMBRANE LINER, 40 MIL	2222.2	SY	6.66	14,799.85	0.98	2,177.76	0.00	0.00	0.00	16,977.61
	RECOVERY SUMP AND PUMP	2.0	EA	5175.00	10,350.00	1120.00	2,240.00	1500.00	3,000.00	0.00	15,590.00
	ELECTRICAL POWER	2.0	EA	500.00	1,000.00	560.00	1,120.00	1500.00	3,000.00	7,000.00	12,120.00
	SUBTOTAL				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
	TOTAL SHEET NO. 2										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

FILENAME: LANTDIV2.WK1

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS, STAGING AREA AND SITE ACCESS	2.0	EA	11000.00	22,000.00	2400.00	4,800.00	600.00	1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS										
A	REMOVAL OF ASH PILE AND SOILS	910.0	CY	7.82	7,116.20	8.75	7,962.50	0.00	0.00	0.00	15,078.70
B	ADDITIONAL/OVEREXCAVATION OF ASH PILE	228.0	CY	7.82	1,782.96	8.75	1,995.00	0.00	0.00	0.00	3,777.96
C	REMOVAL OF SURFICIAL BATTERIES AND ASSOCIATED SOILS										
	AREA 4	201.0	CY	14.07	2,828.07	70.00	14,070.00	0.00	0.00	0.00	16,898.07
	AREA 16	50.0	CY	14.07	703.50	70.00	3,500.00	0.00	0.00	0.00	4,203.50
	AREA 21	1850.0	CY	14.07	26,029.50	70.00	129,500.00	0.00	0.00	0.00	155,529.50
D	BACKFILL BATTERY EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 4	150.8	CY	10.06	1,516.92	6.65	1,002.49	0.00	0.00	0.00	2,519.41
	AREA 16	37.5	CY	10.06	377.34	6.65	249.38	0.00	0.00	0.00	626.72
	AREA 21	1387.5	CY	10.06	13,961.72	6.65	9,226.88	0.00	0.00	0.00	23,188.59
	LOW PERM. SOILS FOR ASH PILE EXCAVATIONS-ASH PILE AREAS	854.0	CY	10.06	8,591.24	6.65	5,679.10	0.00	0.00	0.00	14,270.34
E	REMOVAL OF ALL SURFACE DRUMS, NO SOILS SEPARATION REQUIRED										
	AREA 4	925.0	CY	9.38	8,676.50	17.50	16,187.50	0.00	0.00	0.00	24,864.00
	AREA 16	160.0	CY	9.38	1,500.80	17.50	2,800.00	0.00	0.00	0.00	4,300.80
	AREA 21	115.0	CY	9.38	1,078.70	17.50	2,012.50	0.00	0.00	0.00	3,091.20
F	REMOVE MATERIALS FROM DRUMS AND CRUSH DRUMS										
	AREA 4	925.0	CY	35.18	32,536.88	70.00	64,750.00	0.00	0.00	0.00	97,286.88
	AREA 16	160.0	CY	35.18	5,628.00	70.00	11,200.00	0.00	0.00	0.00	16,828.00
	AREA 21	115.0	CY	35.18	4,045.13	70.00	8,050.00	0.00	0.00	0.00	12,095.13
G	REMOVAL OF SURFICIAL WASTE MATERIALS, NO SOILS SEPARATION REQUIRED										
	AREA 4	220.0	CY	7.82	1,720.40	8.75	1,925.00	0.00	0.00	0.00	3,645.40
	AREA 16	330.0	CY	7.82	2,580.60	8.75	2,887.50	0.00	0.00	0.00	5,468.10
	AREA 21	75.0	CY	7.82	586.50	8.75	656.25	0.00	0.00	0.00	1,242.75
	MINES	44.0	EA	200.00	8,800.00	140.00	6,160.00	0.00	0.00	4,500.00	19,460.00
	WORK ITEM SUBTOTAL				130,060.95		289,814.09		0.00	4,500.00	424,375.04
	TOTAL SHEET NO. 3										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS (CONTINUED)										
	WORK ITEM SUBTOTAL, BROUGHT FORWARD				130,060.95		289,814.09		0.00	4,500.00	424,375.04
I	BACKFILL DRUM EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 4	693.8	CY	10.06	6,980.86	6.65	4,613.44	0.00	0.00	0.00	11,594.30
	AREA 16	120.0	CY	10.06	1,207.50	6.65	798.00	0.00	0.00	0.00	2,005.50
	AREA 21	86.3	CY	10.06	867.89	6.65	573.56	0.00	0.00	0.00	1,441.45
J	BACKFILL SURFICIAL WASTE EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 4	165.0	CY	10.06	1,660.31	6.65	1,097.25	0.00	0.00	0.00	2,757.56
	AREA 16	247.5	CY	10.06	2,490.47	6.65	1,645.88	0.00	0.00	0.00	4,136.34
	AREA 21	56.3	CY	10.06	566.02	6.65	374.06	0.00	0.00	0.00	940.08
	SUBTOTAL				143,834.00		298,916.28		0.00	4,500.00	447,250.28
	TOTAL SHEET NO. 4										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
7	TRANSPORTATION AND DISPOSAL										
A	DISPOSAL OF ASH PILE, BATTERIES, SOILS, AND OTHER AT HAZARDOUS WASTE DISPOSAL SITE										
	ASH AND ASSOCIATED SOILS	1138.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	386,920.00	386,920.00
	BATTERIES AND ASSOCIATED SOILS	2101.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	714,340.00	714,340.00
	TRANSPORT OF MINE CASINGS, ROUND TRIP, EOD	44.0	EA	0.00	0.00	35.00	1,540.00	0.00	0.00	4,400.00	5,940.00
B	DISPOSAL OF DRUMS AND CONTENTS										
	DRUMS, TOTAL	1200.0	CY								
	HAZARDOUS	840.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	285,600.00	285,600.00
	SANITARY	360.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	22,500.00	22,500.00
C	DISPOSAL OF WASTE MATERIALS AT SANITARY LANDFILL										
	SURFICIAL WASTE MATERIALS	625.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	39,062.50	39,062.50
	MINES	44.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	5,500.00	5,500.00
D	SAMPLING AND DECON OF MINE CASINGS 24 HOUR LAB TURNAROUND	44.0	EA	200.00	8,800.00	280.00	12,320.00	0.00	0.00	50,600.00	71,720.00
E	SOILS SAMPLING										
	SITE 4	63.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	107,793.00	107,793.00
	SITE 16	34.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	58,174.00	58,174.00
	SITE 21	33.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	56,463.00	56,463.00
F	EXCAVATION OF STAINED SOILS	10.0	CY	14.07	140.70	70.00	700.00	0.00	0.00	0.00	840.70
G	WATER SAMPLING (24 HOUR TURNAROUND)	1.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	2,250.00	2,250.00
H	SAMPLING OF DISPOSAL MATERIALS										
	TCLP	7.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	9,170.00	9,170.00
	IRC	7.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	2,198.00	2,198.00
I	WATER HOLDING TANK, 10,000 GALLON CAPACITY	1.0	LS	2500.00	2,500.00	1400.00	1,400.00	6325.00	6,325.00	3,500.00	13,725.00
	SUBTOTAL				11,440.70		15,960.00		6,325.00	1,748,471	1,782,196.20
	SOILS SAMPLING LABORATORY ANALYSIS:										
	TCL VOC									248.00	
	TCL BNA									453.00	
	TAL METALS									277.00	
	PESTICIDES/PCB									269.00	
	EXPLOSIVES									334.00	
	TOC									62.00	
	TPH									68.00	
	SAMPLING TOTAL									1711.00	
	TOTAL SHEET NO. 5										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W.O. NO. :06629-001-012-3000-00
LOCATION :YORKTOWN WEAPONS STATION, YORKTOWN, VA.
ESTIMATE :CONCEPTUAL/PRELIMINARY
ESTIMATOR :NGA
DATE : 13-Dec-93 08:47 AM

ESTIMATE ACCURACY: +30% TO -15%

ITEM	DESCRIPTION ALTERNATIVE 2	MATERIAL UNIT QUANTITY	UNIT	UNIT COST	TOTAL MATERIAL	LABOR UNIT COST	TOTAL LABOR	EQUIPMENT UNIT COST	TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21 P R O J E C T S U M M A R Y										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES				65,500.00		7,000.00		0.00	5,000.00	77,500.00
2	CLEARING AND GRUBBING				0.00		0.00		0.00	28,600.00	28,600.00
3	EROSION AND SEDIMENTATION CONTROLS				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS				22,000.00		4,800.00		1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS				218,272.12		566,524.79		0.00	4,500.00	789,296.91
7	TRANSPORTATION AND DISPOSAL				11,440.70		15,960.00		6,325.00	2904164.88	2,937,890.58
8	PERMITTING FEES	1.0	LS								4,000.00
9	PERMIT FOR DRUMS WITH SOLIDIFIED MATERIAL	1.0	LS								10,000.00
10	DISPOSAL CONTINGENCY FOR UNKNOWN LIQUIDS IN DRUMS (AND LAND BAN MATERIALS)	1.0	LS								4,000.00
	SUBTOTAL										3,985,700.00
11	OPERATIONS AND MAINTENANCE COSTS: (PRESENT WORTH)										
	DRUM SAMPLING LABOR	40.0	HRS			60.00					2,400.00
	ANALYTICS	10.0	EA							1150.00	11,500.00
	EROSION AND SEDIMENTATION CONTROLS MAINTENANCE (3 YEARS DURATION; INTEREST @ 6%)	3.0	YRS								16,650.00
	PROJECT SUBTOTAL										4,016,250.00
12	ADMIN. AND CONSTRUCTION SERVICES @ 20%										803,300.00
13	CONTINGENCY @ 15%										722,900.00
	T O T A L (ROUNDED)										5,542,450.00

SHEET NO. 1

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES										
1A	MOBILIZATION AND DEMOBILIZATION - ALLOWANCE	1.0	LS	5000.00	5,000.00	4200.00	4,200.00	0.00	0.00	3,500.00	12,700.00
1B	CONSTRUCTION FACILITIES										
	TEMPORARY FACILITIES REQUIRED FOR SUPPORT OF FIELD ACTIVITIES										
	APPROXIMATE DURATION	6.0	MO								
	MONTHLY ALLOWANCE FOR TEMPORARY FACILITIES										
	ALLOW $9,500.00 PER MONTH	1.0	MO	9500.00	57,000.00	0.00	0.00	0.00	0.00	0.00	57,000.00
	ALLOWANCE FOR INSTALLATION/SETUP	1.0	LS	3500.00	3,500.00	2800.00	2,800.00	0.00	0.00	1,500.00	7,800.00
	SUBTOTAL				65,500.00		7,000.00		0.00	5,000.00	77,500.00
2	CLEARING AND GRUBBING										
	SITE 4	4.0	ACRE								
	SITE 16	1.0	ACRE								
	SITE 21	0.5	ACRE								
	TOTAL AREA	5.5	ACRE	0.00	0.00	0.00	0.00	0.00	0.00	28,600.00	28,600.00
3	EROSION AND SEDIMENTATION CONTROLS										
	SILT FENCING	4960.0	LF	1.35	6,696.00	0.56	2,777.60	0.00	0.00	0.00	9,473.60
	ROCK CHECK DAMS	35.0	EA	28.75	1,006.25	63.00	2,205.00	0.00	0.00	0.00	3,211.25
	STAKED HAYBALES	180.0	EA	3.75	675.00	5.84	1,050.30	0.00	0.00	0.00	1,725.30
	TIRE CLEANERS	6.0	EA	57.50	345.00	94.50	567.00	0.00	0.00	0.00	912.00
	MAINTENANCE	1.0	LS	2500.00	2,500.00	2800.00	2,800.00	0.00	0.00	0.00	5,300.00
	NOTE: FOR COMBINED SITES 4, 16 AND 21										
	SUBTOTAL				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA										
4A	SITE ACCESS ROAD										
	GRADING, GEOTEXTILE AND CRUSHED STONE	4388.9	SY	4.87	21,373.94	1.08	4,740.01	0.00	0.00	0.00	26,113.96
	NOTE: FOR COMBINED SITES 4, 16 AND 21										
4B	STAGING AREA(S)										
	NOTE: FOR COMBINED SITES 4 AND 16										
	GRADING	2222.2	SY	0.80	1,777.76	0.50	1,111.10	0.00	0.00	0.00	2,888.86
	GEOTEXTILES	4444.4	SY	1.89	8,399.92	0.15	666.66	0.00	0.00	0.00	9,066.58
	HDPE MEMBRANE LINER, 40 MIL	2222.2	SY	6.66	14,799.85	0.98	2,177.76	0.00	0.00	0.00	16,977.61
	RECOVERY SUMP AND PUMP	2.0	EA	5175.00	10,350.00	1120.00	2,240.00	1500.00	3,000.00	0.00	15,590.00
	ELECTRICAL POWER	2.0	EA	500.00	1,000.00	560.00	1,120.00	1500.00	3,000.00	7,000.00	12,120.00
	SUBTOTAL				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
	TOTAL SHEET NO. 2										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS, STAGING AREA AND SITE ACCESS	2.0	EA	11000.00	22,000.00	2400.00	4,800.00	600.00	1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS										
A	REMOVAL OF ASH PILE AND SOILS	910.0	CY	7.82	7,116.20	8.75	7,962.50	0.00	0.00	0.00	15,078.70
B	ADDITIONAL/OVEREXCAVATION OF ASH PILE	228.0	CY	7.82	1,782.96	8.75	1,995.00	0.00	0.00	0.00	3,777.96
C	REMOVAL OF ALL BATTERIES AND ASSOCIATED SOILS										
	AREA 4	945.0	CY	14.07	13,296.15	70.00	66,150.00	0.00	0.00	0.00	79,446.15
	AREA 16	50.0	CY	14.07	703.50	70.00	3,500.00	0.00	0.00	0.00	4,203.50
	AREA 21	4550.0	CY	14.07	64,018.50	70.00	318,500.00	0.00	0.00	0.00	382,518.50
D	BACKFILL BATTERY EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 4	708.8	CY	10.06	7,130.03	6.65	4,713.19	0.00	0.00	0.00	11,843.21
	AREA 16	37.5	CY	10.06	377.25	6.65	249.38	0.00	0.00	0.00	626.63
	AREA 21	3412.5	CY	10.06	34,329.75	6.65	22,693.13	0.00	0.00	0.00	57,022.88
	LOW PERM. SOILS FOR ASH PILE EXCAVATIONS-ASH PILE AREAS	854.0	CY	10.06	8,591.24	6.65	5,679.10	0.00	0.00	0.00	14,270.34
E	REMOVAL OF ALL SURFACE DRUMS, WITH ONSITE SOILS SEPARATION										
	AREA 4	925.0	CY	9.38	8,676.50	21.88	20,234.38	0.00	0.00	0.00	28,910.88
	AREA 16	160.0	CY	9.38	1,500.80	21.88	3,500.00	0.00	0.00	0.00	5,000.80
	AREA 21	115.0	CY	9.38	1,078.70	21.88	2,515.63	0.00	0.00	0.00	3,594.33
F	REMOVE MATERIALS FROM DRUMS AND CRUSH DRUMS										
	AREA 4	925.0	CY	35.18	32,536.88	70.00	64,750.00	0.00	0.00	0.00	97,286.88
	AREA 16	160.0	CY	35.18	5,628.00	70.00	11,200.00	0.00	0.00	0.00	16,828.00
	AREA 21	115.0	CY	35.18	4,045.13	70.00	8,050.00	0.00	0.00	0.00	12,095.13
G	REMOVAL OF SURFICIAL WASTE MATERIALS, WITH ONSITE SOILS SEPARATION										
	AREA 4	220.0	CY	7.82	1,720.40	15.31	3,368.75	0.00	0.00	0.00	5,089.15
	AREA 16	330.0	CY	7.82	2,580.60	15.31	5,053.13	0.00	0.00	0.00	7,633.73
	AREA 21	75.0	CY	7.82	586.50	15.31	1,148.44	0.00	0.00	0.00	1,734.94
	MINES	44.0	EA	200.00	8,800.00	140.00	6,160.00	0.00	0.00	4,500.00	19,460.00
	WORK ITEM SUBTOTAL				204,499.08		557,422.60		0.00	4,500.00	766,421.68
	TOTAL SHEET NO. 3										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS (CONTINUED)										
	WORK ITEM SUBTOTAL, BROUGHT FORWARD				204,499.08		557,422.60		0.00	4,500.00	766,421.68
I	BACKFILL DRUM EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 4	693.8	CY	10.06	6,980.86	6.65	4,613.44	0.00	0.00	0.00	11,594.30
	AREA 16	120.0	CY	10.06	1,207.50	6.65	798.00	0.00	0.00	0.00	2,005.50
	AREA 21	86.3	CY	10.06	867.89	6.65	573.56	0.00	0.00	0.00	1,441.45
J	BACKFILL SURFICIAL WASTE EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 4	165.0	CY	10.06	1,660.31	6.65	1,097.25	0.00	0.00	0.00	2,757.56
	AREA 16	247.5	CY	10.06	2,490.47	6.65	1,645.88	0.00	0.00	0.00	4,136.34
	AREA 21	56.3	CY	10.06	566.02	6.65	374.06	0.00	0.00	0.00	940.08
	SUBTOTAL				218,272.12		566,524.79		0.00	4,500.00	789,296.91
	TOTAL SHEET NO. 4										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV2.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-3000-00

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 4, 16 AND 21										
7	TRANSPORTATION AND DISPOSAL										
A	DISPOSAL OF ASH PILE, BATTERIES, SOILS, AND OTHER AT HAZARDOUS WASTE DISPOSAL SITE										
	ASH AND ASSOC. SOILS	1138.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	386,920.00	386,920.00
	BATTERIES AND ASSOCIATED SOILS	5545.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	1885300.00	1,885,300.00
	TRANSPORT OF MINE CASINGS, ROUND TRIP, EOD	44.0	EA	0.00	0.00	35.00	1,540.00	0.00	0.00	4,400.00	5,940.00
B	DISPOSAL OF DRUMS AND CONTENTS										
	DRUMS, TOTAL	1200.0	CY								
	HAZARDOUS	840.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	285,600.00	285,600.00
	SANITARY	360.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	22,500.00	22,500.00
C	DISPOSAL OF WASTE MATERIALS AT SANITARY LANDFILL										
	SURFICIAL WASTE MATERIALS	468.8	CY	0.00	0.00	0.00	0.00	0.00	0.00	29,296.88	29,296.88
	MINES	0.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	RECYCLE WASTE MATERIALS										
	SURFICIAL WASTE MATERIALS	156.3	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MINES	44.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	SAMPLING AND DECON OF MINE CASINGS(24 HR TRN)	44.0	EA	200.00	8,800.00	280.00	12,320.00	0.00	0.00	50,600.00	71,720.00
F	SOILS SAMPLING *										
	AREA 4	63.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	107,793.00	107,793.00
	AREA 16	34.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	58,174.00	58,174.00
	AREA 21	33.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	56,463.00	56,463.00
G	EXCAVATION OF STAINED SOILS	10.0	CY	14.07	140.70	70.00	700.00	0.00	0.00	0.00	840.70
H	WATER SAMPLING (24 HOUR TURNAROUND)	1.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	2,250.00	2,250.00
I	SAMPLING OF DISPOSAL MATERIALS										
	TCLP	7.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	9,170.00	9,170.00
	IRC	7.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	2,198.00	2,198.00
I	WATER HOLDING TANK, 10,000 GALLON CAPACITY	1.0	LS	2500.00	2,500.00	1400.00	1,400.00	6325.00	6,325.00	3,500.00	13,725.00
	SUBTOTAL				11,440.70		15,960.00		6,325.00	2,904,165	2,937,890.58

* SEE ALTERNATIVE NO. 1 FOR ANALYSIS DETAIL COSTS

TOTAL SHEET NO. 5

APPENDIX C

RISK-BASED CONCENTRATIONS

United States
Environmental Protection Agency

Region III
Philadelphia, PA 19107

EPA/903/R-93-001
January 1993

Region III
Technical Guidance Manual
Risk Assessment

Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening

EPA Contact: Dr. Roy L. Smith

EPA
Region III

Hazardous Waste Management Division
Office of Superfund Programs
January 1993

Human health risk assessment includes effort-intensive steps which require many detailed calculations by experts. Most baseline risk assessments are dominated by a few chemicals and a few routes of exposure. Effort expended on minor contaminants and exposure routes, i.e., those which do not influence overall risk, is essentially wasted. This guidance is intended to identify and focus on dominant contaminants of concern and exposure routes at the earliest feasible point in the baseline risk assessment. Use of these methods will decrease effort and time spent assessing risk, without loss of protectiveness. This guidance is not intended for other risk assessment activities, such as determining preliminary remediation goals.

SELECTING CONTAMINANTS AND EXPOSURE ROUTES OF CONCERN

Most samples from hazardous waste sites are analyzed for 103 target compounds and analytes recommended by the EPA Superfund program. Semi-volatile analysis can detect additional tentatively identified compounds not on the target lists. Special analytical services procedures, if used, may find still more contaminants. The combined number of contaminants detected at a site sometimes exceeds one hundred.

While EPA considers it necessary to gather information on many contaminants, very little of this data actually influences the overall quantitative assessment of health risk. For most sites, baseline risk assessments are dominated by a few contaminants and a few routes of exposure. The remaining tens, or hundreds, of detected contaminants have a minimal influence on total risk. This small impact is lost by rounding. Entire environmental media may contain not a single contaminant at a concentration which could adversely affect public health. Quantitative risk calculations using data from such "risk-free" media have no effect on the overall risk estimate for the site.

The EPA baseline risk assessment process at several points requires careful data evaluation by scientific experts. These evaluations, which are contaminant-specific, include: (1) statistical comparisons between site-related and background samples, (2) special handling of undetected contaminants, (3) calculation of toxicity equivalence, (4) evaluation of frequency of detection, and (5) comparison with ARARs. Because overall risk is usually driven by a few contaminants and exposure routes, effort spent in detailed evaluation of minor contaminants and routes of exposure is essentially wasted. For some sites, this wasted effort exceeds 90% of the total.

The baseline risk assessment process can be made more efficient by focusing on dominant contaminants and routes of exposure at the earliest feasible stage. The mechanisms recommended for this are (1) a re-ordering of the process of eliminating contaminants and routes of exposure, and (2) use of a risk-based concentration screen. Appropriately used, this process can dramatically reduce the effort of risk assessment, while not changing the result significantly.

EXISTING GUIDANCE

Chapter 5 of "RAGS IA" (Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A); EPA, 1989) provides a detailed procedure for evaluating data for a baseline risk assessment. This

procedure includes steps by which the risk assessor selects contaminants of concern in each exposure medium. These steps are summarized in Table 1.

There are two major limitations to the RAGS procedure. First, the eliminating step (a concentration toxicity screen) comes late in the process. Many of the preceding steps (e.g., evaluation of quantitation limits, comparison with background, calculation of toxicity equivalence, and evaluation of frequency of detection) are contaminant- and medium-specific. They require the sustained attention of an expert, and cannot be automated. If the contaminant is eliminated, this work is wasted.

The second limitation is that the concentration toxicity screen compares only relative risk among contaminants in the same medium. While very efficient at selecting dominant contaminants in each medium, this method does not evaluate significance of total risk for the medium. Thus, the concentration toxicity screen can eliminate contaminants, but not routes of exposure.

RECOMMENDED METHODOLOGY

This guidance makes two changes intended to remove the limitations in existing guidance. These recommendations are intended for baseline risk assessments.

1. **Re-ordering of steps.** The eliminating screen is moved forward in the data evaluation process to a point immediately following data quality evaluation. The new process is shown in Table 2. Effort-intensive steps such as evaluation of quantitation limits and comparison with background now follow the eliminating screen. The steps are divided into four categories: data quality evaluation, initial data set reduction, re-inclusion of special cases, and optional final data set reduction.

The data quality evaluation steps (evaluating appropriateness of methods and qualifiers, significance of blank contamination, and need for special analyses) should be done as described in RAGS IA, Chapter 5. Next, the risk assessor should consult with the RPM to discuss the use of the risk-based concentration table (described in item [2] below) as a screening mechanism. With the RPM's approval, the risk assessor should reduce the data set and document the rationale for eliminating contaminants routes of exposure from further analysis.

After the initial data set reduction, the risk assessor and RPM should consider retaining specific contaminants on the basis of historical data, toxicity, mobility, persistence, bioaccumulation, special exposure routes, special treatability problems, or exceedance of ARARs. These activities should proceed as described in Section 5.9 of RAGS IA.

Finally, optional further reductions in the data set may be justified, based on the status of a contaminant as an essential nutrient, low frequency of detection, or no statistical difference between site and background levels. These evaluations, the most complicated and contaminant-specific, are saved for last.

2. **Screening by risk-based concentrations.** The screening method is changed from the relative concentration toxicity screen of RAGS IA to an absolute comparison of risk. This is done by means of a table of risk-based concentrations (Appendix I). This table contains levels of nearly 600 contaminants in air, drinking water, fish tissue, and soil, which correspond to a systemic hazard quotient of 0.1 or a lifetime cancer risk of 10^{-6}. The risk-based concentrations were developed using protective default exposure scenarios suggested by EPA (1991) and the best available reference doses and carcinogenic potency slopes (see the table for sources), and represent relatively protective environmental concentrations at which EPA would typically not take action.

The risk-based concentration screen is used as follows:

(a) The risk assessor extracts the maximum concentration of each substance detected in each medium.

(b) If the maximum concentration exceeds the risk-based concentration for that medium, the contaminant is retained for risk assessment, for all routes of exposure involving that medium. Otherwise the contaminant is dropped for that medium.

(c) If a specific contaminant does not exceed its risk-based concentration for any medium, the contaminant is dropped from the risk assessment.

(d) If no contaminant in a specific medium exceeds its risk-based concentration, the medium is dropped from the risk assessment.

(e) All contaminants and exposure routes which are dropped are kept on a sub-list and considered for re-inclusion, based on special properties.

(f) If the risk assessor wants to include a route of exposure not covered in the risk-based concentration table, the equations provided in Appendix I can serve as the basis for new risk-

based concentrations. Similarly, the risk assessor can use the same equations to calculate alternate risk levels (i.e., other than a systemic hazard quotient of 0.1 and lifetime cancer risk of 10^{-6}) to be the basis for screening.

SUMMARY

The process by which contaminants and exposure routes are selected in quantitative risk assessment can be made less effort-intensive by two simple changes. First, high-effort steps should be postponed until later in the selection process, because performing these operations on trivial contaminants and exposure routes is pointless. Second, changing from a relative concentration toxicity screen to an absolute risk-based concentration screen improves the risk assessor's ability to focus on dominant contaminants and exposure routes at an earlier stage.

REFERENCES

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". OSWER Directive 9285.6-03, Office of Emergency and Remedial Response, March 25, 1991.

EPA, 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, December, 1989. EPA/540/1-89/002.

For additional information, call (215) 597-6682.

Approved by: _____

Thomas C. Voltaggio, Director
Hazardous Waste Management Division

Table 1. Summary of existing EPA guidance on selecting contaminants of concern (EPA, 1989, chapter 5)
Section 5.1: Combining data from site investigations
1. Determine if methods are appropriate
2. Evaluate quantitation limits
3. Determine if qualifiers are appropriate
4. Determine if significant blank contamination exists
5. Determine if special analyses for tentatively identified compounds are needed
6. Compare site samples to background
Section 5.9: Further reduction in the number of chemicals (optional)
7. Consult with RPM
8. Document rationale for eliminating chemicals
9. Examine historical information
10. Consider exceptional toxicity, mobility, persistence, or bioaccumulation
11. Consider special exposure routes
12. Consider special treatability problems
13. Determine if contaminants exceed ARARs
14. Group chemicals by class, evaluate toxicity equivalence
15. Evaluate frequency of detection
16. Evaluate essentiality
17. Use a concentration toxicity screen

Table 2. EPA Region III guidance on selecting contaminants and exposure routes of concern
A. Data quality evaluation
1. Determine if methods are appropriate
2. Determine if qualifiers are appropriate
3. Determine if significant blank contamination exists
4. Determine if special analyses for tentatively identified compounds are needed
B. Reduce data set using risk-based concentration screen
5. Consult with RPM
6. Use risk-based concentration table to screen contaminants and exposure routes of concern
7. Document rationale for eliminating chemicals and exposure routes
C. Consider re-including eliminated chemicals and routes, based on:
8. Historical information
9. Exceptional toxicity, mobility, persistence, or bioaccumulation
10. Special exposure routes
11. Special treatability problems
12. ARARs exceedance
13. Toxicity equivalence of chemical class (*e.g.*, CDD/CDFs, PAHs)
D. Make further specific reductions in data set (optional)
14. Evaluate essentiality
15. Evaluate frequency of detection
16. Compare site samples to background

Appendix I:
EPA Region III Risk-Based Concentration Table
Background Information

The risk-based concentrations were calculated as follows:

GENERAL: Separate risk-based concentrations were calculated for carcinogenic and non-carcinogenic effects of each compound for each pathway. The concentration in the table is the lower of the two, rounded to two significant figures. For non-carcinogenic effects, the averaging time equals the exposure duration, so the exposure duration term has been used for both. The following terms were used in the calculations:

General:	
Oral carcinogenic slope factor $(mg/kg/d)^{-1}$:	SF_o
Inhaled carcinogenic slope factor $(mg/kg/d)^{-1}$:	SF_i
Oral reference dose (mg/kg/d):	RfD_o
Inhaled reference dose (mg/kg/d):	RfD_i
Target cancer risk:	TR
Target hazard quotient:	THQ
Body weight, adult (kg):	BW_a
Body weight, child age 1-6 (kg):	BW_c
Averaging time (years of life):	AT
Air breathed (m^3/d):	IR_a
Drinking water ingestion (L/d):	IR_w
Fish ingestion (g/d):	IR_f
Soil ingestion - age adjusted (mg/d)	IRS_{adj}
Soil ingestion - age 1-6 (mg/d):	IRS_c
Soil ingestion - adult (mg/d):	IRS_a
Residential:	
Exposure frequency (d/y):	EF_r
Exposure duration (y):	ED_r
Volatilization factor (L/m^3):	VF
Commercial/industrial:	
Exposure frequency (d/y):	EF_c
Exposure duration (y):	ED_c

The priority among sources of toxicological constants was as follows: (1) IRIS, (2) HEAST, (3) HEAST alternative method, (4) ECAO-Cincinnati, (5) other EPA documents, (6) withdrawn from IRIS, and (7) withdrawn from HEAST. Each source was used only if numbers from higher-priority sources were unavailable.

ALGORITHMS:

1. Residential water use ($\mu g/L$). Volatilization terms were calculated only for compounds with "y" in the "Volatile" column. Compounds having a Henry's Law constant greater than 10^{-5} were considered volatile. The list may be incomplete, but is unlikely to include false positives. The equations and the volatilization factor (VF, above) were obtained from the draft RAGS IB. Oral potency slopes and reference doses were used for both oral and inhaled exposures for volatile compounds lacking inhalation values. Inhaled potency slopes were substituted for unavailable oral potency slopes only for volatile compounds; inhaled RfDs were substituted for unavailable oral RfDs for both volatile and non-volatile compounds.

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot ([VF \cdot IR_a \cdot CPS_i] + [IR_w \cdot SF_o])}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot BW_a \cdot ED_r \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot \left(\frac{VF \cdot IR_a}{RfD_i} + \frac{IR_w}{RfD_o}\right)}$$

2. Air ($\mu g/m^3$). Oral potency slopes and references were used where inhalation values were not available.

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot IR_a \cdot SF_i}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_i \cdot BW_a \cdot ED_r \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot IR_a}$$

3. Fish (mg/kg):

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y}}{EF_r \cdot ED_r \cdot \frac{IR_f}{1000\frac{g}{kg}} \cdot SF_o}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_o \cdot BW_a \cdot ED_c \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IR_s}{1000\frac{mg}{kg}}}$$

4. Soil commercial/industrial (mg/kg): The default exposure assumption that only 50% of incidential soil ingestion occurs at work has been omitted.

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y}}{EF_o \cdot ED_o \cdot \frac{IRS_o}{10^6\frac{mg}{kg}} \cdot SF_o}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_o \cdot BW_a \cdot ED_o \cdot 365\frac{d}{y}}{EF_o \cdot ED_o \cdot \frac{IRS_o}{10^6\frac{mg}{kg}}}$$

5. Soil residential (mg/kg):

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IRS_a}{10^6\frac{mg}{kg}} \cdot CPS_o}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_o \cdot BW_c \cdot ED_c \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IRS_c}{10^6\frac{mg}{kg}}}$$

EXPOSURE ASSUMPTIONS:	
1-General:	
Target cancer risk:	1e-06
Target hazard quotient:	0.1
Body weight, adult (kg):	70
Body weight, age 1-6 (kg):	15
Averaging time (years of life):	70
Air breathed (m3/d):	20
Drinking water ingestion (l/d):	2
Fish ingestion (g/d):	54
Soil ingestion - age adjusted (mg/d):	100
Soil ingestion - age 1-6 (mg/d):	200
Soil ingestion - adult (mg/d):	100
2-Residential:	
Exposure frequency (d/y):	350
Exposure duration (y):	30
Volatilization factor (L/m3):	0.5
3-Occupational:	
Exposure frequency (d/y):	250
Exposure duration (y):	25

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Acephate	4.00e-03 i		8.70e-03 i			9.8	0.98	0.36	330	31
Acetaldehyde		2.57e-03 i		7.70e-03 i		9.4	0.94			
Acetone	1.00e-01 i					370	37	14	10000	780
Acetone cyanohydrin	7.00e-02 h	2.86e-03 a				260	1	9.5	7200	550
Acetonitrile	6.00e-03 i	1.43e-02 a				22	5.2	0.81	610	47
Acetophenone	1.00e-01 i	5.71e-06 a			y	0.0042	0.0021	14	10000	780
Acifluorfen	1.30e-02 i					47	4.7	1.8	1300	100
Acrolein	2.00e-02 h	5.71e-06 i				73	0.0021	2.7	2000	160
Acrylamide	2.00e-04 i		4.50e+00 i	4.55e+00 i		0.019	0.0019	0.0007	0.64	0.38
Acrylic acid	8.00e-02 i	8.57e-05 i				290	0.031	11	8200	630
Acrylonitrile		5.71e-04 i	5.40e-01 i	2.38e-01 i		0.16	0.036	0.0058	5.3	3.2
Alachlor	1.00e-02 i		8.05e-02 h			1.1	0.11	0.039	36	21
Alar	1.50e-01 i					550	55	20	15000	1200
Aldicarb	2.00e-04 i					0.73	0.073	0.027	20	1.6
Aldicarb sulfone	3.00e-04 x					1.1	0.11	0.041	31	2.3
Aldrin	3.00e-05 i		1.70e+01 i	1.72e+01 i		0.005	0.0005	0.00019	0.17	0.1
Ally	2.50e-01 i					910	91	34	26000	2000
Allyl alcohol	5.00e-03 i					18	1.8	0.68	510	39
Allyl chloride	5.00e-02 h	2.86e-04 i				180	0.1	6.8	5100	390
Aluminum	2.90e+00 o					11000	1100	390	300000	23000
Aluminum phosphide	4.00e-04 i					1.5	0.15	0.054	41	3.1
Amdro	3.00e-04 i					1.1	0.11	0.041	31	2.3
Ametryn	9.00e-03 i					33	3.3	1.2	920	70
m-Aminophenol	7.00e-02 h					260	26	9.5	7200	550
4-Aminopyridine	2.00e-05 h					0.073	0.0073	0.0027	2	0.16
Amitraz	2.50e-03 i					9.1	0.91	0.34	260	20
Ammonia		2.86e-02 i				100	10			
Ammonium sulfamate	2.00e-01 i					730	73	27	20000	1600
Aniline		2.86e-04 i	5.70e-03 i			1	0.1	0.55	500	300
Antimony and compounds	4.00e-04 i					1.5	0.15	0.054	41	3.1
Antimony pentoxide	5.00e-04 h					1.8	0.18	0.068	51	3.9
Antimony potassium tartrate	9.00e-04 h					3.3	0.33	0.12	92	7
Antimony tetroxide	4.00e-04 h					1.5	0.15	0.054	41	3.1
Antimony trioxide	4.00e-04 h					1.5	0.15	0.054	41	3.1
Apollo	1.30e-02 i					47	4.7	1.8	1300	100
Aramite	5.00e-02 h		2.50e-02 i	2.49e-02 i		3.4	0.34	0.13	110	68
Arsenic	3.00e-04 i					1.1	0.11	0.041	31	2.3
Arsenic (as carcinogen)			1.75e+00 i	1.51e+01 i		0.049	0.00057	0.0018	1.6	0.97

Key to Data Sources: i=IRIS x=Withdrawn from IRIS h=HEAST a=HEAST alternate method y=Withdrawn from HEAST c=EPA-ECAO o=Other EPA documents

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Assure	9.00e-03 i					33	3.3	1.2	920	70
Asulam	5.00e-02 i					180	18	6.8	5100	390
Atrazine	5.00e-03 i		2.22e-01 h			0.38	0.038	0.014	13	7.7
Avermectin B1	4.00e-04 i					1.5	0.15	0.054	41	3.1
Azobenzene			1.10e-01 i	1.09e-01 i		0.77	0.078	0.029	26	15
Barium and compounds	7.00e-02 i	1.43e-04 a				260	0.052	9.5	7200	550
Baygon	4.00e-03 i					15	1.5	0.54	410	31
Bayleton	3.00e-02 i					110	11	4.1	3100	230
Baythroid	2.50e-02 i					91	9.1	3.4	2600	200
Benefin	3.00e-01 i					1100	110	41	31000	2300
Benomyl	5.00e-02 i					180	18	6.8	5100	390
Bentazon	2.50e-03 i					9.1	0.91	0.34	260	20
Benzaldehyde	1.00e-01 i				y	61	37	14	10000	780
Benzene			2.90e-02 i	2.91e-02 i	y	0.49	0.29	0.11	99	59
Benzidine	3.00e-03 i		2.30e+02 i	2.35e+02 i		0.00037	0.000036	0.000014	0.012	0.0074
Benzoic acid	4.00e+00 i					15000	1500	540	410000	31000
Benzotrichloride			1.30e+01 i			0.0066	0.00066	0.00024	0.22	0.13
Benzyl alcohol	3.00e-01 h					1100	110	41	31000	2300
Benzyl chloride			1.70e-01 i		y	0.083	0.05	0.019	17	10
Beryllium and compounds	5.00e-03 i		4.30e+00 i	8.40e+00 i		0.02	0.001	0.00073	0.67	0.4
Bidrin	1.00e-04 i					0.37	0.037	0.014	10	0.78
Biphenthrin (Talstar)	1.50e-02 i					55	5.5	2	1500	120
1,1-Biphenyl	5.00e-02 i					180	18	6.8	5100	390
Bis(2-chloroethyl)ether			1.10e+00 i	1.16e+00 i	y	0.012	0.0074	0.0029	2.6	1.5
Bis(2-chloroisopropyl)ether	4.00e-02 i		7.00e-02 h	3.50e-02 h	y	0.35	0.24	0.045	41	24
Bis(chloromethyl)ether			2.20e+02 i	2.17e+02 i	y	0.000065	0.000039	0.000014	0.013	0.0077
Bis(2-chloro-1-methylethyl)ether			7.00e-02 y	7.00e-02 y		1.2	0.12	0.045	41	24
Bis(2-ethylhexyl)phthalate (DEHP)	2.00e-02 i		1.40e-02 i			6.1	0.61	0.23	200	120
Bisphenol A	5.00e-02 i					180	18	6.8	5100	390
Boron	9.00e-02 i	5.71e-03 h				330	2.1	12	9200	700
Boron trifluoride		2.00e-04 h				0.73	0.073			
Bromodichloromethane	2.00e-02 i		1.30e-01 i		y	0.11	0.066	0.024	22	13
Bromoethene				1.10e-01 h	y	0.13	0.077			
Bromoform (tribromomethane)	2.00e-02 i		7.90e-03 i	3.85e-03 i	y	3.1	2.2	0.4	360	160
Bromomethane	1.40e-03 i	1.43e-03 i			y	0.87	0.52	0.19	140	11
4-Bromophenyl phenyl ether	5.80e-02 o					210	21	7.8	5900	450
Bromophos	5.00e-03 h					18	1.8	0.68	510	39
Bromoxynil	2.00e-02 i					73	7.3	2.7	2000	160

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Bromoxynil octanoate	2.00e-02 i					73	7.3	2.7	2000	160
1,3-Butadiene				9.80e-01 i	y	0.014	0.0087			
1-Butanol	1.00e-01 i					370	37	14	10000	780
Butylate	5.00e-02 i					180	18	6.8	5100	390
Butyl benzyl phthalate	2.00e-01 i					730	73	27	20000	1600
Butylphthalyl butylglycolate	1.00e+00 i					3700	370	140	100000	7800
Cacodylic acid	3.00e-03 h					11	1.1	0.41	310	23
Cadmium and compounds	5.00e-04 i			6.30e+00 i		1.8	0.0014	0.068	51	3.9
Caprolactam	5.00e-01 i					1800	180	68	51000	3900
Captafol	2.00e-03 i		8.60e-03 h			7.3	0.73	0.27	200	16
Captan	1.30e-01 i		3.50e-03 h			24	2.4	0.9	820	490
Carbaryl	1.00e-01 i					370	37	14	10000	780
Carbazole			2.00e-02 h			4.3	0.43	0.16	140	85
Carbofuran	5.00e-03 i					18	1.8	0.68	510	39
Carbon disulfide	1.00e-01 i	2.86e-03 h			y	2.1	1	14	10000	780
Carbon tetrachloride	7.00e-04 i		1.30e-01 i	5.25e-02 i	y	0.22	0.16	0.024	22	5.5
Carbosulfan	1.00e-02 i					37	3.7	1.4	1000	78
Carboxin	1.00e-01 i					370	37	14	10000	780
Chloral	2.00e-03 i					7.3	0.73	0.27	200	16
Chloramben	1.50e-02 i					55	5.5	2	1500	120
Chloranil			4.03e-01 h			0.21	0.021	0.0078	7.1	4.2
Chlordane	6.00e-05 i		1.30e+00 i	1.30e+00 i		0.066	0.0066	0.0024	2.2	0.47
Chlorimuron-ethyl	2.00e-02 i					73	7.3	2.7	2000	160
Chlorine dioxide		5.71e-05 i				0.21	0.021			
Chloroacetaldehyde	6.90e-03 o					25	2.5	0.93	710	54
Chloroacetic acid	2.00e-03 h					7.3	0.73	0.27	200	16
2-Chloroacetophenone		8.57e-06 i				0.031	0.0031			
4-Chloroaniline	4.00e-03 i					15	1.5	0.54	410	31
Chlorobenzene	2.00e-02 i	5.71e-03 a			y	3.9	2.1	2.7	2000	160
Chlorobenzilate	2.00e-02 i					73	7.3	2.7	2000	160
p-Chlorobenzoic acid	2.00e-01 h					730	73	27	20000	1600
4-Chlorobenzotrifluoride	2.00e-02 h					73	7.3	2.7	2000	160
2-Chloro-1,3-butadiene	7.00e-03 h	2.86e-02 a			y	11	10	0.95	720	55
1-Chlorobutane	4.00e-01 h				y	240	150	54	41000	3100
2-Chloroethyl vinyl ether	2.50e-02 o				y	15	9.1	3.4	2600	200
Chloroform	1.00e-02 i		6.10e-03 i	8.05e-02 i	y	0.21	0.11	0.52	470	78
Chloromethane			1.30e-02 h	6.30e-03 h	y	1.9	1.4	0.24	220	130
4-Chloro-2-methylaniline			5.80e-01 h			0.15	0.015	0.0054	4.9	2.9

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
4-Chloro-2,2-methylaniline hydrochloride			4.60e-01 h			0.19	0.019	0.0069	6.2	3.7
beta-Chloronaphthalene	8.00e-02 i					290	29	11	8200	630
o-Chloronitrobenzene			2.50e-02 h		y	0.57	0.34	0.13	110	68
p-Chloronitrobenzene			1.80e-02 h		y	0.79	0.47	0.18	160	95
2-Chlorophenol	5.00e-03 i					18	1.8	0.68	510	39
2-Chloropropane		2.86e-02 h			y	17	10			
Chlorothalonil	1.50e-02 i		1.10e-02 h			7.7	0.77	0.29	260	120
o-Chlorotoluene	2.00e-02 i				y	12	7.3	2.7	2000	160
Chlorpropham	2.00e-01 i					730	73	27	20000	1600
Chlorpyrifos	3.00e-03 i					11	1.1	0.41	310	23
Chlorpyrifos-methyl	1.00e-02 h					37	3.7	1.4	1000	78
Chlorsulfuron	5.00e-02 i					180	18	6.8	5100	390
Chlorthiophos	8.00e-04 h					2.9	0.29	0.11	82	6.3
Chromium III and compounds	1.00e+00 i	5.71e-07 y				3700	0.00021	140	100000	7800
Chromium VI and compounds	5.00e-03 i			4.20e+01 i		18	0.0002	0.68	510	39
Coal tars				2.20e+00 h			0.0039			
Cobalt		2.86e-04 e				1	0.1			
Coke Oven Emissions				2.17e+00 i			0.0039			
Copper and compounds	3.71e-02 h					140	14	5	3800	290
Crotonaldehyde	1.00e-02 x		1.90e+00 h	1.90e+00 y		0.045	0.0045	0.0017	1.5	0.9
Cumene	4.00e-02 i	2.57e-03 h				150	0.94	5.4	4100	310
Cyanazine	2.00e-03 x					7.3	0.73	0.27	200	16
Cyanides										
Barium cyanide	1.00e-01 h					370	37	14	10000	780
Copper cyanide	5.00e-03 i					18	1.8	0.68	510	39
Calcium cyanide	4.00e-02 i					150	15	5.4	4100	310
Cyanogen	4.00e-02 i					150	15	5.4	4100	310
Cyanogen bromide	9.00e-02 i					330	33	12	9200	700
Cyanogen chloride	5.00e-02 i					180	18	6.8	5100	390
Free cyanide	2.00e-02 i					73	7.3	2.7	2000	160
Hydrogen cyanide	2.00e-02 i					73	7.3	2.7	2000	160
Potassium cyanide	5.00e-02 i					180	18	6.8	5100	390
Potassium silver cyanide	2.00e-01 i					730	73	27	20000	1600
Silver cyanide	1.00e-01 i					370	37	14	10000	780
Sodium cyanide	4.00e-02 i					150	15	5.4	4100	310
Zinc cyanide	5.00e-02 i					180	18	6.8	5100	390
Cyclohexanone	5.00e+00 i				y	3000	1800	680	510000	39000

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Cyclohexlamine	2.00e-01 i					730	73	27	20000	1600
Cyhalothrin/Karate	5.00e-03 i					18	1.8	0.68	510	39
Cypermethrin	1.00e-02 i					37	3.7	1.4	1000	78
Cyromazine	7.50e-03 i					27	2.7	1	770	59
Dacthal	5.00e-01 i					1800	180	68	51000	3900
Dalapon	3.00e-02 i					110	11	4.1	3100	230
Danitol	5.00e-04 i					1.8	0.18	0.068	51	3.9
DDD			2.40e-01 i			0.35	0.035	0.013	12	7.1
DDE			3.40e-01 i			0.25	0.025	0.0093	8.4	5
DDT	5.00e-04 i		3.40e-01 i	3.40e-01 i		0.25	0.025	0.0093	8.4	3.9
Decabromodiphenyl ether	1.00e-02 i				y	6.1	3.7	1.4	1000	78
Demeton	4.00e-05 i					0.15	0.015	0.0054	4.1	0.31
Diallate			6.10e-02 h		y	0.23	0.14	0.052	47	28
Diazinon	9.00e-04 h					3.3	0.33	0.12	92	7
1,4-Dibromobenzene	1.00e-02 i				y	6.1	3.7	1.4	1000	78
Dibromochloromethane	2.00e-02 i		8.40e-02 i		y	0.17	0.1	0.038	34	20
1,2-Dibromo-3-chloropropane		5.71e-05 i	1.40e+00 h	2.40e-03 h	y	0.035	0.021	0.0023	2	1.2
1,2-Dibromoethane			8.50e+01 i	7.70e-01 i	y	0.00096	0.011	0.000037	0.034	0.02
Di-n-butyl phthalate	1.00e-01 i					370	37	14	10000	780
Dicamba	3.00e-02 i					110	11	4.1	3100	230
1,2-Dichlorobenzene	9.00e-02 i	5.71e-02 a			y	37	21	12	9200	700
1,3-Dichlorobenzene	8.90e-02 o				y	54	32	12	9100	700
1,4-Dichlorobenzene		2.00e-01 h	2.40e-02 h		y	0.59	0.35	0.13	120	71
3,3*-Dichlorobenzidine			4.50e-01 i			0.19	0.019	0.007	6.4	3.8
1,4-Dichloro-2-butene				9.30e+00 h	y	0.0015	0.00092			
Dichlorodifluoromethane	2.00e-01 i	5.71e-02 a			y	39	21	27	20000	1600
1,1-Dichloroethane	1.00e-01 h	1.43e-01 a			y	81	52	14	10000	780
1,2-Dichloroethane (EDC)			9.10e-02 i	9.10e-02 i	y	0.16	0.094	0.035	31	19
1,1-Dichloroethylene	9.00e-03 i		6.00e-01 i	1.75e-01 i	y	0.058	0.049	0.0053	4.8	2.8
1,2-Dichloroethylene (cis)	1.00e-02 h				y	6.1	3.7	1.4	1000	78
1,2-Dichloroethylene (trans)	2.00e-02 i				y	12	7.3	2.7	2000	160
1,2-Dichloroethylene (mixture)	9.00e-03 h				y	5.5	3.3	1.2	920	70
2,4-Dichlorophenol	3.00e-03 i					11	1.1	0.41	310	23
4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	8.00e-03 i					29	2.9	1.1	820	63
2,4-Dichlorophenoxyacetic Acid (2,4-D)	1.00e-02 i				y	6.1	3.7	1.4	1000	78
1,2-Dichloropropa ie		1.14e-03 i	6.80e-02 h		y	0.21	0.13	0.046	42	25

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
1,3-Dichloropropene	3.00e-04 i	5.71e-03 i	1.80e-01 h	1.30e-01 h	y	0.1	0.066	0.018	16	2.3
2,3-Dichloropropanol	3.00e-03 i					11	1.1	0.41	310	23
Dichlorvos	8.00e-04 x		2.90e-01 i			0.29	0.029	0.011	9.9	5.9
Dicofol			4.40e-01 x			0.19	0.019	0.0072	6.5	3.9
Dicyclopentadiene	3.00e-02 h	5.71e-05 a			y	0.042	0.021	4.1	3100	230
Dieldrin	5.00e-05 i		1.60e+01 i	1.61e+01 i		0.0053	0.00053	0.0002	0.18	0.11
Diethylene glycol, monobutyl ether		5.71e-03 h				21	2.1			
Diethylene glycol, monoethyl ether	2.00e+00 h					7300	730	270	200000	16000
Diethylformamide	1.10e-02 h					40	4	1.5	1100	86
Di(2-ethylhexyl)adipate	6.00e-01 i		1.20e-03 i			71	7.1	2.6	2400	1400
Diethyl phthalate	8.00e-01 i					2900	290	110	82000	6300
Diethylstilbestrol			4.70e+03 h			0.000018	0.0000018	0.00000067	0.00061	0.00036
Difenzoquat (Avenge)	8.00e-02 i					290	29	11	8200	630
Diflubenzuron	2.00e-02 i					73	7.3	2.7	2000	160
Diisopropyl methylphosphonate (DIMP)	8.00e-02 i					290	29	11	8200	630
Dimethipin	2.00e-02 i					73	7.3	2.7	2000	160
Dimethoate	2.00e-04 i					0.73	0.073	0.027	20	1.6
3,3'-Dimethoxybenzidine			1.40e-02 h			6.1	0.61	0.23	200	120
Dimethylamine		5.71e-06 x				0.021	0.0021			
N,N-Dimethylaniline	2.00e-03 i					7.3	0.73	0.27	200	16
2,4-Dimethylaniline			7.50e-01 h			0.11	0.011	0.0042	3.8	2.3
2,4-Dimethylaniline hydrochloride			5.80e-01 h			0.15	0.015	0.0054	4.9	2.9
3,3'-Dimethylbenzidine			9.20e+00 h			0.0093	0.00093	0.00034	0.31	0.19
1,1-Dimethylhydrazine			2.60e+00 h	3.50e+00 h		0.033	0.0024	0.0012	1.1	0.66
1,2-Dimethylhydrazine			3.70e+01 h	3.70e+01 h		0.0023	0.00023	0.000085	0.077	0.046
N,N-Dimethylformamide	1.00e-01 h	8.57e-03 i				370	3.1	14	10000	780
2,4-Dimethylphenol	2.00e-02 i					73	7.3	2.7	2000	160
2,6-Dimethylphenol	6.00e-04 i					2.2	0.22	0.081	61	4.7
3,4-Dimethylphenol	1.00e-03 i					3.7	0.37	0.14	100	7.8
Dimethyl phthalate	1.00e+01 h					37000	3700	1400	1000000	78000
Dimethyl terephthalate	1.00e-01 i					370	37	14	10000	780
4,6-Dinitro-o-cyclohexyl phenol	2.00e-03 i					7.3	0.73	0.27	200	16
1,2-Dinitrobenzene	4.00e-04 h					1.5	0.15	0.054	41	3.1
1,3-Dinitrobenzene	1.00e-04 i					0.37	0.037	0.014	10	0.78
1,4-Dinitrobenzene	4.00e-04 h					1.5	0.15	0.054	41	3.1
2,4-Dinitrophenol	2.00e-03 i					7.3	0.73	0.27	200	16
Dinitrotoluene mixture			6.80e-01 i			0.13	0.013	0.0046	4.2	2.5

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2,4-Dinitrotoluene	2.00e-03 i		i			7.3	0.73	0.27	200	16
2,6-Dinitrotoluene			6.80e-01 i			0.13	0.013	0.0046	4.2	2.5
Dinoseb	1.00e-03 i					3.7	0.37	0.14	100	7.8
di-n-Octyl phthalate	2.00e-02 h					73	7.3	2.7	2000	160
1,4-Dioxane			1.10e-02 i			7.7	0.77	0.29	260	150
Diphenamid	3.00e-02 i					110	11	4.1	3100	230
Diphenylamine	2.50e-02 i					91	9.1	3.4	2600	200
1,2-Diphenylhydrazine			8.00e-01 i	7.70e-01 i		0.11	0.011	0.0039	3.6	2.1
Diquat	2.20e-03 i					8	0.8	0.3	220	17
Direct black 38			8.60e+00 h			0.0099	0.00099	0.00037	0.33	0.2
Direct blue 6			8.10e+00 h			0.011	0.0011	0.00039	0.35	0.21
Direct brown 35			9.30e+00 h			0.0092	0.00092	0.00034	0.31	0.18
Disulfoton	4.00e-05 i					0.15	0.015	0.0054	4.1	0.31
Diuron	2.00e-03 i					7.3	0.73	0.27	200	16
Dodine	4.00e-03 i					15	1.5	0.54	410	31
Endosulfan	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Endothall	2.00e-02 i					73	7.3	2.7	2000	160
Endrin	3.00e-04 i					1.1	0.11	0.041	31	2.3
Epichlorohydrin	2.00e-03 h	2.86e-04 i	9.90e-03 i	4.20e-03 i		7.3	0.1	0.27	200	16
1,2-Epoxybutane		5.71e-03 i				21	2.1			
EPTC (S-Ethyl dipropylthiocarbamate)	2.50e-02 i					91	9.1	3.4	2600	200
Ethephon (2-chloroethyl phosphonic acid)	5.00e-03 i					18	1.8	0.68	510	39
Ethion	5.00e-04 i					1.8	0.18	0.068	51	3.9
2-Ethoxyethanol	4.00e-01 h	5.71e-02 i				1500	21	54	41000	3100
2-Ethoxyethanol acetate	3.00e-01 a					1100	110	41	31000	2300
Ethyl acetate	9.00e-01 i					3300	330	120	92000	7000
Ethyl acrylate			4.80e-02 h			1.8	0.18	0.066	60	35
Ethylbenzene	1.00e-01 i	2.86e-01 i			y	130	100	14	10000	780
Ethylene cyanohydrin	3.00e-01 h					1100	110	41	31000	2300
Ethylene diamine	2.00e-02 h					73	7.3	2.7	2000	160
Ethylene glycol	2.00e+00 i					7300	730	270	200000	16000
Ethylene glycol, monobutyl ether		5.71e-03 h				21	2.1			
Ethylene oxide			1.02e+00 h	3.50e-01 h		0.083	0.024	0.0031	2.8	1.7
Ethylene thiourea (ETU)	8.00e-05 i		6.00e-01 h			0.14	0.014	0.0053	4.8	0.63
Ethyl chloride	2.00e-02 e	2.86e+00 i			y	71	1000	2.7	2000	160
Ethyl ether	2.00e-01 i				y	120	73	27	20000	1600

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Ethyl methacrylate	9.00e-02 h					330	33	12	9200	700
Ethyl p-nitrophenyl phenylphosphorothioate	1.00e-05 i					0.037	0.0037	0.0014	1	0.078
Ethylnitrosourea			1.40e+02 h			0.00061	0.000061	0.000023	0.02	0.012
Ethylphthalyl ethyl glycolate	3.00e+00 i					11000	1100	410	310000	23000
Express	8.00e-03 i					29	2.9	1.1	820	63
Fenamiphos	2.50e-04 i					0.91	0.091	0.034	26	2
Fluometuron	1.30e-02 i					47	4.7	1.8	1300	100
Fluoride	6.00e-02 i					220	22	8.1	6100	470
Fluoridone	8.00e-02 i					290	29	11	8200	630
Flurprimidol	2.00e-02 i					73	7.3	2.7	2000	160
Flutolanil	6.00e-02 i					220	22	8.1	6100	470
Fluvalinate	1.00e-02 i					37	3.7	1.4	1000	78
Folpet	1.00e-01 i		3.50e-03 i			24	2.4	0.9	820	490
Fomesafen			1.90e-01 i			0.45	0.045	0.017	15	9
Fonofos	2.00e-03 i					7.3	0.73	0.27	200	16
Formaldehyde	2.00e-01 i			4.55e-02 i		730	0.19	27	20000	1600
Formic Acid	2.00e+00 h					7300	730	270	200000	16000
Fosetyl-al	3.00e+00 i					11000	1100	410	310000	23000
Furan	1.00e-03 i					3.7	0.37	0.14	100	7.8
Furazolidone			3.80e+00 h			0.022	0.0022	0.00083	0.75	0.45
Furfural	3.00e-03 i	1.43e-02 a				11	5.2	0.41	310	23
Furium			5.00e+01 h			0.0017	0.00017	0.000063	0.057	0.034
Furmecyclox			3.00e-02 i			2.8	0.28	0.11	95	57
Glufosinate-ammonium	4.00e-04 i					1.5	0.15	0.054	41	3.1
Glycidaldehyde	4.00e-04 i	2.86e-04 h				1.5	0.1	0.054	41	3.1
Glyphosate	1.00e-01 i					370	37	14	10000	780
Haloxyfop-methyl	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Harmony	1.30e-02 i					47	4.7	1.8	1300	100
Heptachlor	5.00e-04 i		4.50e+00 i	4.55e+00 i	y	0.0031	0.0019	0.0007	0.64	0.38
Heptachlor epoxide	1.30e-05 i		9.10e+00 i	9.10e+00 i	y	0.0016	0.00094	0.00035	0.31	0.1
Hexabromobenzene	2.00e-03 i				y	1.2	0.73	0.27	200	16
Hexachlorobenzene	8.00e-04 i		1.60e+00 i	1.61e+00 i	y	0.0088	0.0053	0.002	1.8	1.1
Hexachlorobutadiene	2.00e-03 i		7.80e-02 i	7.70e-02 i	y	0.18	0.11	0.04	37	16
HCH (alpha)			6.30e+00 i	6.30e+00 i		0.014	0.0014	0.0005	0.45	0.27
HCH (beta)			1.80e+00 i	1.80e+00 i		0.047	0.0047	0.0018	1.6	0.95
HCH (gamma) Lindane	3.00e-04 i		1.30e+00 h			0.066	0.0066	0.0024	2.2	1.3
HCH-technical			1.80e+00 i	1.79e+00 i		0.047	0.0048	0.0018	1.6	0.95

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Hexachlorocyclopentadiene	7.00e-03 i	2.00e-05 h			y	0.015	0.0073	0.95	720	55
Hexachlorodibenzo-p-dioxin mixture (HxCDD)			6.20e+03 i	4.55e+03 i		0.000014	0.0000019	0.00000051	0.00046	0.00027
Hexachloroethane	1.00e-03 i		1.40e-02 i	1.40e-02 i	y	0.61	0.37	0.14	100	7.8
Hexachlorophene	3.00e-04 i					1.1	0.11	0.041	31	2.3
n-Hexane	6.00e-02 h	5.71e-02 i			y	35	21	8.1	6100	470
Hexazinone	3.30e-02 i					120	12	4.5	3400	260
Hydrazine, hydrazine sulfate			3.00e+00 i	1.72e+01 i		0.028	0.0005	0.0011	0.95	0.57
Hydrogen chloride		2.00e-03 i				7.3	0.73			
Hydrogen sulfide	3.00e-03 i	2.57e-04 i				11	0.094	0.41	310	23
p-Hydroquinone	4.00e-02 h					150	15	5.4	4100	310
Imazalil	1.30e-02 i					47	4.7	1.8	1300	100
Imazaquin	2.50e-01 i					910	91	34	26000	2000
Iprodione	4.00e-02 i					150	15	5.4	4100	310
Isobutanol	3.00e-01 i				y	180	110	41	31000	2300
Isophorone	2.00e-01 i		9.50e-04 i			90	9	3.3	3000	1600
Isopropalin	1.50e-02 i					55	5.5	2	1500	120
Isopropyl methyl phosphonic acid (IMPA)	1.00e-01 i					370	37	14	10000	780
Isoxaben	5.00e-02 i					180	18	6.8	5100	390
Kepone			1.80e+01 e			0.0047	0.00047	0.00018	0.16	0.095
Lactofen	2.00e-03 i					7.3	0.73	0.27	200	16
Lead (tetraethyl)	1.00e-07 i					0.00037	0.000037	0.000014	0.01	0.00078
Linuron	2.00e-03 i					7.3	0.73	0.27	200	16
Lithium	2.00e-02 e					73	7.3	2.7	2000	160
Londax	2.00e-01 i					730	73	27	20000	1600
Malathion	2.00e-02 i					73	7.3	2.7	2000	160
Maleic anhydride	1.00e-01 i					370	37	14	10000	780
Maleic hydrazide	5.00e-01 i					1800	180	68	51000	3900
Malononitrile	2.00e-05 h					0.073	0.0073	0.0027	2	0.16
Mancozeb	3.00e-02 h					110	11	4.1	3100	230
Maneb	5.00e-03 i					18	1.8	0.68	510	39
Manganese and compounds	1.00e-01 x	1.14e-04 i				370	0.042	14	10000	780
Mephosfolan	9.00e-05 h					0.33	0.033	0.012	9.2	0.7
Mepiquat	3.00e-02 i					110	11	4.1	3100	230
Mercury and compounds (methyl)	3.00e-04 i					1.1	0.11	0.041	31	2.3
Mercury and compounds (inorganic)	3.00e-04 h	8.57e-05 h				1.1	0.031	0.041	31	2.3
Merphos	3.00e-05 i					0.11	0.011	0.0041	3.1	0.23

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Merphos oxide	3.00e-05 i					0.11	0.011	0.0041	3.1	0.23
Metalaxyl	6.00e-02 i					220	22	8.1	6100	470
Methacrylonitri	1.00e-04 i	2.00e-04 a				0.37	0.073	0.014	10	0.78
Methamidopho	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Methanol	5.00e-01 i					1800	180	68	51000	3900
Methidathion	1.00e-03 i					3.7	0.37	0.14	100	7.8
Methomyl	2.50e-02 i					91	9.1	3.4	2600	200
Methoxychlor	5.00e-03 i					18	1.8	0.68	510	39
2-Methoxyethanol	4.00e-03 h	5.71e-03 i				15	2.1	0.54	410	31
2-Methoxyethanol acetate	2.00e-03 a					7.3	0.73	0.27	200	16
2-Methoxy-5-nitroaniline			4.60e-02 h			1.9	0.19	0.069	62	37
Methyl acetate	1.00e+00 h					3700	370	140	100000	7800
Methyl acrylate	3.00e-02 a					110	11	4.1	3100	230
2-Methylaniline (o-toluidine)			2.40e-01 h			0.35	0.035	0.013	12	7.1
2-Methylaniline hydrochloride			1.80e-01 h			0.47	0.047	0.018	16	9.5
Methyl chlorocarbonate	1.00e+00 x					3700	370	140	100000	7800
2-Methyl-4-chlorophenoxyacetic acid	5.00e-04 i					1.8	0.18	0.068	51	3.9
4-(2-Methyl-4-chlorophenoxy) butyric acid (MCPB)	1.00e-02 i					37	3.7	1.4	1000	78
2-(2-Methyl-4-chlorophenoxy) propionic acid	1.00e-03 i					3.7	0.37	0.14	100	7.8
2-(2-Methyl-1,4-chlorophenoxy) propionic acid (MCPP)	1.00e-03 i					3.7	0.37	0.14	100	7.8
Methylcyclohexane		8.57e-01 h				3100	310			
4,4'-Methylenediphenyl isocyanate		5.71e-06 h			y	0.0035	0.0021			
4,4'-Methylenebisbenzeneamine			2.50e-01 h			0.34	0.034	0.013	11	6.8
4,4'-Methylene bis(2-chloroaniline)	7.00e-04 h		1.30e-01 h	1.30e-01 h		0.66	0.066	0.024	22	5.5
4,4'-Methylene bis(N,N'-dimethyl)aniline			4.60e-02 i			1.9	0.19	0.069	62	37
Methylene bromide	1.00e-02 a				y	6.1	3.7	1.4	1000	78
Methylene chloride	6.00e-02 i	8.57e-01 h	7.50e-03 i	1.65e-03 i	y	5.4	5.2	0.42	380	230
Methyl ethyl ketone	5.00e-02 h	2.86e-01 i				180	100	6.8	5100	390
Methyl hydrazine			1.10e+00 h			0.077	0.0077	0.0029	2.6	1.5
Methyl isobutyl ketone	5.00e-02 h	2.29e-02 a				180	8.3	6.8	5100	390
Methyl methacrylate	8.00e-02 h					290	29	11	8200	630
2-Methyl-5-nitroaniline			3.30e-02 h			2.6	0.26	0.096	87	52
Methyl parathion	2.50e-04 i					0.91	0.091	0.034	26	2
2-Methylphenol (o-cresol)	5.00e-02 i					180	18	6.8	5100	390

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3-Methylphenol (m-cresol)	5.00e-02 i					180	18	6.8	5100	390
4-Methylphenol (p-cresol)	5.00e-03 h					18	1.8	0.68	510	39
Methyl styrene (mixture)	6.00e-03 a	1.14e-02 a			y	6	4.2	0.81	610	47
Methyl styrene (alpha)	7.00e-02 a				y	43	26	9.5	7200	550
Methyl tertbutyl ether (MTBE)	5.00e-03 e	1.43e-01 i				18	52	0.68	510	39
Metolachor (Dual)	1.50e-01 i					550	55	20	15000	1200
Metribuzin	2.50e-02 i					91	9.1	3.4	2600	200
Mirex	2.00e-04 i		1.80e+00 h			0.047	0.0047	0.0018	1.6	0.95
Molinate	2.00e-03 i					7.3	0.73	0.27	200	16
Molybdenum	5.00e-03 h					18	1.8	0.68	510	39
Monochloramine	1.00e-01 h					370	37	14	10000	780
Naled	2.00e-03 i					7.3	0.73	0.27	200	16
Napropamide	1.00e-01 i					370	37	14	10000	780
Nickel and compounds	2.00e-02 i					73	7.3	2.7	2000	160
Nickel refinery dust				8.40e-01 i			0.01			
Nickel subsulfide				1.70e+00 i			0.005			
Nitrapyrin	1.50e-03 x					5.5	0.55	0.2	150	12
Nitrate	1.60e+00 i					5800	580	220	160000	13000
Nitric Oxide	1.00e-01 i					370	37	14	10000	780
Nitrite	1.00e-01 i					370	37	14	10000	780
2-Nitroaniline	6.00e-05 h	5.71e-05 h				0.22	0.021	0.0081	6.1	0.47
3-Nitroaniline	3.00e-03 o					11	1.1	0.41	310	23
4-Nitroaniline	3.00e-03 o					11	1.1	0.41	310	23
Nitrobenzene	5.00e-04 i	5.71e-04 a			y	0.34	0.21	0.068	51	3.9
Nitrofurantoin	7.00e-02 h					260	26	9.5	7200	550
Nitrofurazone			1.50e+00 h	9.40e+00 h		0.057	0.00091	0.0021	1.9	1.1
Nitrogen dioxide	1.00e+00 i					3700	370	140	100000	7800
Nitroguanidine	1.00e-01 i					370	37	14	10000	780
4-Nitrophenol	6.20e-02 o					230	23	8.4	6300	480
2-Nitropropane		5.71e-03 i		9.40e+00 h		21	0.00091			
N-Nitrosodi-n-butylamine			5.40e+00 i	5.60e+00 i		0.016	0.0015	0.00058	0.53	0.32
N-Nitrosodiethanolamine			2.80e+00 i			0.03	0.003	0.0011	1	0.61
N-Nitrosodiethylamine			1.50e+02 i	1.51e+02 i		0.00057	0.000057	0.000021	0.019	0.011
N-Nitrosodimethylamine			5.10e+01 i	4.90e+01 i		0.0017	0.00017	0.000062	0.056	0.033
N-Nitrosodiphenylamine			4.90e-03 i			17	1.7	0.64	580	350
N-Nitroso di-n-propylamine			7.00e+00 i			0.012	0.0012	0.00045	0.41	0.24
N-Nitroso-N-methylethylamine			2.20e+01 i			0.0039	0.00039	0.00014	0.13	0.077
N-Nitrosopyrrolidine			2.10e+00 i	2.14e+00 i		0.041	0.004	0.0015	1.4	0.81

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m-Nitrotoluene	1.00e-02 h				y	6.1	3.7	1.4	1000	78
p-Nitrotoluene	1.00e-02 h				y	6.1	3.7	1.4	1000	78
Norflurazon	4.00e-02 i					150	15	5.4	4100	310
NuStar	7.00e-04 i					2.6	0.26	0.095	72	5.5
Octabromodiphenyl ether	3.00e-03 i					11	1.1	0.41	310	23
Octahydro-1357 tetranitro-1357-tetrazocine (HMX)	5.00e-02 i					180	18	6.8	5100	390
Octamethylpyrophosphoramide	2.00e-03 h					7.3	0.73	0.27	200	16
Oryzalin	5.00e-02 i					180	18	6.8	5100	390
Oxadiazon	5.00e-03 i					18	1.8	0.68	510	39
Oxamyl	2.50e-02 i					91	9.1	3.4	2600	200
Oxyfluorfen	3.00e-03 i					11	1.1	0.41	310	23
Paclobutrazol	1.30e-02 i					47	4.7	1.8	1300	100
Paraquat	4.50e-03 i					16	1.6	0.61	460	35
Parathion	6.00e-03 h					22	2.2	0.81	610	47
Pebulate	5.00e-02 h					180	18	6.8	5100	390
Pendimethalin	4.00e-02 i					150	15	5.4	4100	310
Pentabromo-6-chloro cyclohexane			2.30e-02 h			3.7	0.37	0.14	120	74
Pentabromodiphenyl ether	2.00e-03 i					7.3	0.73	0.27	200	16
Pentachlorobenzene	8.00e-04 i				y	0.49	0.29	0.11	82	6.3
Pentachloronitrobenzene	3.00e-03 i		2.60e-01 h		y	0.055	0.033	0.012	11	6.6
Pentachlorophenol	3.00e-02 i		1.20e-01 i			0.71	0.071	0.026	24	14
Permethrin	5.00e-02 i					180	18	6.8	5100	390
Phenmedipham	2.50e-01 i					910	91	34	26000	2000
Phenol	6.00e-01 i					2200	220	81	61000	4700
m-Phenylenediamine	6.00e-03 i					22	2.2	0.81	610	47
p-Phenylenediamine	1.90e-01 h					690	69	26	19000	1500
Phenylmercuric acetate	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Phenylphenol			1.94e-03 h			44	4.4	1.6	1500	880
Phorate	2.00e-04 h					0.73	0.073	0.027	20	1.6
Phosmet	2.00e-02 i					73	7.3	2.7	2000	160
Phosphine	3.00e-04 i	8.57e-06 h				1.1	0.0031	0.041	31	2.3
Phosphorus (white)	2.00e-05 i					0.073	0.0073	0.0027	2	0.16
p-Phthalic acid	1.00e+00 h					3700	370	140	100000	7800
Phthalic anhydride	2.00e+00 i					7300	730	270	200000	16000
Picloram	7.00e-02 i					260	26	9.5	7200	550
Pirimiphos-methyl	1.00e-02 i					37	3.7	1.4	1000	78
Polybrominated biphenyls	7.00e-06 h		8.90e+00 h			0.0096	0.00096	0.00035	0.32	0.055

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Polychlorinate iphenyls (PCBs)			7.70e+00 i			0.011	0.0011	0.00041	0.37	0.22
Polychlorinate rphenyls (PCTs)			4.50e+00 e			0.019	0.0019	0.0007	0.64	0.38
Polynuclear aromatic hydrocarbons										
Acenaphthene	6.00e-02 i					220	22	8.1	6100	470
Anthanthrene			2.31e+00 o	1.93e+00 o		0.037	0.0044	0.0014	1.2	0.74
Anthracene	3.00e-01 i					1100	110	41	31000	2300
Benz[a]anthracene			1.06e+00 o	8.85e-01 o		0.08	0.0096	0.003	2.7	1.6
Benzo[b]fluoranthene			8.96e-01 o	7.49e-01 o		0.095	0.011	0.0035	3.2	1.9
Benzo[j]fluoranthene			3.82e-01 o	3.19e-01 o		0.22	0.027	0.0083	7.5	4.5
Benzo[k]fluoranthene			3.88e-01 o	3.25e-01 o		0.22	0.026	0.0081	7.4	4.4
Benzo[ghi]perylene			1.55e-01 o	1.29e-01 o		0.55	0.066	0.02	18	11
Benzo[a]pyrene			7.30e+00 i	6.10e+00 h		0.012	0.0014	0.00043	0.39	0.23
Benzo[e]pyrene			5.11e-02 o	4.27e-02 o		1.7	0.2	0.062	56	33
Dibenz[ah]anthracene			8.10e+00 o	6.77e+00 o		0.011	0.0013	0.00039	0.35	0.21
Fluoranthene	4.00e-02 i					150	15	5.4	4100	310
Fluorene	4.00e-02 i					150	15	5.4	4100	310
Indeno[1,2,3-cd]pyrene			2.03e+00 o	1.70e+00 o		0.042	0.005	0.0016	1.4	0.84
Naphthalene	4.00e-02 h					150	15	5.4	4100	310
Phenanthrene	2.90e-02 o					110	11	3.9	3000	230
Pyrene	3.00e-02 i					110	11	4.1	3100	230
Prochloraz	9.00e-03 i		1.50e-01 i			0.57	0.057	0.021	19	11
Profluralin	6.00e-03 h					22	2.2	0.81	610	47
Prometon	1.50e-02 i					55	5.5	2	1500	120
Prometryn	4.00e-03 i					15	1.5	0.54	410	31
Pronamide	7.50e-02 i					270	27	10	7700	590
Propachlor	1.30e-02 i					47	4.7	1.8	1300	100
Propanil	5.00e-03 i					18	1.8	0.68	510	39
Propargite	2.00e-02 i					73	7.3	2.7	2000	160
Propargyl alcohol	2.00e-03 i					7.3	0.73	0.27	200	16
Propazine	2.00e-02 i					73	7.3	2.7	2000	160
Propham	2.00e-02 i					73	7.3	2.7	2000	160
Propiconazole	1.30e-02 i					47	4.7	1.8	1300	100
Propylene glycol	2.00e+01 h					73000	7300	2700	2000000	160000
Propylene glycol, monoethyl ether	7.00e-01 h					2600	260	95	72000	5500
Propylene glycol, monomethyl ether	7.00e-01 h	5.71e-01 i				2600	210	95	72000	5500
Propylene oxide		8.57e-03 i	2.40e-01 i	1.30e-02 i		0.35	0.66	0.013	12	7.1
Pursuit	2.50e-01 i					910	91	34	26000	2000
Pydrin	2.50e-02 i					91	9.1	3.4	2600	200

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EPA Region III Risk-Based Concentrations (for use with Region III technical guidance on selecting exposure routes and contaminants of concern by risk-based screening): October 26, 1992

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Pyridine	1.00e-03 i					3.7	0.37	0.14	100	7.8
Quinalphos	5.00e-04 i					1.8	0.18	0.068	51	3.9
Quinoline			1.20e+01 h			0.0071	0.00071	0.00026	0.24	0.14
RDX (Cyclonite)	3.00e-03 i		1.10e-01 i			0.77	0.077	0.029	26	15
Resmethrin	3.00e-02 i					110	11	4.1	3100	230
Ronnel	5.00e-02 h					180	18	6.8	5100	390
Rotenone	4.00e-03 i					15	1.5	0.54	410	31
Savey	2.50e-02 i					91	9.1	3.4	2600	200
Selenious Acid	5.00e-03 i					18	1.8	0.68	510	39
Selenium	5.00e-03 i					18	1.8	0.68	510	39
Selenourea	5.00e-03 h					18	1.8	0.68	510	39
Sethoxydim	9.00e-02 i					330	33	12	9200	700
Silver and compounds	5.00e-03 i					18	1.8	0.68	510	39
Simazine	2.00e-03 h		1.20e-01 h			0.71	0.071	0.026	24	14
Sodium azide	4.00e-03 i					15	1.5	0.54	410	31
Sodium diethyldithiocarbamate	3.00e-02 i		2.70e-01 h			0.32	0.032	0.012	11	6.3
Sodium fluoroacetate	2.00e-05 i					0.073	0.0073	0.0027	2	0.16
Sodium metavanadate	1.00e-03 h					3.7	0.37	0.14	100	7.8
Strontium, stable	6.00e-01 i					2200	220	81	61000	4700
Strychnine	3.00e-04 i					1.1	0.11	0.041	31	2.3
Styrene	2.00e-01 i		3.00e-02 o		y	0.47	0.28	0.11	95	57
Sythane	2.50e-02 i					91	9.1	3.4	2600	200
2,3,7,8-TCDD (dioxin)			1.50e+05 h	1.50e+05 h		0.00000057	0.000000057	0.000000021	0.000019	0.000011
Tebuthiuron	7.00e-02 i					260	26	9.5	7200	550
Temephos	2.00e-02 h					73	7.3	2.7	2000	160
Terbacil	1.30e-02 i					47	4.7	1.8	1300	100
Terbufos	2.50e-05 h					0.091	0.0091	0.0034	2.6	0.2
Terbutryn	1.00e-03 i					3.7	0.37	0.14	100	7.8
1,2,4,5-Tetrachlorobenzene	3.00e-04 i				y	0.18	0.11	0.041	31	2.3
1,1,1,2-Tetrachloroethane	3.00e-02 i		2.60e-02 i	2.59e-02 i	y	0.55	0.33	0.12	110	66
1,1,2,2-Tetrachloroethane			2.00e-01 i	2.03e-01 i	y	0.07	0.042	0.016	14	8.5
Tetrachloroethylene (PCE)	1.00e-02 i		5.20e-02 e	2.03e-03 e	y	1.4	3.7	0.061	55	33
2,3,4,6-Tetrachlorophenol	3.00e-02 i					110	11	4.1	3100	230
p,a,a,a-Tetrachlorotoluene			2.00e+01 h		y	0.00071	0.00043	0.00016	0.14	0.085
Tetrachlorovinphos	3.00e-02 i		2.40e-02 h			3.5	0.35	0.13	120	71
Tetraethyldithiopyrophosphate	5.00e-04 i					1.8	0.18	0.068	51	3.9
Tetrahydrofuran	2.00e-03 o					7.3	0.73	0.27	200	16
Thallic oxide	7.00e-05 h					0.26	0.026	0.0095	7.2	0.55

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Thallium acetate	9.00e-05 i					0.33	0.033	0.012	9.2	0.7
Thallium carbonate	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Thallium chloride	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Thallium nitrate	9.00e-05 i					0.33	0.033	0.012	9.2	0.7
Thallium selenite	9.00e-05 i					0.33	0.033	0.012	9.2	0.7
Thallium sulfate	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Thiobencarb	1.00e-02 i					37	3.7	1.4	1000	78
2-(Thiocyanomethylthio)-benzothiazole (TCMTB)	3.00e-02 y					110	11	4.1	3100	230
Thiofanox	3.00e-04 h					1.1	0.11	0.041	31	2.3
Thiophanate-methyl	8.00e-02 i					290	29	11	8200	630
Thiram	5.00e-03 i					18	1.8	0.68	510	39
Tin and compounds	6.00e-01 h					2200	220	81	61000	4700
Toluene	2.00e-01 i	1.14e-01 h			y	75	42	27	20000	1600
Toluene-2,4-diamine			3.20e+00 h			0.027	0.0027	0.00099	0.89	0.53
Toluene-2,5-diamine	6.00e-01 h					2200	220	81	61000	4700
Toluene-2,6-diamine	2.00e-01 h					730	73	27	20000	1600
Toxaphene			1.10e+00 i	1.12e+00 i		0.077	0.0076	0.0029	2.6	1.5
Tralomethrin	7.50e-03 i					27	2.7	1	770	59
Triallate	1.30e-02 i					47	4.7	1.8	1300	100
Triasulfuron	1.00e-02 i					37	3.7	1.4	1000	78
1,2,4-Tribromobenzene	5.00e-03 i				y	3	1.8	0.68	510	39
Tributyltin oxide (TBTO)	3.00e-05 i					0.11	0.011	0.0041	3.1	0.23
2,4,6-Trichloroaniline			3.40e-02 h			2.5	0.25	0.093	84	50
2,4,6-Trichloroaniline hydrochloride			2.90e-02 h			2.9	0.29	0.11	99	59
1,2,4-Trichlorobenzene	1.00e-02 i	2.57e-03 a			y	1.8	0.94	1.4	1000	78
1,1,1-Trichloroethane	9.00e-02 h	2.86e-01 a			y	130	100	12	9200	700
1,1,2-Trichloroethane	4.00e-03 i		5.70e-02 i	5.60e-02 i	y	0.25	0.15	0.055	50	30
Trichloroethylene (TCE)	6.00e-03 e		1.10e-02 y	6.00e-03 e	y	2.1	1.4	0.29	260	47
Trichlorofluoromethane	3.00e-01 i	2.00e-01 a			y	130	73	41	31000	2300
2,4,5-Trichlorophenol	1.00e-01 i					370	37	14	10000	780
2,4,6-Trichlorophenol			1.10e-02 i	1.09e-02 i		7.7	0.78	0.29	260	150
2,4,5-Trichlorophenoxyacetic Acid	1.00e-02 i					37	3.7	1.4	1000	78
2-(2,4,5-Trichlorophenoxy) propionic acid	8.00e-03 i					29	2.9	1.1	820	63
1,1,2-Trichloropropane	5.00e-03 i				y	3	1.8	0.68	510	39
1,2,3-Trichloropropane	6.00e-03 i				y	3.7	2.2	0.81	610	47
1,2,3-TCP as carcinogen			2.70e+00 e		y	0.0053	0.0032	0.0012	1.1	0.63

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
1,2,3-Trichloropropene	5.00e-03 h				y	3	1.8	0.68	510	39
1,1,2-Trichloro-1,2,2-trifluoroethane	3.00e+01 i	8.57e+00 h			y	5900	3100	4100	3100000	230000
Tridiphane	3.00e-03 i					11	1.1	0.41	310	23
Triethylamine		2.00e-03 i				7.3	0.73			
Trifluralin	7.50e-03 i		7.70e-03 i			11	1.1	0.41	370	59
Trimethyl phosphate			3.70e-02 h			2.3	0.23	0.085	77	46
1,3,5-Trinitrobenzene	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Trinitrophenylmethylnitramine	1.00e-02 h					37	3.7	1.4	1000	78
2,4,6-Trinitrotoluene	5.00e-04 i		3.00e-02 i			1.8	0.18	0.068	51	3.9
Uranium (soluble salts)	3.00e-03 i					11	1.1	0.41	310	23
Vanadium	7.00e-03 h					26	2.6	0.95	720	55
Vanadium pentoxide	9.00e-03 i					33	3.3	1.2	920	70
Vanadyl sulfate	2.00e-02 h					73	7.3	2.7	2000	160
Vanadium sulfate	2.00e-02 h					73	7.3	2.7	2000	160
Vernam	1.00e-03 i					3.7	0.37	0.14	100	7.8
Vinclozolin	2.50e-02 i					91	9.1	3.4	2600	200
Vinyl acetate	1.00e+00 h	5.71e-02 i				3700	21	140	100000	7800
Vinyl chloride			1.90e+00 h	3.00e-01 h	y	0.025	0.028	0.0017	1.5	0.9
Warfarin	3.00e-04 i					1.1	0.11	0.041	31	2.3
m-Xylene	2.00e+00 i	2.00e-01 y			y	140	73	270	200000	16000
o-Xylene	2.00e+00 i	2.00e-01 y			y	140	73	270	200000	16000
p-Xylene		8.57e-02 y			y	52	31			
Xylene (mixed)	2.00e+00 i				y	1200	730	270	200000	16000
Zinc	3.00e-01 i					1100	110	41	31000	2300
Zinc phosphide	3.00e-04 i					1.1	0.11	0.041	31	2.3
Zineb	5.00e-02 i					180	18	6.8	5100	390

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