OU1

2nd ESD

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

Watertown AMTL 5.4

June 7, 2001

Mr. Robert Chase
BRAC Environmental Coordinator
Department of the Army
United States Research Laboratory
Aberdeen Proving Ground, MD 21005-5066

Re: Explanation of Significant Differences for Charles River Park Area
Army Materials Technology Laboratory
Watertown, MA

Dear Mr. Chase:

This serves as a letter of concurrence for the Explanation of Significant Differences (ESD), dated May 2001, prepared by the Army to document changes made to the Soil and Groundwater Operable Unit (OU1) Record of Decision (ROD) signed by the Army and EPA-New England, with concurrence from the Massachusetts Department of Environmental Protection (DEP) in September 1996. This second OU1 ESD was prepared to meet the requirements of Section 117 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the National Contingency Plan and EPA guidance.

EPA-New England concurs with the use of soil cleanup standards described in the ESD for the protection of construction/utility workers. These cleanup standards apply to soils greater than two feet below ground surface across the entire parcel referred to as the Charles River Park parcel of the Army Materials Technology Laboratory (AMTL). Soil below a depth of two feet in the Charles River Park is a potential pathway only to construction/utility workers. All soils from the surface to a depth of two-feet below ground surface have been or will be excavated, thereby resulting in protection for recreational users of the area as well as ecological receptors. This approach is consistent with the September 1996 Record of Decision, which called for soil cleanup based on future use of the property.

EPA believes the changes to the OU1 remedy outlined in this ESD results in a remedy that is protective of human health and the environment, and is cost-effective.

EPA-New England looks forward to continuing to work with the Army and the DEP on the completion of the cleanup at the former Army Materials Technology Laboratory.

Sincerely,

for Patricia Meaney, Director
Office of Site Remediation and Restoration

cc: Craig Durrett/MA DEP
Randy Godfrey/Army Corps of Engineers
Mary Sanderson/EPA
John Beling/EPA
Meghan Cassidy/EPA

Watertown AMTL
5.4

ESD #2 (CHARLES RIVER PARK PARCEL) BRIEFING
SOIL AND GROUNDWATER OU
ARMY MATERIALS TECHNOLOGY LABORATORY
WATERTOWN, MA
JUNE 2001

This Explanation of Significant Difference (ESD) calls for the use of soil cleanup values for polynuclear aromatic hydrocarbons (PAHs) based on future exposure to construction/ utility workers within the Charles River Park parcel of the Army Materials Technology Laboratory (AMTL) in Watertown, Massachusetts. These cleanup standards have been and will be used during remediation (excavation) of soils greater than two-feet below the ground surface (bgs). These clean-up values are in addition to values already established in the 1996 Record of Decision (ROD) for surface soil.

This ESD applies to the Soil and Groundwater ROD signed in September 1996. This is the second ESD associated with the 1996 ROD. Cleanup standards designated in the September 1996 ROD were developed based on the intended future use of different areas (zones) of the installation. The original exposure assumptions for the entire site, were based on residential, commercial/industrial and open space end uses. For the Charles River Park parcel specifically, the end use is open space/recreational. The ROD called for off-site disposal/reuse of excavated soils. This ESD results in less excavation at depth, yet remains protective of the end use of the property.

BACKGROUND

AMTL was slated for closure in the Base Realignment and Closure Act of 1988. AMTL was listed on the NPL in May 1994. EPA and the Army entered into a Federal Facility Agreement in July 1995. AMTL officially closed in September 1995.

AMTL was established in 1816. Throughout the installation's history, AMTL's mission has included weapons development, production, and research. The original AMTL site encompassed 37 acres. Remediation of approximately 37 acres of the AMTL site was completed in 1997. These 37 acres were deleted from the NPL in November 1999 through the partial deletion process. The 37 acres have been transferred from Army ownership, have been redeveloped, and are now occupied by various businesses.

SUMMARY OF SELECTED REMEDY

In September 1996, the Army and EPA signed a ROD addressing the Soil and Groundwater Operable Unit (OU1). The Massachusetts Department of Environmental Protection (DEP) provided a letter stating their concurrence on the selected remedy.

Within the Charles River Park parcel, PAHs were the only contaminants of concern for human health identified in the ROD. There were also several areas identified within Charles River Park that were shown to present elevated risks to ecological receptors.

The original remedy for site soils, estimated to cost $5.7 million (entire site), includes:

- Excavation of soil exceeding established cleanup levels.
- Off-site disposal of excavated soil. The soil characterized as hazardous is being shipped to a RCRA Treatment, Storage, and Disposal Facility (TSDF). Non-hazardous soil will be recycled at an asphalt-batching plant or used as daily cover at a landfill.
- Confirmatory sampling of the excavation to ensure that all soil exceeding cleanup levels has been removed.
- Backfilling of excavation with clean fill.
- Institutional controls for those areas of the site that will not be remediated to allow for unrestricted future use.
- Five-year reviews.

During 1997, the Army began remedial activities within the Charles River Park parcel. Two areas within the approximate 11-acre Park parcel were remediated, but remedial work in the remainder of the Park was suspended because the excavation volumes required to achieve soil cleanup levels specified in the ROD were significantly larger than estimated resulting in a significant increase in estimated costs of the remedy for the Charles River Park parcel.

EXPLANATION OF SIGNIFICANT DIFFERENCE

During the first phase of remediation (on two other parcels), it was realized that in the non-residential zones, the more realistic and appropriate exposure scenario for soils at depths greater than one-foot below ground surface would be that of a construction/utility worker. Because the Baseline Risk Assessment did not include the construction worker exposure scenario, additional risk assessment work was performed. The construction worker exposure scenario recognizes that periodic maintenance and/or installation of subsurface utilities/structures will likely be required in the future.

The additional risk assessment work performed evaluated the carcinogenic risks and non-cancer hazard indices from exposure to PAHs in soil for a construction/utility worker. The construction worker exposure scenario was evaluated for soils using PAHs because the nature and extent of soil contamination encountered at AMTL, and in particular within the Charles River Park parcel, consisted primarily of PAHs. Additional risk-based PAH soil clean-up goals were then calculated. These supplemental PAH clean-up goals were incorporated into the remedy for use on two other AMTL parcels through a 1998 ESD. This second ESD incorporates the use of these same clean-up goals at the Charles River Park parcel.

This ESD (May 2001) allows for the use of the construction/maintenance worker PAH soil cleanup goals for sub-surface soils within the Charles River Park parcel. In the case of the Charles River Park parcel, the supplemental clean-up standards apply to soils at depths greater than two feet below ground surface (bgs). This is due to the fact that several areas within the Charles River Park require removal of the top two-feet of soil in order to address elevated ecological risks. Soils on the other two AMTL parcels did not present a risk to ecological receptors. Therefore, this ESD calls for use of the construction/maintenance worker clean-up values at depths greater than two-feet bgs. Based on this information, the remedy for the Charles River Park parcel will now involve excavation of the top two feet of soil across nearly the entire parcel. Soil below two-feet bgs will be sampled to determine if the construction/maintenance worker clean-up goals have bet met. If the soils below two-feet exceed these supplemental clean-up goals, additional excavation will occur. All excavated soils will be disposed of offsite at either an asphalt-batching plant or as daily cover at a landfill.

Applying the supplemental PAH soil clean-up goals for non-surface soils (below two feet bgs) in the Charles River Park parcel is both protective of human health and the environment, and is cost-effective. The Army estimates that the use of these clean-up goals represents a cost savings between $1 million and $1.5 million. Institutional controls reflect the future use of the property, and five-year reviews will be conducted to ensure protectiveness of the remedy.

The Commonwealth of Massachusetts, Department of Environmental Protection has provided a letter of concurrence regarding this ESD.

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

ARGEO PAUL CELLUCCI
Governor

JANE SWIFT
Lieutenant Governor

BOB DURAND
Secretary

LAUREN A. LISS
Commissioner

April 12, 2001

Robert Chase
U.S. Army Research Laboratory
Attn: AMSRL-CS-AP-RK
Aberdeen Proving Ground, MD 21005

RE: Explanation of Significant Differences
Charles River Park Area - Outdoor Soil Remediation Unit
Former Army Materials Technology Laboratory, Watertown, MA
RTN# 3-0455

Dear Mr. Chase:

The Department of Environmental Protection (DEP) has reviewed the Explanation of Significant Differences (ESD) for the above-referenced site. The document presents an explanation of a modification to the selected remedy for soils remediation described in the Proposed Plan and Record of Decision (ROD; September 1996) for the AMTL in Watertown, Massachusetts. The modification described in the ESD pertains to the Charles River Park portion of AMTL bounded between North Beacon Street to the north and the Charles River to the south and consisting of approximately 11 acres.

The future use of the Charles River Park is open space/public access use. The ESD proposes applying the same construction worker exposure scenario to subsurface soils in the Charles River Park that was applied to other areas covered in the ROD that are zoned for open space/public access use. This ESD incorporates the previously established construction worker scenario cleanup goals for polyaromatic hydrocarbons (PAHs) for non-surface soils (at or greater than two feet below ground surface) in the Charles River Park.

DEP has reviewed and considered the proposed modifications and believes them to be protective of human health and the environment. We concur with the Army's proposal, as outlined in the Explanation of Significant Difference for the Charles River Park Area Outdoor Soil Remediation Unit of the AMTL Site. This parcel will also have an institutional control placed on it.

DEP thanks you in advance for your continued cooperation. Should you have any questions or comments, please do not hesitate to contact Craig Durrett, Project Manager, at (617) 348-4039.

Very truly yours,

Deirdre C. Menoyo

Deirdre C. Menoyo
Assistant Commissioner
Bureau of Waste Site Cleanup

DM/csd
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cc: Meghan Cassidy, USEPA
Randy Godfrey, USACE
Mark Boyle, Watertown Planning Director
Anne Malewicz, DEP-BWSC
Craig Durrett, DEP-BWSC
Watertown RAB Cochairs

OU1
2nd ESD

EXPLANATION OF SIGNIFICANT DIFFERENCES
CHARLES RIVER PARK AREA
OUTDOOR SOIL REMEDIATION UNIT
ARMY MATERIALS TECHNOLOGY LABORATORY
WATERTOWN, MASSACHUSETTS

14 MAY 2001

Introduction

This document provides members of the community with an explanation of a modification that was made to the selected remedy for soils remediation described in the Proposed Plan and Record of Decision (ROD; September 1996) for the Army Materials Technology Laboratory (MTL) in Watertown, Massachusetts. The modification described below pertains only to the approximate 11 acre Charles River Park portion of MTL bounded between North Beacon Street to the north and the Charles River to the south.

After summarizing the history of the MTL facility, this document reviews the selected remedial action alternative described in the Record of Decision (ROD) and provides details about the modification to the selected remedy. This process of documenting differences in the remedial action is known as an Explanation of Significant Differences (ESD).

Legal Authority

This ESD document (May 2001) has been written to meet the requirements in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 117 (c), the National Contingency Plan (NCP), and U.S. Environmental Protection Agency (USEPA) guidance which states that if the lead agency determines that differences in the remedial action significantly change, but do not fundamentally alter the remedy selected in the ROD with respect to scope, performance, or cost, the lead agency shall publish an explanation of the significant differences between the remedial action being undertaken and the remedial action set forth in the ROD and the reasons such changes are being made. Under CERCLA and the MTL Federal Facility Agreement, the Department of the Army is the lead agency for the soil remediation at MTL; and the USEPA and the Commonwealth of Massachusetts Department of Environmental Protection (MADEP) are oversight agencies.

This ESD will become part of the Administrative Record for MTL. The Administrative Record is a collection of documents that form the basis for the selection of an environmental response action. Both the ESD and the Administrative Record are available for public review at the Watertown Free Public Library.

History of MTL

The Watertown Arsenal was established in 1816 by President James Madison and was originally used for the storage, cleaning, repair, and issue of small arms and ordnance supplies. During the 1800s, this mission was expanded to include ammunition and pyrotechnics development; materials testing and experimentation with paint, lubricants, and cartridges; and development/testing of breech-loading steel guns and cartridges for field and siege guns. The mission, staff, and facilities continued to expand until after World War II, at which time the facility encompassed 131 acres, including 53 buildings and structures, and employed approximately 10,000 people. In 1960, the U.S. Army's first materials research nuclear reactor was completed at the Watertown Arsenal, and it was used actively in molecular and atomic structure research activities until 1970 when it was deactivated.

Arms development and testing continued at the facility until an operational phase-down was initiated in 1967. At the time of the phase-down, much of the Watertown Arsenal property was transferred to the General Services Administration (GSA), and in 1968 approximately 55 acres were sold to the Town of Watertown and subsequently used for the construction of apartment buildings, the Arsenal Mall, and a public park and playground. Of the approximately 47.5 acres retained by the Army, approximately 37 acres (36.5 acres) became the Army Materials and Mechanics Research Center (AMMRC), which was designated a historical landmark by the American Society of Metals in 1983. The facility discontinued operations on 29 September 1995. The remaining acreage (approximately 11 acres) comprised the area known as the Charles River Park where the Army granted a permanent right-of-way to the Metropolitan District Commission (MDC).

In 1988, the site was placed on the Base Realignment and Closure (BRAC) list. The site was also first listed in January 1987 by MADEP as a Location-To-Be-Investigated (LTBI). Investigations relating to facility closure started in 1988. These investigations were performed in accordance with the Massachusetts Contingency Plan (MCP) with MADEP oversight. On 30 May 1994 the site was placed on the National Priorities List (NPL) under CERCLA, commonly known as the Superfund Program. As a result, there has been a division of regulatory authority between MADEP and the USEPA (Region I). The USEPA, is the regulatory authority over the Soil and Groundwater Operable Unit for the facility, to which this ESD is applicable.

In July 1992, the U.S. Army Corps of Engineers (USACE) began decommissioning the research reactor and the depleted uranium facilities. The reactor building (Building 100) and Building 241 were completely removed and an extensive cleanup of depleted uranium was completed in Buildings 37, 39, 43, 97, 292, 311, 312, and 313. The bulk of the cleanup was performed by the summer of 1993, and the radiological decontamination and decommissioning of MTL was completed in 1995. The U.S. Nuclear Regulatory Commission terminated the reactor license in September 1993, and the remaining facility licenses were terminated in July 1997.

Roy F. Weston (WESTON) performed the site investigation work under contract to the USACE. The *Phase 2 Remedial Investigation Report* (WESTON, 1994) defined the nature and extent of contamination at the site. The *Baseline Risk Assessment of Human Health Effects* (presented in the *Phase 2 Remedial Investigation Report, May 1994*) indicated that some of the detected soil contaminant concentrations posed a risk to human health. The information developed in these documents is summarized in the next section of this ESD document (Remedial Investigation Results) and was used to develop the ROD.

In September 1996, the ROD was signed for the remediation of soil throughout the site. The remedy, excavation and off-site disposal/reuse, was selected for the twenty (20) soil areas identified for remediation. Remedial activities at these identified areas on the approximate 37 acres were performed between November 1996 and November 1997.

The remedial work in the Charles River Park Parcel commenced in May 1997. This work was performed by WESTON under contract to the USACE. Two areas (Areas N and O) were remediated but remedial work in Areas M, P and Q was suspended in August 1997 because the excavation volumes required to achieve soil cleanup levels specified in the ROD were significantly larger than estimated based on the particular disposal requirements. The remedial work was summarized by WESTON in a report titled *Draft Charles River Park Summary of Work Completed Between May 1997 and September 1997* (WESTON, 1999). Based on the findings in 1997, a decision was made to re-evaluate remedial alternatives to assess whether another less costly but equally protective remedy is available.

An ESD was signed by the Army, with concurrence from EPA and MADEP, in January 1998. The January 1998 ESD established an additional set of clean-up values for PAHs in certain areas within the approximate 37-acre parcel at depths of greater than two feet below ground surface. In August 1998 the Army transferred 7.42 acres to the Town of Watertown and sold 29.42 acres to the Watertown Arsenal Development Corporation (WADC). These two parcels were deleted from the NPL on November 22, 1999.

Remedial Investigation Results

The *Phase 2 Remedial Investigation Report* (WESTON, 1994) defined the nature and extent of contamination at the site. The remedial investigation for the Soil and Groundwater Operable Unit consisted of surface soil sampling, as well as the advancement of soil borings and the installation of monitoring wells for subsurface soil and groundwater sample collection. Soil sample analysis results indicated that polycyclic aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyl compounds (PCBs) were present on the site, primarily in shallow soils. In the Charles River Park portion of the Outdoor Soil Remediation Unit, PAHs were the only contaminants of concern. The *Baseline Risk Assessment of Human Health Effects* (presented in the *Phase 2 Remedial Investigation Report*; *May 1994*) indicated that some of the detected soil contaminant concentrations posed a risk to human health. There were several areas identified within the Charles River Park that were shown to present elevated risks to ecological receptors.

Due to this risk, clean-up alternatives to remediate the soils were developed in the *Feasibility Study* (FS; WESTON, January 1996a) and were detailed in the Proposed Plan (WESTON, April 1996b). The Proposed Plan put forth the Army's preferred site-wide alternative (on-site chemical oxidation) and a contingency remedy (excavation and off-site reuse/disposal).

Following issuance of the Proposed Plan, in-situ (via soil borings) Toxicity Characteristic Leaching Procedure (TCLP) sampling and analysis was conducted at several locations throughout the site. Analytical results indicated TCLP toxicity (and therefore hazardous waste classification) at only one of the locations sampled (based on TCLP results for lead). (This location was not in the Charles River Park.) Therefore, the original costs for the excavation and off-site reuse/disposal alternative detailed in the FS were adjusted downward to account for a lesser volume of TCLP hazardous soil than originally anticipated.

Due to this adjustment, the total cost for excavation and off-site reuse/disposal became equivalent to the cost for the preferred alternative documented in the Proposed Plan (on-site chemical oxidation). In addition, the implementation duration of the excavation and off-site reuse/disposal alternative was found to be approximately one year shorter than for on-site chemical oxidation. Therefore, between issuance of the Proposed Plan (April 1996) and the ROD (September 1996), the U.S. Army's preferred remedial alternative for the soils was revised from on-site chemical oxidation to excavation and off-site reuse/disposal. Both the USEPA and the MADEP concurred with the selected remedy detailed in the September 1996 ROD, and it was further supported by the former Watertown Arsenal Reuse Committee and the Restoration Advisory Board (RAB).

Summary of the Selected Remedy for Soil Remediation

The U.S. Army's selected remedy for soils at MTL consists of the excavation and off-site reuse of the soils for beneficial use as landfill daily cover or as aggregate mix for asphalt batching. Based on the RI results, areas of MTL were identified for excavation. Excavation work at all of the areas on the approximate 37-acre parcel and 2 of the 5 areas in the approximate 11-acre River Park was completed. Soil samples were collected from the excavations for laboratory analysis to confirm that identified soils above the risk-based clean-up goals were removed. The excavations were backfilled using clean borrow material obtained from an off-site source. Site restoration and transportation/disposal activities were completed in December 1997.

Soil clean-up goals were established for different zones at MTL based on the intended future use of particular areas of MTL. The clean-up goals were developed to provide for a future mixed use of the site, including residential, commercial, and public access scenarios.

The Need for an ESD

Soil clean-up goals for organic contaminants were developed in the *Baseline Risk Assessment of Human Health Effects* that was contained in the *Phase 2 Remedial Investigation Report for the Army Materials Technology Laboratory* dated May 1994 and the *Supplemental Risk Assessment for Polycyclic Aromatic Hydrocarbons in Soil Samples* dated May 28, 1997. These Risk Assessments were performed in accordance with USEPA guidance documents and are consistent with the requirements of both CERCLA and the NCP. Guidance documents from the MADEP were also considered during Risk Assessment performance. The 1996 ROD specified the clean-up goals to be applied in the Charles River Park to allow for public access. The ROD also called for the removal of a limited amount of soil at certain locations in order to reduce the overall site *risk posed to ecological receptors. Excavation in these limited areas was to be to two feet below* ground surface (bgs).

During remediation excavation activities at the approximate 37-acre parcel, it was realized that in the commercial and open space zones the most appropriate clean-up values for soils at a depth greater than one foot bgs would be those developed for a construction worker scenario. In order to address this pathway and incorporate it into the remedy, an ESD was developed in January 1998. The January 1998 ESD established additional cleanup goals for protection of construction workers. The 1998 ESD provided that the new construction worker clean-up values be applied to only certain locations within the approximate 37-acre parcel.

Public Access exposures are typically limited to interaction with the surface soil and possible minimal intrusive activity in the soil to a maximum depth of one foot (e.g., from incidental digging by children, dirt bikes, picnicking). The construction worker exposure scenario recognizes that periodic maintenance and/or installation of subsurface utilities/structures may be required in the Park area in the future. The construction worker exposure scenario mimics the potential need to perform periodic subsurface work. In addition, soil within the top two feet bgs is considered to be an area that may pose a risk to ecological receptors.

Both the Commander's Park (open space zone of the approximate 37-acre parcel) and the Charles River Park are slated for public access use in the future. Since the future use of the Charles River Park is the same as the Commander's Park, it is appropriate to apply the same construction worker exposure scenario to certain soils in the Charles River Park. Therefore, a second ESD is necessary to allow the construction worker clean-up goals to be applied, as appropriate, to the Charles River Park.

Description of the Significant Difference from the ROD

The difference from the ROD, as explained in this second ESD (May 2001), is that less soil will be excavated at depth in Charles River Park. This change still results in a remedy that is protective of human health, based on the future reuse of the property for passive recreation, and the environment.

Additional risk assessment work was performed by WESTON (1997) to estimate the carcinogenic risks and non-cancer hazard indices from exposure to PAHs in soil for a construction worker who may be performing building construction, excavation and/or other similar types of activities in Zones 1, 2, and 4 at MTL. The construction worker exposure scenario was evaluated for soils using PAHs because the nature and extent of soil contamination encountered at MTL primarily consisted of PAHs. These are the same contaminants found in Charles River Park. Revised risk-based soil clean-up goals were developed for the PAHs of concern based on the construction worker exposure scenario. A Final Report dated 28 May 1997 detailing the results of this additional risk assessment work is attached to this document. This report was reviewed again in November 1999 (in the *Draft Final Feasibility Study Addendum Report for the Charles River Park Parcel*, Foster Wheeler, 1999) for consistency with current risk assessment practices and found to be suitable for application to the soils at Charles River Park.

In summary, the risk assessment for the construction worker scenario concluded that the PAH concentrations observed during the remedial activities exhibited an acceptable total cancer risk of less than $1x10^{-5}$ and an acceptable hazard index less than 0.1. Revised risk-based PAH soil clean-up goals were then calculated using a target carcinogenic risk level of $1x10^{-5}$ and a target hazard index for non-cancer health effects of 0.1. Table 1 presents the revised PAH soil clean-up goals for the construction worker exposure scenario; these clean-up goals can also be found in Table 16 of the attached risk assessment report.

TABLE 1
Revised PAH Cleanup Goals

PAH	Units	Construction Worker Clean-up Goal for Subsurface Soil
Benzo(a)anthracene	mg/kg	1,760
Benzo(b)fluoranthene	mg/kg	1,760
Benzo(k)fluoranthene	mg/kg	17,600
Benzo(a)pyrene	mg/kg	154
Indeno(1,2,3-cd)pyrene	mg/kg	1,760
Chrysene	mg/kg	176,000
Dibenzo(a,h)anthracene	mg/kg	154

It is noted that the construction worker exposure scenario considers only soil at depths greater than one foot below ground surface (bgs). However, at Charles River Park the upper two feet of soil are being excavated to achieve ecologically based cleanup goals developed for the Outdoor Soils FS Unit. Therefore, the modified remedy at Charles River Park includes:

- Excavation of areas with contaminated soils that are above soil cleanup goals to a minimum depth of 2 feet, with excavation beyond two feet in depth only in areas where cleanup goals provided in Table 1 (above) of this document have not been met;
- Confirmatory soil sampling within excavations after contaminated soil removal;
- Off-site landfill disposal or reuse of the excavated soil;
- Placement of a marker fabric within the excavation;
- Backfilling of clean soils into the excavation;
- Installation of stormwater best management practices (BMPs); and
- Implementation of institutional controls.

From September through November 2000, Foster Wheeler Environmental Corporation (Foster Wheeler) under a contract to the USACE excavated soils throughout the Park parcel (Areas P and Q) according to the modified remedy described above except at the following areas:

- Areas previously excavated and remediated by WESTON in 1997;
- Designated trees deemed significant by the MDC and Waterown Conservation Commission where pre-excavation sampling confirmed that ROD cleanup goals were met in soils within the tree dripline; and
- The strip of land approximately 10 feet wide adjacent to the Charles River where additional testing was performed in Fall 2000 and Winter 2001 to delineate specific areas exceeding ROD cleanup goals for remediation in Spring 2001.

Confirmatory sampling results from the 2000 remediation program demonstrated that the soils underlying the 2 feet excavation depths not only met the revised construction worker clean up goals presented in Table 1 above, but the majority of the samples met the ROD cleanup goals. These results were presented to the RAB in November 2000.

The remainder of the Charles River Park (Area M and the Riverbank Segments in Areas M, P and Q) will be remediated in Spring and Summer 2001.

Justification for this Alternative

The U.S. Army believes that revising the PAH soil clean-up goals for non-surface soils (below 2 feet bgs) in Charles River Park is both protective of human health and the environment and is cost-effective. It is believed that soils below one foot bgs are typically not accessed by the commercial worker, periodic trespasser or the public access user, and will typically be accessed only by a construction worker performing utility work or foundation work.

Furthermore, institutional controls will be put in place that will restrict certain uses of the property, require that any soils excavated below two feet be handled according to a specific soil handling protocol, and require maintenance of a two-foot cover of clean soil. A Memorandum of Agreement will be developed as a component of the remedial action to itemize any property and use restrictions that will be established until formalized into the final institutional controls mechanism (i.e., a Grant of Environmental Restrictions).

By implementing the revised PAH soil clean-up goals in Charles River Park, the U.S. Army estimates that it has passed on a cost savings between $1 million and $1.5 million to the taxpayer, while at the same time, providing a permanent solution that is protective of human health and the environment.

Support Agency Comments

The USEPA and the MADEP have worked with the U.S. Army in developing the changes described in this May 2001 ESD document, and comments received on the draft ESD have been incorporated into this document. Both MADEP and USEPA concur with this second ESD, and this information will be made part of the administrative record file.

Affirmation of the Statutory Determinations

The proposed change to the selected remedy described in the ROD continues to satisfy all of the statutory requirements of CERCLA and the NCP. Considering the new information that has been developed and the proposed change to the selected remedy, the U.S. Army, together with the USEPA and the MADEP, believes that the remedy remains protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to this remedial action, and is cost effective. In addition, the revised remedy will provide a permanent remedy for the site.

Public Participation

As stated earlier in this document, no formal public comment period is required for documentation of an ESD. In the interest of community awareness, the U.S. Army presented this information at public meetings convened by the RAB in December 1999 and April 2000 and provided this document to the RAB's consultant for review.

For More Information

If you have questions about the ESD for MTL please contact:

Randy N. Godfrey, Project Manager
U.S. Army Corps of Engineers, New England District
696 Virginia Road
Concord, Massachusetts 01742-2751
(978) 318-8717

References

ESD, 1998. Explanation of Significant Difference, Outdoor Soil Remediation, Army Materials Technology Laboratory, Watertown, Massachusetts, prepared by USACE, 12 January 1998.

Foster Wheeler, 1999. Work Plan for Feasibility Studies, CERCLA Requirements at Army Research Laboratory - Watertown (ARL-WT), Watertown, Massachusetts, prepared by Foster Wheeler Environmental Corporation, August 1999.

Foster Wheeler, 2000. Draft Final Feasibility Study Addendum Report for the Charles River Park Parcel of the Army Research Laboratory – Watertown, Watertown, Massachusetts prepared by Foster Wheeler Environmental Corporation, February 2000.

ROD, 1996. Final Record of Decision, Soils and Groundwater Operable Unit, Army Materials Technology Laboratory, Watertown, Massachusetts, prepared by Roy F. Weston, Inc., September 1996.

WESTON, 1994. Phase 2 Remedial Investigation Report, Army Materials Technology Laboratory, Watertown, Massachusetts, prepared by Roy F. Weston, Inc., May 1994.

WESTON, 1996a. Feasibility Study (Outdoor) for Base Closure, Remedial Investigation/Feasibility Study, Army Materials Technology Laboratory, Watertown, Massachusetts, prepared by Roy F. Weston, Inc., January 1996.

WESTON, 1996b. Final Proposed Plan, Army Materials Technology Laboratory, Watertown, Massachusetts, prepared by Roy F. Weston, Inc., April 1996.

WESTON, 1997. Supplemental Risk Assessment for Polycyclic Aromatic Hydrocarbons in Soil Samples, prepared by Roy F. Weston, Inc., May 28, 1997.

WESTON, 1999. Draft Charles River Park, Summary of Work Completed Between May 1997 and September 1997, Outdoor Soil Removal, Army Materials Technology Laboratory, Watertown, Massachusetts, prepared by Roy F. Weston, Inc., 21 May 1999.

Declaration

For the foregoing reasons, by my signature below, I approve the issuance of this Explanation of Significant Difference for the Army Materials Technology Laboratory in Watertown, Massachusetts.

By:

Robert E. Chase
BRAC Environmental Coordinator

30 May 2001
Date

ATTACHMENT

SUPPLEMENTAL RISK ASSESSMENT FOR POLYCYCLIC AROMATIC HYDROCARBONS IN SOIL SAMPLES

MAY 28, 1997

SUPPLEMENTAL RISK ASSESSMENT FOR POLYCYCLIC AROMATIC HYDROCARBONS IN SOIL SAMPLES ARMY MATERIALS TECHNOLOGY LABORATORY WATERTOWN, MASSACHUSETTS

7 JANUARY 1998

OBJECTIVES AND BACKGROUND

During the Outdoor Soil Removal at the Army Materials Technology Laboratory in Watertown, Massachusetts, it came to the attention of the U.S. Army that an appropriate risk exposure scenario for soils in the commercial zones, at depths greater than 1 foot below ground surface (bgs), would be that of a construction worker. Because the Baseline Risk Assessment did not include the construction worker exposure scenario, additional risk assessment work was performed relative to polycyclic aromatic hydrocarbon (PAH) contamination. Previous reports have characterized risks and calculated cleanup goals for various contaminants at the site (EPA, 1994, 1996) and portions of the site have already been remedied based on soil cleanup goals calculated in these previous reports.

Roy F. Weston, Inc. (WESTON) was tasked with estimating carcinogenic risks and noncancer hazard indices from exposure to these PAHs by a construction worker who may be performing building construction, excavation, or other similar types of activities in the Record of Decision (ROD). Additionally, WESTON was directed to develop risk-based soil cleanup goals for PAHs based on a construction worker scenario. This report summarizes the methods and results from these tasks.

METHODS

General guidance for performing the risk assessment was obtained from EPA (1989). Default exposure assumptions were obtained from EPA (1991).

Data Evaluation

Data from one soil sample was used for estimating risks in this report. Concentrations of PAHs in this sample, taken from Zone 2 at a depth of 2 feet bgs, appeared elevated for the site. These PAH concentrations are listed in the table below:

PAH	Concentration (mg/kg)
Benzo[a]anthracene	13
Benzo[b]fluoranthene	13
Benzo[k]fluoranthene	5.7
Benzo[a]pyrene	13
Indeno[1,2,3-cd]pyrene	7

These concentrations were used as the exposure point soil concentrations for the respective PAH in the carcinogenic and noncancer dose calculations. (Two other carcinogenic PAHs and 8 noncarcinogenic PAHs were added to this list for the evaluation of risk-based concentrations, as discussed later in this report.)

Exposure Algorithms and Assumptions

Exposure algorithms for the construction worker were developed based on some assumptions from the original risk assessment (EPA, 1993), and supplemented with those recommended by EPA Region I (EPA, 1997a). Three pathways of soil exposure were evaluated: soil ingestion; dust inhalation; and dermal contact with soil. The dose equations and exposure assumptions used are shown in attached Tables 1, 2, and 3, respectively. At the request of EPA Region I (EPA, 1997a), WESTON evaluated two exposure frequencies: 18 days/year, as originally assumed in the risk assessment performed in 1993 and considered as an average value; and, 125 days/year, assumed by WESTON as a high end estimate for potential exposure of the construction worker. Carcinogenic doses were estimated using a duration of 70 years (25,550 days). Noncancer doses were averaged over a 1 year duration (365 days).

Toxicity Criteria

The oral carcinogenic risks and cleanup goals calculated for all PAHs in the original risk assessment reports (EPA, 1993, 1996) were based on the oral slope factor for benzo[a]pyrene (BaP). The current oral slope factor for BaP is 7.3E+00 $(mg/kg\text{-}day)^{-1}$ (EPA, 1997b). The toxicity equivalency factor (TEF) approach (EPA, 1993b) was used to estimate the oral cancer potency for ingestion of PAHs in soil in this report. The TEF values for each of the 7 carcinogenic PAH congeners are:

PAH	Toxicity Equivalency Factor
Benzo[a]anthracene	0.1
Benzo[b]fluoranthene	0.1
Benzo[k]fluoranthene	0.01
Benzo[a]pyrene	1.0
Indeno[1,2,3-cd]pyrene	0.1
Chrysene	0.001
Dibenzo[a,h]anthracene	1.0

Inhalation slope factors for BaP and dibenzo[a,h]anthracene were recommended by EPA Region I as 1.8E+00 $(mg/kg\text{-}d)^{-1}$ (EPA, 1997C). All other PAHs were not evaluated for carcinogenic inhalation risk in this report.

The oral reference dose (RfD) for pyrene (3E-02 mg/kg-day; EPA, 1997c) was assigned for noncancer health effects for all PAHs. Inhalation RfDs for the PAHs were not available and, therefore, dust inhalation hazard quotients were not calculated.

Gastrointestinal (GI) absorption of all PAHs was assumed to be 100% at the recommendation of EPA Region I (EPA, 1997c). Therefore, dermal CSFs and dermal RfDs for PAHs were directly extrapolated from their oral values.

Risk Characterization

Carcinogenic risks for the 5 PAHs detected in the soil sample were calculated by multiplying the carcinogenic exposure dose for each exposure pathway by the route-specific CSF. Noncancer hazard quotients for each of these detected PAHs were estimated by dividing the noncancer doses for each pathway by the route-specific RfD. Total cancer risks and noncancer health effects were obtained by summing the respective risks or hazard quotients of all chemicals through all pathways. Risks were calculated for exposures of 18 days per year (original exposure frequency) and 125 days per year (high-end estimate).

Risk-Based Soil Cleanup Goals

Risk-based soil cleanup goals (mg/kg) were calculated for both the potential carcinogenic and noncancer effects of the PAHs. The carcinogenic PAHs were included in the calculations for the noncancer risk-based concentrations. Tables 4, 5, and 6 present the algorithms used to calculate soil cleanup goals for the soil ingestion, dust inhalation and dermal contact pathways, respectively, at 18 days per year or 125 days per year of exposure. The algorithms are rearrangements of the risk characterization equations described above. The target risk level for carcinogens used in these equations was 1E-05, and the target hazard quotient for noncancer health effects was 0.1 (EPA, 1997d).

Table 7 shows the algorithm used to estimate the cleanup goals for each carcinogenic PAH across all soil exposure pathways. This equation was obtained from Rosenblatt et al. (1982).

RESULTS AND DISCUSSION

Table 8 shows that for 18 days per year of exposure, none of the PAHs had individual cancer risks greater than 1E-06. Total risk for all chemicals and all pathways of exposure was 9.6E-07. BaP was the major contributor of all the sampled PAHs. The exposure pathway with the highest risk was soil ingestion at 5.8E-07. Dermal contact with soil was 3.5E-07. These risk numbers were based on only one soil sample, as discussed above. The total hazard index for all chemicals and pathways for 18 days per year of exposure was 0.001, well below the benchmark of 1 (Table 9).

Total cancer risk for 125 days per year of exposure was 6.6E-06 (Table 10). Soil ingestion and dermal contact were the highest at 4E-06 and 2.5E-06, respectively. BaP showed the highest risk at 5.3E-06. Total hazard index for all pathways at 125 days per year exposure frequency was 0.007 (Table 11).

Tables 12 and 13 present the risk-based cleanup levels for carcinogenic risk (1E-05) and noncancer health effects (0.1 hazard quotient), respectively, for each chemical and pathway based on an exposure frequency of 18 days per year. Tables 14 and 15 show cleanup goals based on an exposure frequency of 125 days per year. The total cleanup goal for each chemical based on the combined exposure pathways is shown in the last column of each table. The lowest cleanup goals at either exposure frequency were for BaP and dibenzo[a,h]anthracene based on their carcinogenic effects. For 18 days per year of exposure, the carcinogenic cleanup goal was 154 mg/kg, while for 125 days per year, the carcinogenic cleanup goals were 22.1 mg/kg. The cleanup goals calculated for all pathways can be used to compare with future PAH levels detected in soil samples from various zones at the AMTL site.

For comparison purposes, Table 16 presents a summary of the carcinogenic and noncancer cleanup goals for the PAHs based on 18 days per year of exposure to the construction worker. With the exceptions of benzo[k]fluoranthene and chrysene, cleanup goals were lowest for the carcinogenic PAHs based on their carcinogenic potential. Of course, all those PAHs without carcinogenic potential would be based on their noncancer cleanup goals.

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TABLE 1

Model for Calculating PAH Intakes Through Soil Ingestion

Construction Worker, AMTL Site

$$\text{Intake from Soil ingestion (mg/kg-d)} = \frac{(CS)\,(IR)\,(CF)\,(EF)\,(ED)}{(BW)\,(AT)}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	Soil ingestion rate (mg/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions for Construction Worker:

CS	=	Ash sample value for the PAHs (mg/kg)
IR	=	480 mg/day (EPA, 1991)
EF	=	18 or 125 days/year
ED	=	1 year
BW	=	70 kg for the adult construction worker (EPA, 1991)
AT	=	25,550 days for carcinogenic effects; 365 days for noncancer effects

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TABLE 2

Model for Calculating PAH Intakes Through Dust Inhalation

Construction Worker, AMTL Site

$$\text{Intake through dust inhalation (mg/kg-d)} = \frac{(CS)\,(PM_{10})\,(CF)\,(IR)\,(EF)\,(ED)}{(BW)\,(AT)}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
PM_{10}	=	Particulate matter less than 10 mocrons in diameter (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
IR	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions for Construction Worker:

CS	=	Ash sample value for the PAHs (mg/kg)
PM_{10}	=	5 mg/m^3 (EPA, 1994)
IR	=	20 m^3/day (EPA, 1991)
EF	=	18 or 125 days/year
ED	=	1 year
BW	=	70 kg for the adult construction worker (EPA, 1991)
AT	=	25,550 days for carcinogenic effects; 365 days for noncancer effects.

TABLE 3

Model for Calculating PAH Intakes Through Dermal Contact with Soil

Construction Worker, AMTL Site

$$\text{Intake through dermal contact (mg/kg-d)} = \frac{(CS)(CF)(SA)(AF)(ABS)(EF)(ED)}{(BW)(AT)}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions for Construction Worker:

CS	=	Ash sample value for PAHs (mg/kg)
SA	=	2270 cm^2/day (hands, forearms (EPA, 1992)
AF	=	1 mg/cm2 (EPA, 1992)
ABS	=	0.13 (EPA Region I; EPA, 1997a)
EF	=	18 or 125 days/year
BW	=	70kg for the adult construction worker (EPA, 1991)
AT	=	25,550 days for carcinogenic effects; 365 days for noncancer effects

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TABLE 4

Carcinogenic and Noncancer Risk-Based Soil Concentrations of PAHs Through Soil Ingestion

Construction Worker, AMTL Site

$$\underset{(mg/kg)}{RBSC_{ing}} = \frac{(TR)\,(BW)\,(AT)}{(TC_{ing})\,(IR)\,(CF)\,(EF)\,(ED)}$$

Where:

$RBSC_{ing}$	=	Risk-based soil concentration of PAH through ingstion (mg/kg).
TR	=	Target risk level
BW	=	Body weight (kg)
AT	=	Averaging time (days)
TC_{ing}	=	Toxicity criterion: CSF $(mg/kg\text{-}d)^{-1}$ or 1/RfD $(mg/kg\text{-}d)^{-1}$
IR	=	Ingestion rate (mg/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)

Exposure Assumptions for Construction Worker:

TR	=	Cancer risk of 1E-05, or hazard quotient of 0.1
BW	=	70 kg for the adult construction worker (EPA, 1991)
AT	=	25,550 days for carcinogenic effects; 365 days for noncancer effects
TC_{ing}	=	PAH-specific oral CSF or inverse of oral RfD
IR	=	480 mg/day (EPA, 1991)
EF	=	18 or 125 days/year
ED	=	1 year

TABLE 5

Carcinogenic Risk-Based Soil Concentrations of PAHs Through Dust Inhalation

Construction Worker, AMTL Site

$$\underset{(mg/kg)}{RBSC_{inh}} = \frac{(TR)\,(BW)\,(AT)}{(CSF_{inh})\,(PM_{10})\,(IR)\,(CF)\,(EF)\,(ED)}$$

Where:

$RBSC_{inh}$	=	Risk-based soil concentration of PAH (mg/kg)
TR	=	Target risk level
BW	=	Body weight (kg)
AT	=	Averaging time (days)
CSF_{inh}	=	Inhalation cancer slope factor $(mg/kg\text{-}d)^{-1}$
PM_{10}	=	Particulate matter, 10 micron or less in diameter.
CF	=	Conversion factor (1E-06 kg/mg)
IR	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)

Exposure Assumptions for Construction Worker:

TR	=	Cancer risk of 1E-05
BW	=	70 kg for the adult construction worker (EPA, 1991)
AT	=	25,550 days for carcinogenic effects
CSF_i	=	PAH-specific inhalation slope factor (see text)
PM_{10}	=	5 mg/m^3 (EPA, 1994)
IR	=	20 m^3/day (EPA, 1991)
EF	=	18 or 125 days/year
ED	=	1 year

TABLE 6

Carcinogenic and Noncancer Risk-Based Soil Concentrations of PAHs Through Dermal Contact

Construction Worker, AMTL Site

$$\underset{(mg/kg)}{RBSC_{der}} = \frac{(TR)\,(BW)\,(AT)}{(TC_{der})\,(SA)\,(AF)\,(CF)\,(ABS)\,(EF)\,(ED)}$$

Where:

$RBSC_{der}$	=	Risk-based soil concentration of PAH (mg/kg)
TR	=	Target risk level
BW	=	Body weight (kg)
AT	=	Averaging time (days)
TC_{der}	=	Toxicity criterion: CSF $(mg/kg\text{-}d)^{-1}$ or 1/RfD $(mg/kgnd)^{-1}$
SA	=	Exposed skin surface area per day (cm^2/day)
ABS	=	Dermal absorption factor (unitless)
AF	=	Adherence factor (mg/cm^2)
CF	=	Conversion factor (1E-06 kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)

Exposure Assumptions for Construction Worker:

TR	=	1E-05 or Hazard quotient of 0.1
BW	=	70 kg for adult construction worker (EPA, 1991)
AT	=	25,550 days for carcinogenic effects; 365 days for noncancer effects
TC_{der}	=	PAH specific dermal CSF or inverse of dermal RfD
SA	=	2270 cm^2/day (represents surface area of adult hands, forearms; EPA, 1992)
ABS	=	0.13 (EPA Region I; EPA, 1987a)
AF	=	1.0 mg/cm^2 (EPA, 1992)
EF	=	18 or 125 days/year
ED	=	1 year

Table 7

Method of Calculating A Meduim-Specific Chemical Cleanup Level Through all Exposure Pathways

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$$\underset{(mg/kg)}{RBSC_{all}} = \frac{1}{[RBSC_{ing}]^{-1} + [RBSC_{inh}]^{-1} + [RBSC_{der}]^{-1}}$$

Where:

$RBSC_{all}$	=	Chemical-specific target risk-based soil cleanup level for all exposure pathways evaluated.
$RBSC_{ing}$	=	Chemical-specific target risk-based soil cleanup level through the ingestion pathway.
$RBSC_{inh}$	=	Chemical-specific target risk-based soil cleanup level through the dust inhalation pathway
$RBSC_{der}$	=	Chemical-specific target risk-based soil cleanup level through through the dermal contact pathway.

[a]Rosenblatt et. al. (1982)

Table 8

Potential Carcinogenic Risk For 18 Days/year Exposure
Construction Worker, AMTL Site

Based on Data for sample I.D. # ASH-B2-18-0				
Chemical	Incidental Ingestion of Soil	Dermal Contact With Soil	Inhalation of Windblown Dust	Carcinogenic Risk
Benzo(a)anthracene	4.6E-08	2.8E-08	NTV	7.4E-08
Benzo(b)fluoranthene	4.6E-08	2.8E-08	NTV	7.4E-08
Benzo(k)fluoranthene	2.0E-09	1.2E-09	NTV	3.2E-09
Benzo(a)pyrene	4.6E-07	2.8E-07	2.4E-08	7.6E-07
Indeno(1,2,3-cd)pyrene	2.5E-08	1.5E-08	NTV	4.0E-08
Total Carcinogenic Risk	5.8E-07	3.5E-07	2.4E-08	9.6E-07

NTV = No toxicity value available.

Table 9

Hazard Quotients and Indices For 18 Days/year Exposure
Construction Worker, AMTL Site

Based on Data for sample I.D. # ASH-B2-18-0				
Chemical	Incidental Ingestion of Soil	Dermal Contact With Soil	Inhalation of Windblown Dust	Total Hazard Index
Benzo(a)anthracene	1.5E-04	9.0E-05	NTV	2.4E-04
Benzo(b)fluoranthene	1.5E-04	9.0E-05	NTV	2.4E-04
Benzo(k)fluoranthene	6.4E-05	4.0E-05	NTV	1.0E-04
Benzo(a)pyrene	1.5E-04	9.0E-05	NTV	2.4E-04
Indeno(1,2,3-cd)pyrene	7.9E-05	4.9E-05	NTV	1.3E-04
Total Hazard Index	5.8E-04	3.6E-04	NA	9.4E-04

NA = Not applicable.
NTV = No toxicity value available.

Table 10

Potential Carcinogenic Risk For 125 Days/year Exposure
Construction Worker, AMTL Site

Based on Data for sample I.D. # ASH-B2-18-0				
Chemical	Incidental Ingestion of Soil	Dermal Contact With Soil	Inhalation of Windblown Dust	Carcinogenic Risk
Benzo(a)anthracene	3.2E-07	2.0E-07	NTV	5.1E-07
Benzo(b)fluoranthene	3.2E-07	2.0E-07	NTV	5.1E-07
Benzo(k)fluoranthene	1.4E-08	8.6E-09	NTV	2.3E-08
Benzo(a)pyrene	3.2E-06	2.0E-06	1.6E-07	5.3E-06
Indeno(1,2,3-cd)pyrene	1.7E-07	1.1E-07	NTV	2.8E-07
Total Carcinogenic Risk	4.0E-06	2.5E-06	1.6E-07	6.6E-06

NTV = No toxicity value available.

Table 11

Hazard Quotients and Indices For 125 Days/year Exposure
Construction Worker, AMTL

Based on Data for sample I.D. # ASH-B2-18-0				
Chemical	Incidental Ingestion of Soil	Dermal Contact With Soil	Inhalation of Windblown Dust	Total Hazard Index
Benzo(a)anthracene	1.0E-03	6.3E-04	NTV	1.6E-03
Benzo(b)fluoranthene	1.0E-03	6.3E-04	NTV	1.6E-03
Benzo(k)fluoranthene	4.5E-04	2.7E-04	NTV	7.2E-04
Benzo(a)pyrene	1.0E-03	6.3E-04	NTV	1.6E-03
Indeno(1,2,3-cd)pyrene	5.5E-04	3.4E-04	NTV	8.8E-04
Total Hazard Index	4.0E-03	2.5E-03	NA	6.5E-03

NA = Not applicable.
NTV = No toxicity value available.

Table 12

Carcinogenic Risk Based Clean-Up Goals[a] For 18 Days/year Exposure Construction Worker, AMTL Site

Chemical	Incidental Ingestion of Soil (mg/kg)	Dermal Contact With Soil (mg/kg)	Inhalation of Windblown Dust (mg/kg)	All Pathways [b] (mg/kg)
Acenaphthene	NC	NC	NC	NC
Acenaphthylene	NC	NC	NC	NC
Anthracene	NC	NC	NC	NC
Benzo(a)anthracene	2.84E+03	4.61E+03	NTV	1.76E+03
Benzo(b)fluoranthene	2.84E+03	4.61E+03	NTV	1.76E+03
Benzo(g,h,i)pyrene	NC	NC	NC	NC
Benzo(k)fluoranthene	2.84E+04	4.61E+04	NTV	1.76E+04
Benzo(a)pyrene	2.84E+02	4.61E+02	1.23E+03	1.54E+02
Chrysene	2.84E+05	4.61E+05	NTV	1.76E+05
Dibenzo(a,h)anthracene	2.84E+02	4.61E+02	1.23E+03	1.54E+02
Fluoranthene	NC	NC	NC	NC
Fluorene	NC	NC	NC	NC
Indeno(1,2,3-cd)pyrene	2.84E+03	4.61E+03	NTV	1.76E+03
Naphthalene	NC	NC	NC	NC
Pyrene	NC	NC	NC	NC

[a] Target carcinogenic risk = 1E-05.

[b] According to method of Rosenblatt et al (1982). See text and Table 7.

NC = Not classified as a carcinogen through this exposure route by EPA (1997b).

NTV = No toxicity value available.

Table 13

Noncancer Risk Based Clean-Up Goals[a] For 18 Days/year Exposure
Construction Worker, AMTL Site

Chemical	Incidental Ingestion of Soil (mg/kg)	Dermal Contact With Soil (mg/kg)	Inhalation of Windblown Dust (mg/kg)	All Pathways [b] (mg/kg)
Acenaphthene	8.87E+03	1.44E+04	NA	5.49E+03
Acenaphthylene	8.87E+03	1.44E+04	NA	5.49E+03
Anthracene	8.87E+03	1.44E+04	NA	5.49E+03
Benzo(a)anthracene	8.87E+03	1.44E+04	NA	5.49E+03
Benzo(b)fluoranthene	8.87E+03	1.44E+04	NA	5.49E+03
Benzo(g,h,i)pyrene	8.87E+03	1.44E+04	NA	5.49E+03
Benzo(k)fluoranthene	8.87E+03	1.44E+04	NA	5.49E+03
Benzo(a)pyrene	8.87E+03	1.44E+04	NA	5.49E+03
Chrysene	8.87E+03	1.44E+04	NA	5.49E+03
Dibenzo(a,h)anthracene	8.87E+03	1.44E+04	NA	5.49E+03
Fluoranthene	8.87E+03	1.44E+04	NA	5.49E+03
Fluorene	8.87E+03	1.44E+04	NA	5.49E+03
Indeno(1,2,3-cd)pyrene	8.87E+03	1.44E+04	NA	5.49E+03
Naphthalene	8.87E+03	1.44E+04	NA	5.49E+03
Pyrene	8.87E+03	1.44E+04	NA	5.49E+03

[a] Target hazard quotient = 0.1.

[b] According to method of Rosenblatt et al (1982). See text and Table 7.

NA = Not applicable.

Table 14

Carcinogenic Risk Based Clean-Up Goals[a] For 125 Days/year Exposure
Construction Worker, AMTL Site

Chemical	Incidental Ingestion of Soil (mg/kg)	Dermal Contact With Soil (mg/kg)	Inhalation of Windblown Dust (mg/kg)	All Pathways[b] (mg/kg)
Acenaphthene	NC	NC	NC	NC
Acenaphthylene	NC	NC	NC	NC
Anthracene	NC	NC	NC	NC
Benzo(a)anthracene	4.08E+02	6.64E+02	NTV	2.53E+02
Benzo(b)fluoranthene	4.08E+02	6.64E+02	NTV	2.53E+02
Benzo(g,h,i)pyrene	NC	NC	NC	NC
Benzo(k)fluoranthene	4.08E+03	6.64E+03	NTV	2.53E+03
Benzo(a)pyrene	4.08E+01	6.64E+01	1.77E+02	2.21E+01
Chrysene	4.08E+04	6.64E+04	NTV	2.53E+04
Dibenzo(a,h)anthracene	4.08E+01	6.64E+01	1.77E+02	2.21E+01
Fluoranthene	NC	NC	NC	NC
Fluorene	NC	NC	NC	NC
Indeno(1,2,3-cd)pyrene	4.08E+02	6.64E+02	NTV	2.53E+02
Naphthalene	NC	NC	NC	NC
Pyrene	NC	NC	NC	NC

[a] Target carcinogenic risk = 1E-05.

[b] According to method of Rosenblatt et al (1982). See text and Table 7.

NC = Not classified as a carcinogen through this exposure route by EPA (1997b).

NTV = No toxicity value available.

Table 15

Noncancer Risk Based Clean-Up Goals[a] For 125 Days/year Exposure
Construction Worker, AMTL Site

Chemical	Incidental Ingestion of Soil (mg/kg)	Dermal Contact With Soil (mg/kg)	Inhalation of Windblown Dust (mg/kg)	All Pathways[b] (mg/kg)
Acenaphthene	1.28E+03	2.08E+03	NA	7.91E+02
Acenaphthylene	1.28E+03	2.08E+03	NA	7.91E+02
Anthracene	1.28E+03	2.08E+03	NA	7.91E+02
Benzo(a)anthracene	1.28E+03	2.08E+03	NA	7.91E+02
Benzo(b)fluoranthene	1.28E+03	2.08E+03	NA	7.91E+02
Benzo(g,h,i)pyrene	1.28E+03	2.08E+03	NA	7.91E+02
Benzo(k)fluoranthene	1.28E+03	2.08E+03	NA	7.91E+02
Benzo(a)pyrene	1.28E+03	2.08E+03	NA	7.91E+02
Chrysene	1.28E+03	2.08E+03	NA	7.91E+02
Dibenzo(a,h)anthracene	1.28E+03	2.08E+03	NA	7.91E+02
Fluoranthene	1.28E+03	2.08E+03	NA	7.91E+02
Fluorene	1.28E+03	2.08E+03	NA	7.91E+02
Indeno(1,2,3-cd)pyrene	1.28E+03	2.08E+03	NA	7.91E+02
Naphthalene	1.28E+03	2.08E+03	NA	7.91E+02
Pyrene	1.28E+03	2.08E+03	NA	7.91E+02

[a] Target hazard quotient = 0.1.

[b] According to method of Rosenblatt et al (1982). See text and Table 7.

NA = Not applicable.

Table 16

Summary of Carcinogenic and Noncancer Risk Based Clean-Up Goals
For 18 Days/year Exposure
Construction Worker, AMTL Site

Chemical	Carcinogenic Risk Goal[a] (All Pathways)	Noncancer Hazard Index Goal[b] (All Pathways)
Acenaphthene	NC	5.49E+03
Acenaphthylene	NC	5.49E+03
Anthracene	NC	5.49E+03
Benzo(a)anthracene	1.76E+03	5.49E+03
Benzo(b)fluoranthene	1.76E+03	5.49E+03
Benzo(g,h,i)pyrene	NC	5.49E+03
Benzo(k)fluoranthene	1.76E+04	5.49E+03
Benzo(a)pyrene	1.54E+02	5.49E+03
Chrysene	1.76E+05	5.49E+03
Dibenzo(a,h)anthracene	1.54E+02	5.49E+03
Fluoranthene	NC	5.49E+03
Fluorene	NC	5.49E+03
Indeno(1,2,3-cd)pyrene	1.76E+03	5.49E+03
Naphthalene	NC	5.49E+03
Pyrene	NC	5.49E+03

[a]Target carcinogenic risk = 1E-05.
[b]Target hazard quotient = 0.1
NC = Not classified as a carcinogen through any exposure pathway.