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EPA CONTRACT NUMBER 68-W9-0034
FOSTER WHEELER ENVIRONMENTAL CORPORATION

New Bedford
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DRAFT FINAL
NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY
ADDENDUM
NEW BEDFORD, MASSACHUSETTS
DECEMBER, 1997

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DECEMBER, 1997

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ACRONYMS

AAL	Allowable Ambient Level
ACGIH	American Congress of Government Industrial Hygienists
Aerovox/GE	Aerovox/General Electric
ANSI	American National Standards Institute
ARARs	Applicable or Relevant and Appropriate Requirements
As	Arsenic
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
Battelle	Pacific Northwest Laboratories Division of Battelle Memorial Institute
BH	Back Half
CAA	Clean Air Act
CAD	Contained Aquatic Disposal
CAPP	Chemical Accident Prevention Provisions
CARB	California Air Resources Board
CBD	Commerce Business Daily
CBs	Chlorobenzenes
Cd	Cadmium
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIMS	Chemical Ionization Mass Spectrometer
CLP	EPA Contract Laboratory Program
CMR	Code of Massachusetts Regulations
Cr	Chromium
CRTI	Commodore Remediation Technology, Inc.
Cu	Copper
CWA	Clean Water Act
DEP	Massachusetts Department of Environmental Protection
DEQE	Massachusetts Department of Environmental Quality and Engineering
dioxins	polychlorinated dibenzo-p-dioxins
DIPA	Diisopropylamine
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPH	Massachusetts Department of Public Health
DRE	Destruction and Removal Efficiency
Ebasco	Ebasco Services Incorporated
ECD	Electron Capture Detector
Eco Logic	ELI Eco Logic International, Inc.
EFS	Engineering Feasibility Study
EMTs	Emergency Medical Technicians
EOX	Extractable Organic Halide
EPA	U.S. Environmental Protection Agency

EPA-OEME	EPA Region I Office of Environmental Measurement and Evaluation
EPRI	Electric Power Research Institute
ESAT	Environmental Services Assistance Team
ESD	Explanation of Significant Difference
FDA	Food and Drug Administration
Foster Wheeler	Foster Wheeler Environmental Corporation
FPEO	Floodplain Protection Executive Order
FS	Feasibility Study
furans	polychlorinated dibenzofurans
GAC	Granular Activated Carbon
GC	Gas Chromatograph
GCL	Geocomposite Clay Layer
GCMS	Gas Chromatograph/Mass Spectrometer
Geosafe	Geosafe Corporation
GMCL	General Motors of Canada Limited
gpm	gallon per minute
GRI	General Refining Inc. Superfund site
HASP	Health & Safety Plan
Hazmat	Hazardous Materials
HAZOP	Hazardous Operations Plan
HCl	Hydrochloric Acid
HDPE	High Density Polyethylene
HEPA	High Efficiency Particulate Air
Hg	Mercury
HpCDD	Heptachlorodibenzo-p-dioxin
HpCDF	Heptachlorodibenzofuran
HxCDD	Hexachlorodibenzo-p-dioxin
HxCDF	Hexachlorodibenzofuran
IDS	Indirect Desorption System
Ionics RCC	Ionics Resources Conservation Company
ISV	In-Situ Vitrification
LDR	Land Disposal Restriction
LEL	Lower Explosive Limit
LPG	liquid propane gas
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
MEA	monoethanolamine
MEPA	Massachusetts Environmental Protection Act
Micro-GC	Micro Gas Chromatograph
ml	milliliters
MOE	Ministry of Environment
NAAQS	National Ambient Air Quality Standards
NaOH	Sodium hydroxide

NCP	National Contingency Plan
NEMA	National Equipment Manufacturers Association
NEPA	National Environmental Protection Act
NFPA	National Fire Protection Agency
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPW	Net Present Worth
O&M	Operation and Maintenance
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
OSHA	Occupational Safety and Heath Administration
P&IDs	Piping and Instrumentation Diagrams
PAH	Polynuclear Aromatic Hydrocarbon
Pb	Lead
PCBs	polychlorinated biphenyls
PCDD	polychlorinated dibenzo(p)dioxins (dioxin)
PCDF	polychlorinated dibenzofurans (furan)
PD	Power Density
PE	Performance Evaluation Sample
PeCDD	Pentachlorodibenzo-p-dioxin
PeCDF	Pentachlorodibenzofuran
PFDs	Process Flow Diagrams
PICs	Products of Incomplete Combustion
POTW	Publicly Owned Treatment Works
PPE	Personal Protection Equipment
PRP	Potentially Responsible Party
QC	Quality Control
RAMP	Remedial Action Master Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Difference
S/S	Solidification/Stabilization
SAIC	Science Applications International Corporation
SAL	Scrubber Acid Leg
SARA	Superfund Amendment and Reauthorization Act
SBV	Sequential Batch Vaporizer
SFS	Supplemental Feasibility Study
SIM	Selected Ion Monitoring
SMEAL	Scrubber Monoethanolamine Leg
SOP	Standard Operating Procedure
SSO	Site Safety Officer

SVOC	Semivolatile Organic Compound
SWACL	Scrubber Weak Acid Caustic Leg
SWOL	Scrubber Wash Oil Leg
TBC	To Be Considered
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
TCLP	Toxicity Characteristic Leaching Procedure
TCs	Thermocouples
TDC	Total Direct Cost
TDS/TSS	Total dissolved solids/Total suspended solids
TEF	Toxicity Equivalence Factors
TEL	Threshold Exposure Level
TEQ	2,3,7,8-TCDD toxicity equivalent
TIC	Total Indirect Cost
TMDL	Total Maximum Daily Load
TPD	Ton per day
TRC	TRC Environmental Corporation
TRM	Thermal Reduction Mill
TSCA	Toxic Substances Control Act
Units	
cm	centimeter
cm^3	cubic centimeter (ml or cc)
in.	inch
in^2	square inch
ft	feet
ft^2	square feet
g	grams
kg	kilogram
kW	kilowatt
kWhr	kilowatt hour
lb	pound
mg	milligrams
mg/kg	milligrams/kilogram (equivalent to ppm)
ml	milliliter
mm or mil	millimeter
MM	million
ng	nanogram
pg/gm	picograms per gram
pg/hr	picograms per hour
ppb	parts per billion
ppm	parts per million (equivalent to mg/kg)
ppmv	parts per million (volume/volume)
psi	pounds per square inch
psig	pounds per square inch guage

ug/dsm3	micrograms per dry standard cubic meter
ug/g	micrograms per gram (ppm)
ug/L	micrograms per liter (ppb)
USACE	U.S. Army Corps of Engineers
UV/Ox	Ultraviolet Oxidation
wac	Water Quality Criteria
WESP	Wet Electrostatic Precipitator
WPEO	Wetlands Protection Executive Order
WWT	Waste Water Treatment
Zn	Zinc

1. INTRODUCTION

1. INTRODUCTION

This Feasibility Study (FS) Addendum report was developed to evaluate potential remedial alternatives for the highly contaminated sediments from the Hot Spot area of the New Bedford Harbor Superfund site. These sediments have been removed from the harbor and are currently stored on-site in a lined facility while U.S. Environmental Protection Agency (EPA), the State, and members of the local community Forum Group evaluate potential cleanup alternatives. The Hot Spot sediments have high levels of Polychlorinated Biphenyls (PCBs) and to a lesser degree, are contaminated with polynuclear aromatic hydrocarbons (PAHs) and several heavy metals including cadmium, copper, chromium and lead.

The report is an addendum to the Hot Spot Feasibility Study (Ebasco, 1989) and was prepared by Foster Wheeler Environmental Corporation (Foster Wheeler) for the EPA under Contract No. 68-W9-0034. The results of this report will be used by EPA in conjunction with the documents contained in the New Bedford Harbor Administrative Record, and input received from the state and the local community to evaluate a remedy for the Hot Spot sediments.

This FS Addendum is focused on identifying and evaluating remedial alternatives to address the Hot Spot sediments removed from the harbor. Since this document is an addendum to the 1989 Hot Spot FS it relies on the FS for some of the traditional components of a Feasibility Study, including site characterization, risk assessment, etc. This document is based on the assumption that the overall site cleanup (non-Hot Spot related) will proceed on a separate but parallel track. The remedial alternatives presented in this document were designed to be free standing and are for the most part, not linked to, or dependent upon, overall site cleanup activities.

This FS Addendum includes a full range of remedial alternatives utilizing several remedial approaches including no further action, treatment or containment. The range includes several remedial alternatives that would be conducted entirely at the site, several that include a mix of on-site and off-site activities, and two remedial alternatives which have significant off-site treatment or disposal components. This document utilizes the results of site specific treatability studies recently conducted on the Hot Spot sediment to assess the performance of several alternative treatment technologies.

This section of the report includes a background discussion on the Hot Spot sediments, a general description of the overall New Bedford Harbor site and activities conducted to date, a summary of site investigations performed and an overview of the contents of this report.

1.1 Background Information

A Record of Decision (ROD) for the Hot Spot portion of the New Bedford Harbor site was issued by EPA in April 1990. It called for dredging about 5 acres of sediments with PCB levels in excess of 4,000 parts per million (ppm). The ROD also specified treatment of the contaminated sediments through on-site incineration. However, due to a congressionally supported reversal in public support for the incineration remedy at about the time the incinerator was being mobilized, EPA and the Massachusetts Department of Environmental Protection (DEP) agreed to terminate the incineration contract and pursue treatability studies for alternative treatment technologies.

Removal of the Hot Spot sediments from the harbor was completed via hydraulic dredging during the 1994 and 1995 construction seasons. In 1995, EPA prepared an Explanation of Significant Difference (ESD) (EPA, 1995) to address interim storage of the Hot Spot sediments in the lined facility while the treatability studies and Feasibility Study Addendum were being completed. This interim storage facility is a double-lined Confined Disposal Facility (CDF) constructed along the New Bedford shoreline at the end of Sawyer Street. The CDF was originally constructed in 1988 as part of a pilot dredging and disposal study conducted by EPA and the U.S. Army Corps of Engineers (USACE). The facility was upgraded in 1993 to include a double High Density Polyethylene (HDPE) liner system in support of the initial Hot Spot cleanup activities. Specifically, the CDF was planned to be used as a staging cell for the PCB contaminated sediments following dredging, and prior to incineration.

The treatability study process began in early 1994 with a series of presentations by potential treatment vendors to the community Forum group that was established for the site. Three general types of PCB treatment methods were selected by the Forum group for further treatability studies including: (1) solidification/stabilization (S/S); (2) contaminant destruction; and, (3) contaminant separation and destruction. The difference between the latter two treatment methods recognizes that many treatment technologies require the PCBs to be separated from the wet Hot Spot sediment before the technology will work.

The treatability studies were designed to support the Forum group's goal of finding a viable and safe non-incineration treatment technology to destroy and/or immobilize the toxic constituents (primarily PCBs and metals) of the Hot Spot sediment and to maximize community involvement. The specific objectives of the treatability studies included the following:

- Provide a waste profile for the Hot Spot sediments.
- Evaluate and quantify the effectiveness of each treatment technology to meet the project goals.
- Quantify the disposition of materials to support a mass balance evaluation.
- Produce data of sufficient quality such that a risk assessment of treatment residuals, if required, can be conducted for each technology.
- Evaluate the viability of the treatment technologies/processes to be scaled-up to full scale operations including the overall development time-frame and estimated full scale treatment costs.
- Characterize the operational hazards associated with full scale implementation of the technologies.
- Evaluate the technologies' performance against the nine detailed evaluation criteria contained in the National Contingency Plan (NCP), including the ability of the treatment technologies to reduce the toxicity, mobility, and volume of the hazardous constituents.

The contaminant destruction and contaminant separation and destruction technologies were tested at pilot scale. The tests were conducted on-site during the summer and fall of 1996 and included: (i) solvent extraction and solid phase dechlorination with a combination of Ionics, Resources Conservation Company (Ionics RCC) and Commodore Remediation Technology Incorporated (CRTI) technologies; (ii) Vitrification with the Geosafe Corporation (Geosafe) process; and, (iii) thermal desorption and gas phase chemical destruction with the ELI Eco Logic International, Inc. process operated in a teaming

agreement with Science Applications International Corporation (SAIC/Eco Logic). The treatment methods and a brief process description is included in Table 1-1.

Table 1-1
Pilot Scale Treatability Study Program

Treatability Study No.	Vendor(s)	Treatment Method	Process Description
1	Ionics RCC/CRTI	Separation Destruction	Solvent Extraction Solid Phase Dechlorination
2	Geosafe	Destruction	Vitrification
3	SAIC/Eco Logic	Separation Destruction	Thermal Desorption Gas Phase Reduction

In summary, the results of the treatability study program demonstrated that the contaminant destruction, and contaminant separation and destruction processes were effective to varying degrees. The studies also demonstrated that material handling was more difficult than originally envisioned by each of the treatment technology vendors.

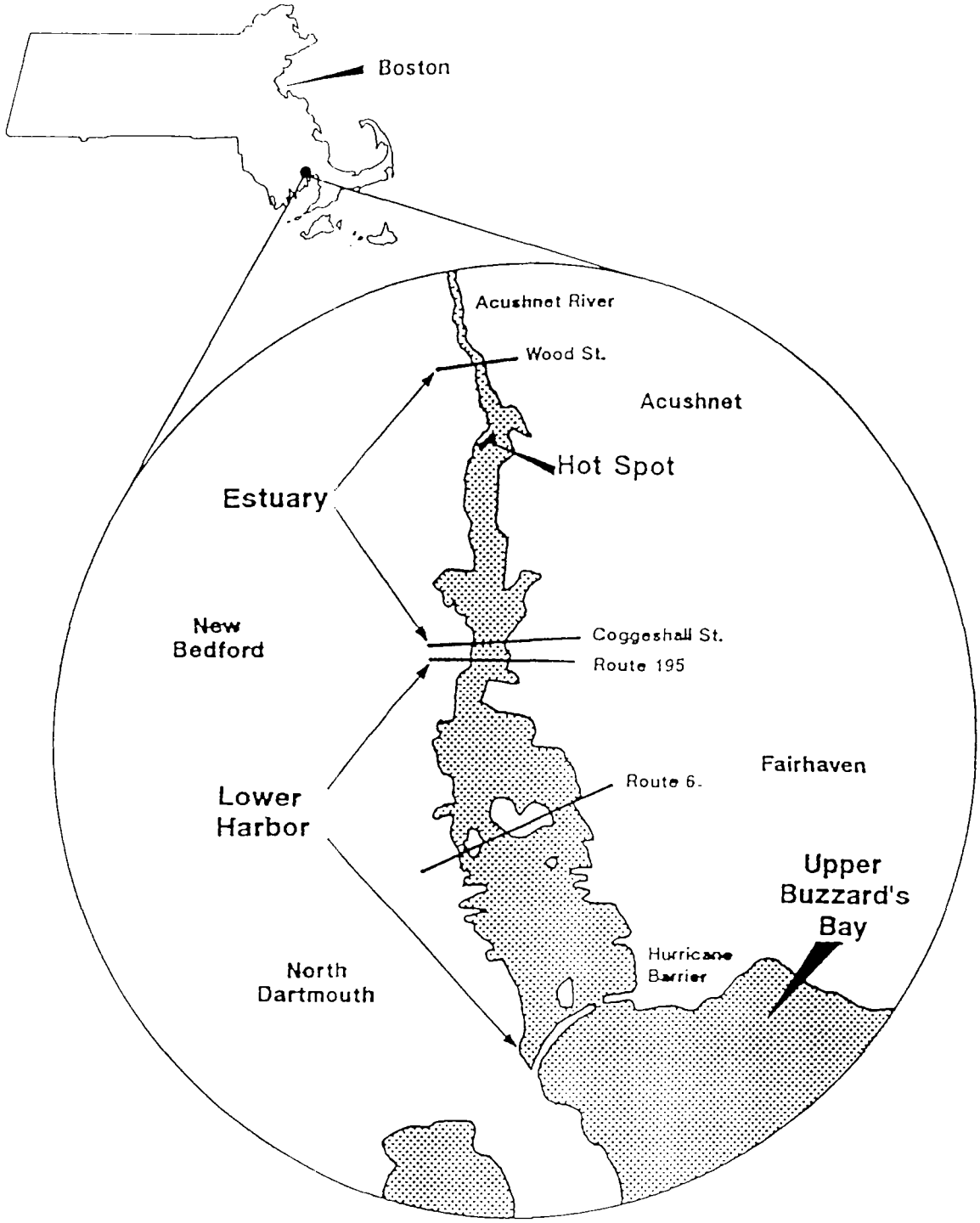
S/S bench scale studies were completed for three different admixtures. Admixtures were provided by MARCOR, Inc. (Marcor) and World Environmental Corporation (World). In addition, commercially available Portland cement and absorbent clay were tested as admixtures. The studies were conducted on-site and at the bench scale level with leaching tests and compressive strength being used as the primary performance indicators. The results of the S/S studies indicated that this technical approach was not effective in minimizing the leachability of the PCBs from the Hot Spot sediment.

A more detailed summary of the treatability testing is included in Section 4.2 The results from each study are presented in detail in subsections of Section 4 of this document.

1.2 Site Location and Description

The New Bedford Harbor Superfund site is located approximately 55 miles south of Boston along the northwestern shore of Buzzards Bay. The site consists of approximately 18,000 acres of estuary, harbor and bay areas contaminated with PCBs and heavy metals (Figure 1-1). Studies conducted by EPA during the late 1970s discovered PCB contamination in sediments over a widespread area and in several species of marine biota. The biota concentrations were in excess of the U.S. Food and Drug Administration (FDA) edible tissue tolerance limit of 2 ppm. In addition to PCBs, other contaminants including lead, cadmium, chromium, copper, and PAHs have also been found in the sediments.

As a result of the widespread PCB contamination and the accumulation of PCBs in marine biota, the Massachusetts Department of Public Health (DPH) established three fishing closure areas in New Bedford Harbor and areas of Buzzards Bay in September 1979 (Figure 1-2). These closures are still in effect. Area I is closed to all fishing: including finfish, shellfish, and lobsters. Area II is closed to the taking of lobsters and bottom-feeding finfish, such as eels, flounder, scup, and tautog. Area III is closed to lobstering only. Closure of the New Bedford Harbor and Upper Buzzards Bay areas to lobstering has resulted in the loss of approximately 18,000 acres of productive lobstering ground.



Not to Scale

FIGURE 1-1

NEW BEDFORD HARBOR HOT SPOT SEDIMENT FEASIBILITY STUDY ADDENDUM REPORT

SITE LOCATION MAP

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

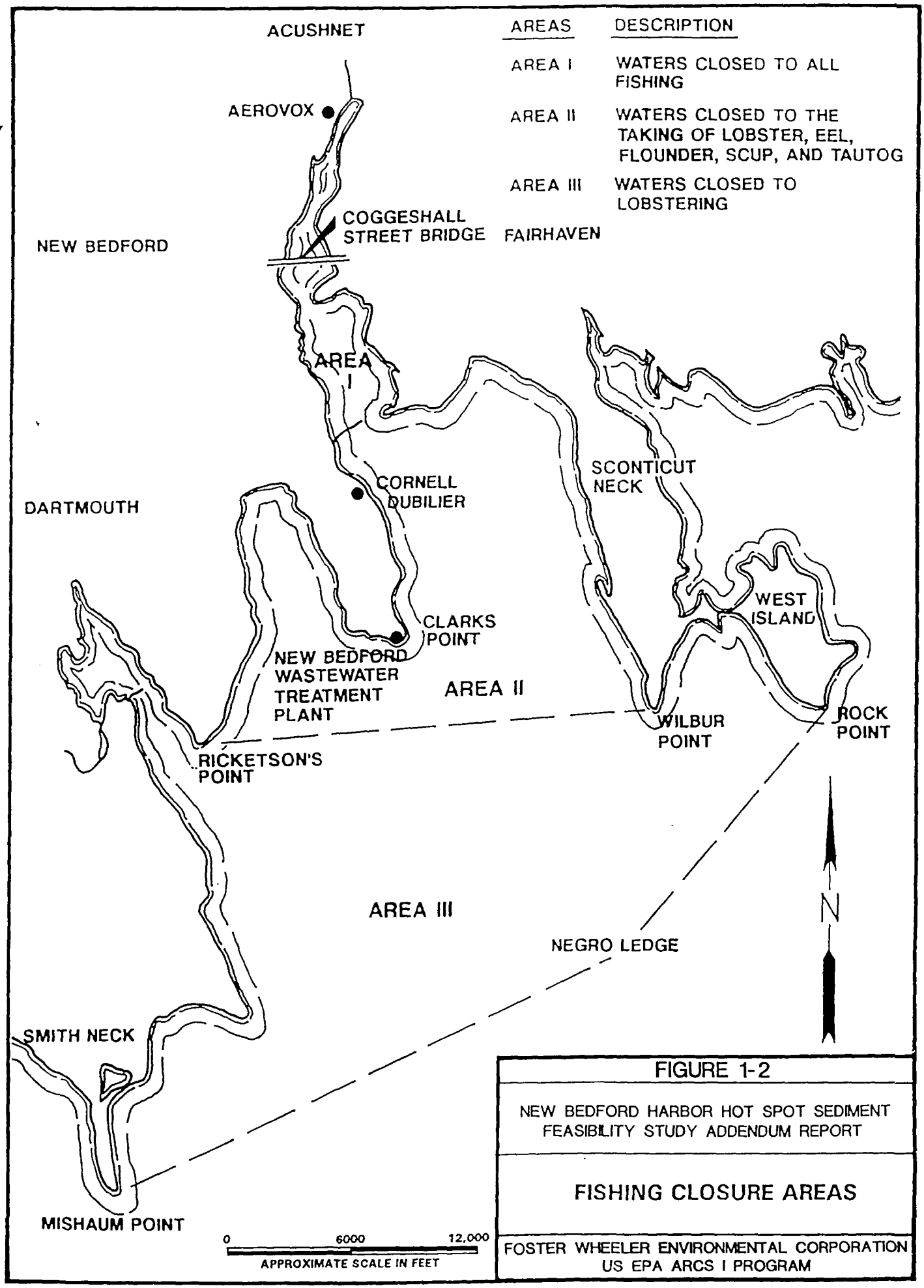


FIGURE 1-2

NEW BEDFORD HARBOR HOT SPOT SEDIMENT FEASIBILITY STUDY ADDENDUM REPORT

FISHING CLOSURE AREAS

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

In July 1982, the site was proposed for addition to the EPA Superfund National Priorities List (NPL) making it eligible for federal funds to further investigate the nature and extent of contamination and to evaluate potential clean-up alternatives for the site.

For the purpose of conducting site studies, the New Bedford Harbor site was divided into three geographical areas: the Hot Spot area, the Acushnet River Estuary and the Lower Harbor/Upper Buzzards Bay (Figure 1-3). Treatment alternatives for the Hot Spot sediment are the focus of this FS Addendum. The Hot Spot was a 5-acre area located along the western bank of the Acushnet River Estuary. PCB concentrations in the Hot Spot area ranged from 4,000 ppm to over 200,000 ppm. In 1989, the Hot Spot was designated by EPA as a separate operable unit for remediation. A ROD was signed on April 6, 1990 by the EPA Region I Administrator documenting the rationale and selection of the preferred remedial measures for the Hot Spot area.

The remedial measures for the Hot Spot included the dredging and treatment of PCB contaminated sediment from this 5-acre area. The dredging for this operable unit was completed during the fall of 1995. The treatment component of the Hot Spot sediment ROD was placed on hold when EPA canceled the incineration contract in 1994. On behalf of EPA and in close coordination with the community Forum Group, Foster Wheeler was requested to conduct an evaluation of non-incineration remedial alternatives for the Hot Spot sediment. The evaluation consisted of the performance of four treatability studies which are discussed in Section 4 of this document. The results of these treatability studies have also been incorporated into the remedial alternatives section (Section 6.0) of this FS Addendum.

The remainder of the site, the Estuary and Lower Harbor/Bay areas, are being addressed by EPA under a separate operable unit. The Acushnet River Estuary is an area of approximately 230 acres (excluding the Hot Spot area), extending from the Wood Street Bridge to the north, to the Coggeshall Street Bridge to the south. Sediment PCB concentrations in this area (excluding the Hot Spot area) range from below detection to approximately 4,000 ppm. The Lower Harbor area consists of approximately 750 acres extending from the Hurricane Barrier, north to the Coggeshall Street Bridge. Sediment PCB concentrations in this area range from below detection to over 100 ppm.

The Upper Buzzards Bay portion of the site extends from the Hurricane Barrier to the southern boundary of Fishing Closure Area III, an area of approximately 17,000 acres. Sediment PCB concentrations in this area range from below detection up to over 100 ppm in certain localized areas. EPA is currently evaluating a remedy for these portions of the site involving removal through dredging and disposal in four CDFs located along the New Bedford shoreline. EPA plans to issue a ROD for these parts of the site in 1998.

1.3 Site Investigations

This section briefly describes some of the major studies that have been conducted for the New Bedford Harbor site. More comprehensive documentation of these studies is included in the EPA Site Administrative Record.

Following the NPL listing, EPA initiated a comprehensive assessment of the PCB problem in the New Bedford area in August 1982. This assessment included environmental sampling at the New Bedford and Sullivan's Ledge landfills; an area-wide ambient air monitoring program; development of a sediment PCB

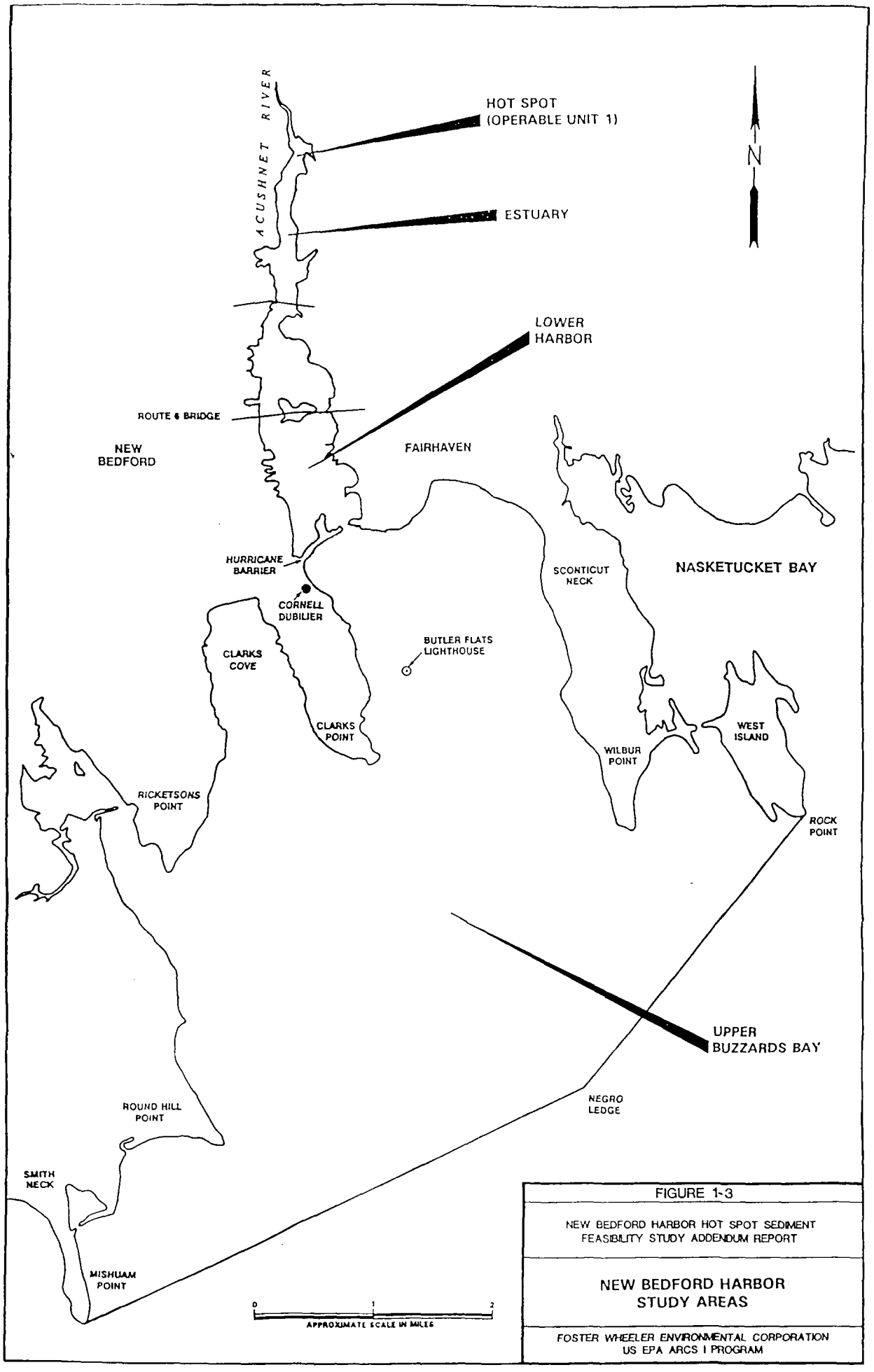


FIGURE 1-3

NEW BEDFORD HARBOR HOT SPOT SEDIMENT
FEASIBILITY STUDY ADDENDUM REPORT

NEW BEDFORD HARBOR
STUDY AREAS

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

profile for the Acushnet River and the Harbor; biota sampling in the Estuary, Lower Harbor, and Bay; and a study of sewer system contamination. The results of this overall assessment were presented in a Remedial Action Master Plan (RAMP) for the site in May 1983 (Roy F. Weston, Inc., 1983). The RAMP included recommendations for studies to further delineate the contamination problems.

Concurrent with the assessments leading to the RAMP, EPA compiled a database of sampling and analytical results from previous studies in the New Bedford Harbor and Buzzards Bay area. The final report on this data collection effort was issued by EPA in August 1983 (Metcalf & Eddy, 1983).

In 1984, a Feasibility Study (FS) was conducted for the EPA by the NUS Corporation (NUS, 1984). This FS presented five remedial clean-up alternatives for the Estuary portion of the site, four of which involved dredging activities to remove or isolate the contaminated sediments. During the public comment period, comments from the general public, the Potentially Responsible Parties (PRPs) and other governmental agencies raised concerns regarding the adequacy of available dredging techniques. These concerns included sediment/contaminant migration and the potential release of leachate from unlined shoreline disposal facilities.

In addressing these questions, EPA obtained assistance from the USACE. This assistance included performing a number of predesign studies to address specific concerns and to develop a conceptual dredging and disposal alternative for the Estuary portion of the site. The predesign studies which were performed included a detailed characterization of the sediment, an evaluation of leachate and surface runoff from sediment disposal facilities, a determination of the required cap thickness to isolate the contaminated sediment, bench-scale testing of solidification technologies and bench-scale testing and computer modeling to evaluate contaminant migration during dredging and sediment disposal activities. The results and conclusions of these predesign studies are presented in an eleven (11) volume Engineering Feasibility Study (EFS) report series (Francingues and Averett, 1988).

In 1986, EPA initiated work on an overall Feasibility Study to address the Hot Spot, Estuary and Lower Harbor/Bay areas of the site. The overall study was designed to evaluate remedial measures for these portions of the New Bedford Harbor site and to integrate the work of the USACE into the process of developing specific remedial alternatives for the three areas. Remedial alternatives for the Hot Spot area were presented in a Feasibility Study completed in 1989 (Ebasco, 1989); remedial alternatives for the Estuary and Lower Harbor/Bay areas were presented in a study completed in 1990 (Ebasco, 1990).

The USACE EFS was expanded to include a pilot-scale demonstration of dredging and dredged material disposal. The pilot study evaluated the performance of three hydraulic dredges and two sediment disposal techniques under actual operating conditions. The study was conducted in a cove along the New Bedford shoreline and included an evaluation of mudcat, matchbox and cutterhead dredges to remove more than 10,000 cubic yards of sediment, of which, approximately 3,000 cubic yards were contaminated with PCBs ranging from 150 ppm to 585 ppm. The results of the study indicated that the cutterhead was the most effective dredge with respect to minimizing sediment resuspension and contaminant migration. The two sediment disposal techniques included a shoreline CDF and a method of subaqueous capping termed Contained Aquatic Disposal (CAD). Disposal studies indicated that the CAD technique was not completely successful in isolating the contaminated material. The results and conclusions of the study were presented in a report prepared by the USACE (Otis et al., 1990).

In 1992, the EPA tasked Foster Wheeler to complete a Supplemental Feasibility Study (SFS) for the Upper Buzzards Bay portion of the site. The SFS evaluated a series of five remedial alternatives to address PCB contamination exceeding 10 ppm in this 17,000 acre area of the site. The five remedial alternatives evaluated for the Upper Bay were consistent with the alternatives evaluated for the Estuary and Lower Harbor areas in the 1990 FS. The alternatives included no action; dredging with shoreline disposal; capping; a combination of capping with shoreline disposal; and dredging, sediment treatment and shoreline disposal.

The SFS was released by the EPA in conjunction with its Addendum Proposed Plan in May 1992. The EPA is currently evaluating comments received on these documents along with the comments received on the January 1992 Proposed Plan for the Estuary, Lower Harbor and Bay portions of the site. The EPA released an updated Proposed Plan in November 1996 which specifically addresses both state and local comments which have been received on the prior Proposed Plans, the Estuary, Lower Harbor and Bay FS (Ebasco, 1990) and the SFS (Ebasco, 1992). EPA is currently preparing a comprehensive Responsiveness Summary to formally address comments on the 1992 and 1996 Proposed Plans. This Responsiveness Summary will be included with the ROD for the overall site cleanup which is scheduled to be issued in early 1998.

1.4 Report Organization

This FS Addendum contains six sections in addition to this introduction. Section 2 provides a description of the Sawyer Street location where the Hot Spot sediments are currently stored and a chemical and physical profile of the sediments. Applicable and Relevant and Appropriate Regulations (ARARs) are presented and discussed in Section 3. The results of the 1996 bench and pilot scale treatability test programs are presented in Section 4. Sections 5 and 6 include the development and detailed analysis of remedial alternatives, respectively. References for this FS Addendum are presented in Section 7.

Appendix A to this FS Addendum includes the Technical Memorandum prepared by Foster Wheeler to discuss the procedures and results of the bench scale S/S testing. Appendix B includes a description of the project specific ARARs for each of the eleven remedial alternatives presented in Section 6. Documents prepared during the treatability study testing and the laboratory data from the tests are included in a ten volume New Bedford Harbor Hot Spot Treatability Study Data Compendium (Data Compendium). The contents of the Data Compendium are referenced, as appropriate in this FS Addendum and are listed below. For treatability studies which used high temperature processes, stack testing was conducted by TRC Environmental Corporation (TRC). Their reports are also included in the Data Compendium.

Volume I:	Ionics RCC/CRTI -	Test Report for On-Site Pilot Scale Demonstration Testing of the B.E.S.T.® Solvent Extraction Process and Solvated Electron Technology at New Bedford Harbor, prepared by Ionics RCC
Volume II:	Ionics RCC/CRTI -	Laboratory Data (Part I)
Volume III:	Ionics RCC/CRTI -	Laboratory Data (Part II)
Volume IV:	Geosafe -	Pilot-Scale Treatability Testing of the In Situ Vitrification (ISV) Technology PCB-Contaminated "Hot Spot" Sediments from the New Bedford Harbor Superfund Site, prepared by Geosafe

Volume V:	Geosafe -	Laboratory Data (Part I)
Volume VI:	Geosafe -	Laboratory Data (Part II)
Volume VII:	Geosafe -	Source Testing Results of Treated Sediment at the New Bedford Harbor Superfund Site, prepared by TRC
Volume VIII:	SAIC/Eco Logic -	On-Site Pilot-Scale Testing of the Eco Logic Process at the New Bedford Harbor Superfund Site, prepared by SAIC Eco Logic
Volume IX:	SAIC/Eco Logic -	Laboratory Data
Volume X:		SAIC Eco Logic - Source Testing Results of a Treatability Study at the New Bedford Superfund Site, prepared by TRC

2. SITE CHARACTERIZATION

2. SITE CHARACTERIZATION

This section of the report provides a description of the shoreline CDF that is currently being used to store these sediments and a chemical and physical description of these sediments. Section 2.1 discusses the overall site layout and the CDF where the Hot Spot sediments are currently stored. Section 2.2 describes the chemical and physical characteristics of the sediment based on a combination of historical data and on the data collected during the recent treatability program.

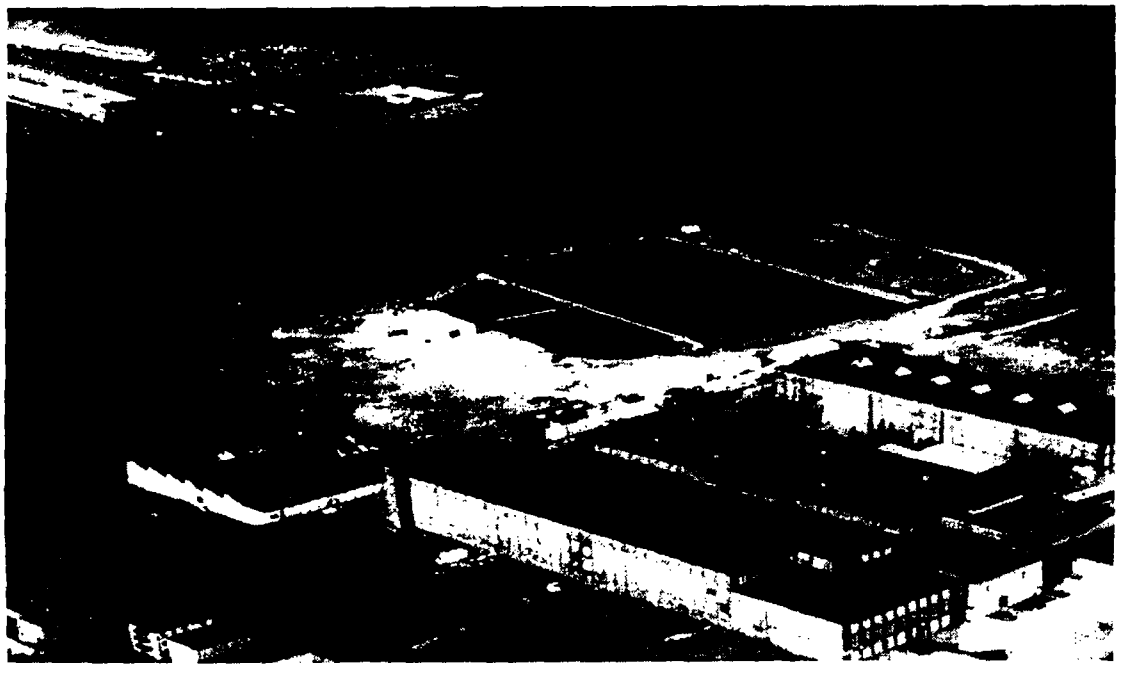
2.1 Existing Site Conditions

The Hot spot sediments are currently stored in a double-lined CDF constructed along the New Bedford Harbor shoreline. This CDF is adjacent to facilities at the Sawyer Street site remaining from the initial Hot Spot cleanup activities that were conducted by EPA and the USACE during 1994 and 1995. The Sawyer Street site was also the location where the treatability studies were conducted. The following subsections describe the overall site layout and the existing CDF condition.

2.1.1 Overall Site Layout

The Sawyer Street location of the New Bedford Harbor is approximately eight acres in size, including approximately three acres occupied by the CDF. The site is located on the north side of Sawyer Street and abuts the Acushnet River to the east and vacant land to the north and west. Land use in the vicinity of the site is a mixture of urban industrial and residential. An aerial photograph of the site and surrounding area is included as Exhibit 2-1. A Site Layout Plan is included as Figure 2-1.

Exhibit 2-1
Aerial Photograph of the Sawyer Street Location



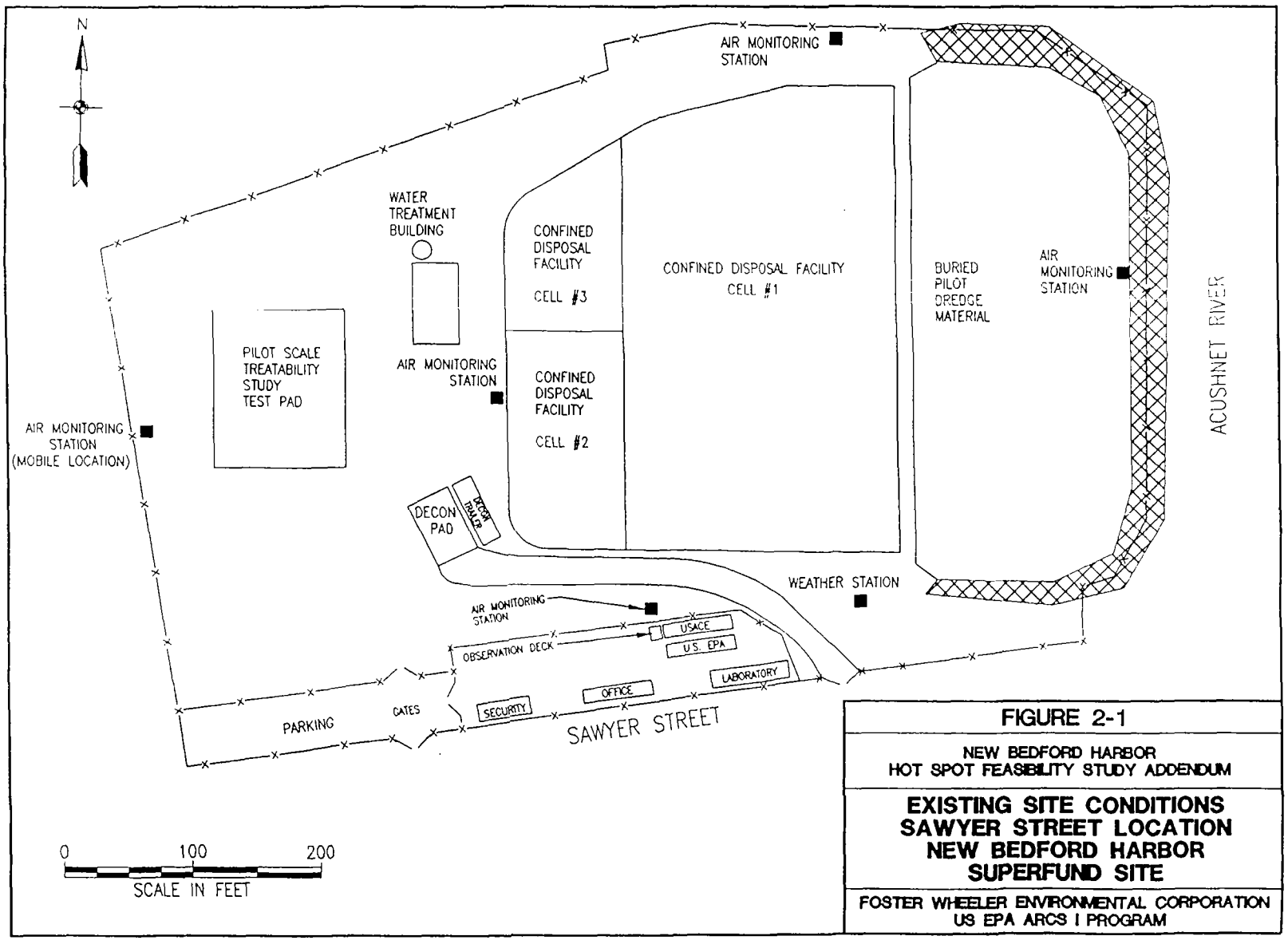


FIGURE 2-1

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

EXISTING SITE CONDITIONS
SAWYER STREET LOCATION
NEW BEDFORD HARBOR
SUPERFUND SITE

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A015.DWG
DATE: 9/04/97

An 80 foot x 120 foot bermed asphalt pad is located on the western side of the site. The pad was constructed for the treatability study program. During the testing, the pad was covered with an impermeable liner to prevent an inadvertent release of sediment or treatment reagents to the soil on the site. Sump drainage from this pad was routed to the on-site water treatment facility. Following completion of the treatability studies in 1996, this liner was appropriately decontaminated.

The site also includes a 350 gallon per minute (gpm) water treatment system enclosed within a building. A concrete decontamination pad equipped with a steam cleaner and sump pump is also located on the site. Six trailers are currently located on the site, these are used as shower/decontamination, laboratory, and office trailers. Six air monitoring stations are located on platforms around the site. Electric power, potable water, and sewage facilities are currently available on the site. Overall site security is provided by a six foot tall chain link fence.

2.1.2 Existing CDF Conditions

The CDF is illustrated on Figure 2-1 and can be seen in the aerial photograph included in Exhibit 2-1. As shown in Figure 2-1, the CDF has three individual cells. Cell #1 was used as the initial settling basin where the Hot Spot sediments were pumped following dredging. The cell has a double HDPE liner and is approximately 200 feet by 400 feet wide and approximately nine feet deep. The Hot Spot sediment in this cell is approximately six to seven feet deep.

The contaminated sediments in the CDF are currently covered with a 10-mil permalon cover. This relatively thin cover was placed over the sediments as a temporary measure to minimize volatilization and potential direct contact by human and/or ecological receptors. The cover is weighted down with sand bags to prevent wind-damage. A layer of water is often maintained over the cover during the summer months to assist in controlling PCB emissions.

As the dredged material settled in Cell #1, the clarified surface layer, or supernatant was routed to Cell #2 for temporary storage/flow equalization before receiving additional water treatment. The supernatant was then pumped into the treatment building where a polymer was added to enhance additional settling of solids in Cell #3, which acted as a secondary clarifier. Subsequent water treatment steps included sand filtration and treatment of the PCBs through Ultra Violet Oxidation (UV/Ox) prior to discharge to the Acushnet River.

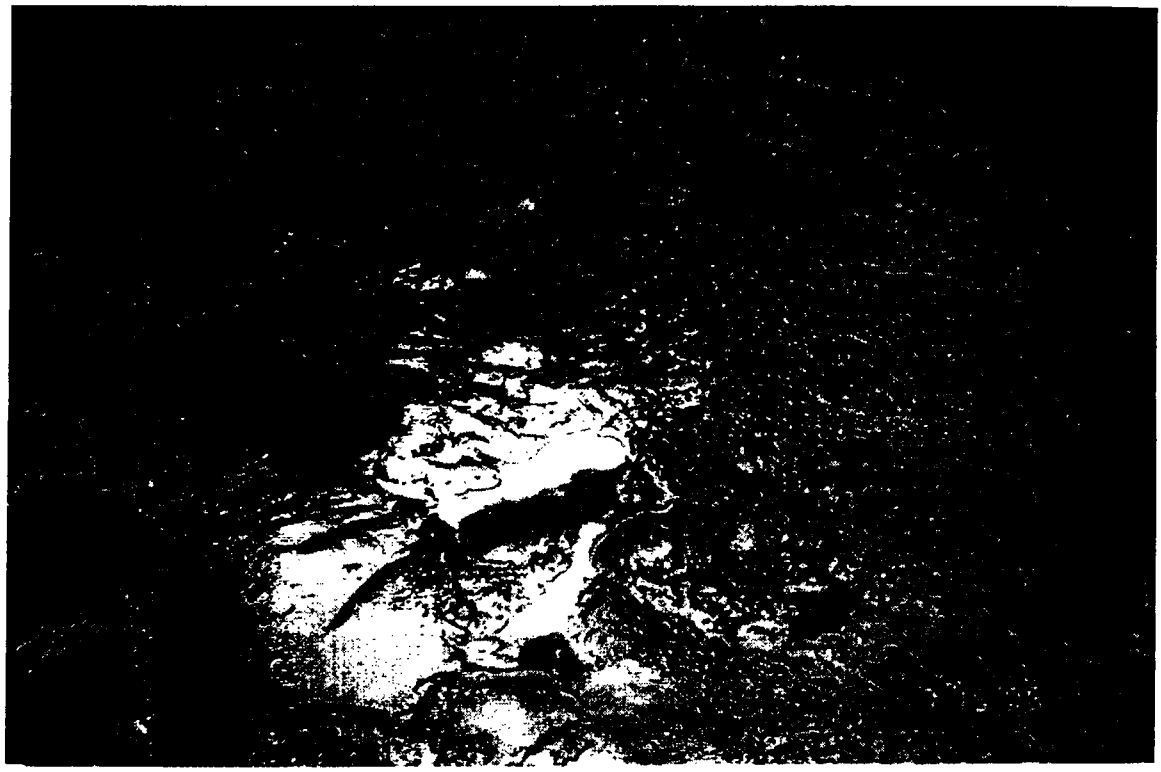
During 1994 and 1995, the Hot Spot sediments were dredged from the northern portion of the Acushnet River and placed in the double-lined CDF. The dredging was continued until analysis of post-dredging samples indicated that the Hot Spot sediments had been removed and the cleanup goal of 4,000 ppm was achieved. In total, approximately 15,000 cubic yards of sediment, weighing approximately 18,000 tons, were removed from the harbor and placed in CDF Cell #1. Additional description of the Hot Spot sediments and their chemical and physical composition are presented in the following section.

2.2 Hot Spot Sediment Characterization

The chemical and physical characteristics of the Hot Spot sediments are described in this section. These descriptions are based largely on recent pilot study data, with reference to historical data, as appropriate. The source of the data points and the results used to characterize the material are discussed below.

Hot Spot sediments were initially defined in-situ as having total PCB concentrations greater than 4,000 ppm and averaging approximately 20,000 ppm to 30,000 ppm. Removal of this Hot Spot sediment was estimated to result in a total reduction of PCBs in the upper harbor by approximately 50 percent. A photograph of Hot Spot sediment is included as Exhibit 2-2.

Exhibit 2-2
Photograph of the Hot Spot Sediment



Sediment PCB concentrations determined during recent sampling of sediments from the CDF ranged from 1,600 to 7,700 ppm. Based on results for samples collected from the CDF in conjunction with available historical data on the physical and chemical nature of the sediment, average PCB concentrations in the CDF are estimated to be approximately 6,000 ppm.

This is slightly lower than the historical in situ average of approximately 20,000 to 30,000 ppm. The reason for this difference was not determined during this study but may be due to a variety of reasons including a biased CDF sampling approach, treatment of PCBs that were transferred to the aqueous and colloidal phases during sediment dredging and disposal within the CDF, dredging more sediments than originally planned, changes in analytical methodology, and/or PCB volatilization.

In addition to PCBs, the Hot Spot sediment contains several other organic and inorganic contaminants. Extractable oil and grease, as measured gravimetrically, comprise approximately two to three percent of the sediment matrix. In addition, the sediment contains concentrations of other organic compounds including

chlorinated benzenes, polynuclear aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans). Several heavy metals including arsenic, cadmium, chromium, copper, lead and zinc, were also detected at elevated concentrations in the samples collected from the CDF. Each of these contaminant groups are described in more detail in Section 2.2.1.

Samples were collected from the CDF during several recent sampling events. The analytical findings from these events are summarized in this section and where appropriate, compared with available historical data. The analytical methodologies and associated measures of quality control and quality assurance are discussed in more detail in Section 4.3. Laboratory data reporting forms for the samples collected during the pilot study program are included in the Data Compendium.

Hot Spot sediment contained in the CDF was sampled on four occasions. These events include a sampling event conducted by the USACE in June 1995 and sampling conducted for each of the three pilot study treatment processes tested in 1996. These three pilot scale studies (Ionics RCC, Geosafe and SAIC/Eco Logic) are hereafter referred to as the first, second and third pilot studies. The results from these four sampling events provide the basis for the Hot Spot sediment characterization described in this section. A limited sampling program was conducted for sediment to be used during the bench scale S/S study. Because this sampling event was so small (two wheelbarrows of sediment were removed using a hollow pipe), the results are discussed for comparison purposes only. Where appropriate, findings from these sampling events are compared and discussed relative to historical data.

Samples collected by the USACE in June 1995 were collected directly from six locations in the CDF. Sediment for the first two pilot studies was removed from the CDF in the spring of 1996 and placed into oversized drums. Samples of this material were collected from the drums prior to its use as feed material for the first and second pilot studies. Sediment for the third study was removed from the CDF, transferred to drums, and sampled from the drums in the fall of 1996. This sediment was removed from a similar location within the CDF. However, the material was retrieved from a greater depth.

Chemical and physical data from the various sampling events are detailed in the following subsections. In summary, the results for samples collected during the third pilot study were chosen as the representative profile of the Hot Spot sediment. These results were generally consistent with the historical Hot Spot data, although the PCB results were lower than the historical average of approximately 20,000 ppm to 30,000 ppm. Results for oil and grease and four heavy metals of concern were essentially the same for the third pilot study and the historical data. Based on the available data the results from the third pilot study appear to represent a reasonable average concentration of contaminants in the CDF.

Initial in-situ sampling of the Hot Spot sediments was conducted from 1982 through 1988. These data sets provide the basis for the historical information on the Hot Spot sediment. The following five sediment sampling data sets were used to determine the nature and extent of PCB contamination in sediment of the Acushnet River Estuary:

- U.S. Coast Guard Sediment Sampling Program (1982)
- USACE FIT Sampling Program (1986)
- Battelle Hot Spot Sediment Sampling Program (1987)
- USACE Wetlands and Benthic Sediment Sampling Program (1988)
- USACE Hot Spot Sediment Sampling Program (1988)

The data sets listed above were used by EPA to support above for the 1990 Hot Spot ROD. Other relevant data sets that were included by EPA in the Administrative Record:

- DEQE sampling (1981)
- EPA sampling (November 1981)
- Aerovox sampling (March 1982)
- Aerovox/GE sampling (June 1986)

In summary, these four data sets are consistent with the magnitude and location of PCB identified within the five data sets used to support the 1990 Hot Spot ROD.

2.2.1 Chemical Characterization

PCB, oil and grease, selected semivolatile, and Toxicity Characteristic Leaching Procedure (TCLP) results for the sediment samples collected during the pilot study program are discussed in this section. Where appropriate, the data are compared with the USACE sampling conducted in June 1995. PCB data from the third pilot study and the USACE 1995 samples 4 through 6 appear to be most representative of the sediment contained within the CDF, based on historical data for the sediment. Samples collected during the first and second pilot study and 1995 samples 1 through 3 appear to represent uncharacteristically low concentrations of contaminants due to settling at the end of the dredge pipe. Limited sampling of sediment for the bench scale S/S testing (Section 4.7) support this premise. These results are further summarized and discussed below.

2.2.1.1 Sediment PCB and Oil and Grease Concentrations

PCB and oil and grease data for the pilot study feed sediment samples are summarized in Table 2-1. The results are presented as averages for the first and second studies, and averages for the third pilot scale study. This reflects the manner in which the sediment was collected and homogenized for each study. During the spring of 1996, approximately five cubic yards of Hot Spot sediment was removed from the CDF and homogenized. A similar procedure was performed in the summer of 1996 to gather and homogenize feed sediment for the third pilot scale study. As shown in the table, the average results for the first and second pilot studies were lower than for the third pilot study.

Table 2-1
Summary of PCB and Oil and Grease Data for the Hot Spot Sediment

Parameter	1st and 2nd Pilot Study Concentration Range (ppm) Minimum	1st and 2nd Pilot Study Concentration Range (ppm) Maximum	3rd Pilot Study Concentration Range (ppm) Minimum	3rd Pilot Study Concentration Range (ppm) Maximum	1st & 2nd Pilot Study Average Conc. (ppm)	3rd Pilot Study Average Conc. (ppm)
PCB	1,600	2,990	3,800	7,700	2,308	5,667
Oil and Grease	11,700	21,800	28,100	36,900	17,863	32,392

The difference in average PCB concentrations between these two sediment removal exercises is not surprising given the variability that is likely to exist throughout the CDF. However, it would appear that sediment removed to support the third treatability study may be more representative of the CDF as a whole. This judgment is in part, based on the PCB results obtained by the UACE during the June 1995 sampling event and the historical in-situ measurements. These results of the USACE's sampling of the CDF are summarized in Table 2-2.

In addition to the chemical analyses, the USACE evaluated the physical and chemical composition of these samples. The results of this evaluation identified two distinctly different types of sediment along the eastern wall of Cell #1 of the CDF. These included, the coarser material which had settled out at the end of the dredge discharge pipe (samples 1 through 3), and the samples that were beyond the initial settling zone (samples 4 through 6). Given the hydrodynamic profile of the CDF as a settling lagoon and based on a comparison with historical data, samples 4 through 6 appeared more likely to be representative of the CDF material than samples 1 through 3.

Table 2-2
PCB and Oil and Grease Results for the USACE Samples Collected in June 1995

Parameter	Sample Number and Concentration (ppm)						Concentration Range (ppm)	Average Conc. (ppm)
	1	2	3	4	5	6		
Total PCB	492	763	3,005	14,412	10,924	7,405	492 - 14,412	6,167
Oil & Grease	780	980	14,000	30,000	34,000	22,000	780 - 34,000	16,960

2.2.1.2 Sediment Semivolatile Concentrations

Feed sample results from the third pilot study for chlorinated benzenes are summarized in Table 2-3. Similar to the PCB and oil and grease results, chlorinated benzene results were slightly lower in the samples collected during the first and second studies that those collected during the third study, indicating that the chlorinated benzene concentrations may be somewhat proportional to the PCB concentrations.

Table 2-3
Summary of Chlorinated Benzene Data for the Hot Spot Sediment (Third Pilot Study)

Parameter	Minimum Conc. (ppm)	Maximum Conc. (ppm)	Average Conc. (ppm)
1,3-Dichlorobenzene	3.9	10	6.8
1,4-Dichlorobenzene	13	28	20
1,2-Dichlorobenzene	0.32	0.90	0.49
1,2,4-Trichlorobenzene	7.7	38	15

PAH results from the third pilot study are summarized in Table 2-4. In contrast to the chlorinated benzenes, the results for PAHs were actually slightly higher in the samples for the first and second study than in those collected during the third study. The average total PAHs were reported to be 65 ppm in the first and second study, almost twice the 37 ppm average reported for the third study. The pattern of PAH contamination does not correlate with the PCB observations. This is likely due to historical point and non-point sources of PAHs along the harbor's edge. These sources likely contributed PCBs to the harbor in a manner different from that of PCB. To maintain consistency, the data from the third pilot study was used in Table 2-4 to categorize the sediment.

Table 2-4
Summary of PAH Concentrations for the Hot Spot Sediment (Third Pilot Study)

Parameter	Minimum Conc. (ppm)	Minimum Conc. (ppm)	Average Conc. (ppm)
Naphthalene	0.31	0.78	0.50
2-Methylnaphthalene	0.50	1.3	0.84
Acenaphthylene	0.16	8.2	1.4
Acenaphthene	0.45	1.9	0.91
Fluorene	0.44	1.7	0.88
Phenanthrene	1.1	6.4	2.3
Anthracene	0.3	1.7	0.62
Fluoranthene	1.8	12	3.9
Pyrene	2.6	8.2	4.8
Benzo(a)anthracene	1.9	6.4	3.7
Chrysene	2.1	7.3	4.1
Benzo(b)fluoranthene	2.0	10	4.2
Benzo(k)fluoranthene	1.5	8.5	3.9
Benzo(a)pyrene	1.8	6.6	3.7
Indeno(1,2,3-cd)pyrene	0.13	0.72	0.28
Dibenz(a,h)anthracene	0.07	3.3	1.1
Benzo(g,h,i)perylene	0.08	0.4	0.22
Total PAH:			37

CDF sample results are consistent with previous in-situ sampling, where total PAH concentrations averaged approximately 70 ppm (the highest PAH concentration of 930 ppm was detected in the Hot Spot area). No discrete areas of elevated levels of PAH compounds were observed in the in-situ sampling, suggesting that the PAH contamination is from non-point sources such as urban runoff. PAH concentrations detected in the upper estuary sediment were similar to PAH concentrations detected in other urban and industrialized areas (EPA, 1992).

Overall, concentrations of the semivolatile compounds, including the PAHs and the chlorinated benzenes, total less than three percent of the PCB concentration. This, in addition to the relatively lower toxicity of

most of these semivolatile compounds with respect to PCBs, indicates that the majority of risk associated with the Hot Spot is attributable to PCBs.

2.2.1.3 Sediment Dioxin and Furan Concentrations

Data for 2,3,7,8-substituted dioxins and furans from the third pilot study and the 2,3,7,8 tetrachlorodibenzo (2,3,7,8-TCDD) toxicity equivalents (TEQs) are summarized in Table 2-5. TEQs were calculated by multiplying the concentration of the specific 2,3,7,8- substituted congener by its specific toxicity equivalent factor (TEFs). Further discussion of TEFs and a table summarizing the TEF values are included in Section 4.3. The TEF calculation adjusts the concentration of the less toxic 2,3,7,8- substituted congeners to the equivalent concentration (based on toxicity) of the most toxic dioxin/furan congener (2,3,7,8-TCDD). Note that, by definition, the TEQ is related to the concentration of 2, 3, 7, 8- substituted congeners but is not necessarily related to the total dioxin/furan concentration.

As was the case for the PCBs, dioxin and furan results from the first and second pilot studies were slightly lower than for the third pilot study. The total 2,3,7,8-substituted isomer concentration was 16,879 (pg/gm) (parts per trillion or ppt) for the first and second studies, with a total TEQ concentration of 1,328 pg/gm.

Table 2-5
Summary of {2, 3, 7, 8 Substituted Isomers} Data
for the Hot Spot Sediment
(Third Pilot Study)

Parameter	3rd Pilot Study Conc. (pg/gm) Average	3rd Pilot Study TEQ (pg/gm)
2,3,7,8-TCDD	3.6	3.6
1,2,3,7,8-PeCDD	9.1	4.5
1,2,3,4,7,8-HxCDD	7.9	0.79
1,2,3,6,7,8-HxCDD	31	3.1
1,2,3,7,8,9-HxCDD	20	2.0
1,2,3,4,6,7,8-HpCDD	386	3.9
OCDD	3,000	3
2,3,7,8-TCDF	690	69
1,2,3,7,8-PeCDF	276	14
2,3,4,7,8-PeCDF	1,520	760
1,2,3,4,7,8-HxCDF	4,440	444
1,2,3,6,7,8-HxCDF	1,920	192
2,3,4,6,7,8-HxCDF	844	84
1,2,3,7,8,9-HxCDF	986	99
1,2,3,4,6,7,8-HpCDF	1,680	17
1,2,3,4,7,8,9-HpCDF	1,260	13
OCDF	1,860	1.9
Total:	18,933	1,714

Table 2-6 summarizes the total dioxin and furan results from the third pilot study. Total dioxins and furans total approximately 30 to 40 parts per billion (ppb). The total 2,3,7,8-TCDD toxicity equivalent averages

were approximately one to two ppb, over one million times less than the total PCB concentration. As with the other semivolatile compounds discussed above, dioxins and furans are expected to be effectively treated by the methods applicable to PCB treatment.

Table 2-6
Summary of Dioxin and Furan Data (Totals)
for the Hot Spot Sediment
(Third Pilot Study)

Parameter	3rd Pilot Study Average (pg/gm)
Total TCDD	17
Total PeCDD	50
Total-HxCDD	284
Total-HpCDD	770
OCDD	3,000
Total TCDF	5,080
Total PeCDF	3,920
Total-HxCDF	10,520
Total-HpCDF	4,580
OCDF	1,860
Total PCDD/PCDF (pg/gm):	30,081

2.2.1.4 Sediment Metals Concentrations

Metals results from the third pilot study are summarized in Table 2-7. Arsenic, cadmium, chromium, copper, lead and zinc were identified as metals of concern for the site during the initial phases of RI/FS studies conducted during the early 1980's. In addition to potential risks associated with these contaminants, metals contamination in the sediment is a concern from an engineering perspective. Heavy metals cannot always be treated with the same treatment technologies identified for PCBs and may serve as a potential source of contamination during disposal of treated sediment.

There are some public health risks associated with exposure to these metals; however, this exposure is expected to comprise a small component of the total risk when compared to risks associated with exposure to PCB-contaminated sediment. The presence of metals in Hot Spot area sediment is important because many treatment technologies capable of treating the PCBs are ineffective for treating metals. The potential impact due to metals contamination may be measured in part, in terms of the leachability of the metals. This determination is typically made using the results of TCLP tests as discussed below.

2.2.1.5 TCLP Concentrations

TCLP results for key contaminants are summarized in Table 2-8. The complete data set of TCLP analysis results, including the raw data sheets for the three pilot studies, is included in the Data Compendium. The key contaminants summarized in Table 2-8 were chosen based on their presence in the Hot Spot sediment

and/or because there is a TCLP regulatory criteria for the contaminant. Some organic contaminants which have a regulatory criteria were not included in this summary table, as they were reported as non-detect by the laboratory. As discussed above, results from the third pilot study were chosen as representative of the Hot Spot sediment, although the results from the first and second studies were similar. TCLP results for the sediment do not exceed regulatory criteria for any of the listed contaminants.

Table 2-7
Summary of Metals Data for the Hot Spot Sediment
(Third Pilot Study)

Parameter	Minimum Concentration	Maximum Concentration	Average Concentration
Aluminum	13,300	17,200	15,658
Antimony	2.9	8.7	5.1
Arsenic	10.2	14.4	11.9
Barium	145	221	159
Beryllium	0.49	0.55	0.51
Cadmium	13.4	17.0	15.1
Calcium	5,910	8,960	7,275
Chromium	295	366	330
Cobalt	7.3	9.3	8.3
Copper	656	861	762
Iron	21,200	28,000	25,533
Lead	550	632	600
Magnesium	6,980	9,210	8,278
Manganese	200	243	223
Mercury	0.87	3.6	1.3
Nickel	56.7	73.7	64.6
Potassium	3,040	3,950	3,458
Selenium	2.4	3.6	3.0
Silver	2.5	4.4	3.2
Sodium	12,200	16,900	14,083
Thallium	ND	0	ND
Vanadium	48.6	69.2	56.8
Zinc	1,720	2,130	1,924

Results are reported in mg/kg
ND = Not Detected

No regulatory criteria are available for TCLP PCBs. Because PCBs are the primary contaminant of concern in the Hot Spot sediment, the leachability (TCLP) data for PCBs are of interest. The average TCLP PCB result was approximately 28 ug/L (ppb). In comparison with the sediment concentration of 5,700 ppm, very little of the PCBs in the Hot Spot sediment leached into the TCLP aqueous solution. This is presumably because the PCBs are preferentially entrained in the high organic matrix of the sediments.

Metals concentrations are significant as they are likely to remain in the sediment following treatment using a PCB separation technology. It is possible that the separation technologies could increase the mobility of metals in the treated sediment, creating a product that exceeds TCLP metals criteria, thereby requiring additional treatment for metals prior to land disposal. Based on the results from the pilot studies conducted, this is not likely to be the case. Metals leachability following treatment for PCBs is discussed further in Section 4.

Table 2-8
TCLP Results for Hot Spot Sediment
(Third Pilot Study)

TCLP Analyte	TCLP Regulatory Limit (ug/L)	Feed Sediment from Third Pilot Study (ug/L)
PCB	NC	26.85
1,3-Dichlorobenzene	NC	22
1,4-Dichlorobenzene	7,500	85
1,2,4-Trichlorobenzene	NC	20
Phenanthrene	NC	ND
Fluoranthene	NC	ND
Pyrene	NC	ND
Arsenic	5,000	22.4
Barium	100,000	352
Cadmium	1,000	18.0
Chromium	5,000	21.2
Copper	NC	50.8
Lead	5,000	472
Mercury	200	ND
Selenium	1,000	12.7
Silver	5,000	ND
Zinc	NC	8,260

NC No Criterion
ND Not Detected

2.2.2 Physical Characteristics

The Hot Spot sediments are generally a fine-sandy silt with some clay sized particles present. The sediments are roughly 50 percent solids and 50 percent water with a wet unit weight of approximately 1.2 tons per cubic yard. The specific gravity of the solid particles within the sediment matrix is on the order of 2.4 to 2.5. The sediments also contain some shell fragments. However, the majority of these fragments, passed a one-inch sieve that was used to pre-screen feed material for two of the three pilot scale treatability studies.

Sediment from the third pilot study was evaluated for grain size distribution and found to be similar in nature to the sediments from stations 4 through 6 of the 1995 USACE CDF sampling program. The results of a comparison of PCB concentrations from these samples have shown similar consistency.

For potential full-scale treatment operations, the sediment would likely be a fine sandy silt, with approximately 50% to 70% of the sediment passing the number 200 sieve. The sediment is also approximately 50 percent moisture by weight. The shell fragments are not expected to hinder the treatment process and are readily broken into small pieces. A small volume of larger sized particles is located in the northeastern corner of the CDF adjacent to the dredge disposal pipe terminus. While these sediments are coarser in nature, they are expected to pass a one-inch screen without crushing and thus would not impact treatment operations. In addition, the contaminant levels associated with these larger particles are generally lower than the average Hot Spot concentrations and thus are not likely to be any more difficult to treat than the finer grained material.

3. IDENTIFICATION OF ARAR's

3. IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS), REMEDIAL ACTION OBJECTIVES POTENTIAL SEDIMENT TARGET TREATMENT GOALS

This section presents a summary of the regulations, laws and other requirements which govern the development, evaluation and implementation of remedial alternatives for the Hot Spot sediments. Those laws and regulations are set forth in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA) of 1986; the National Contingency Plan (NCP), 40 CFR Part 300, in particular, Section 300.430. Further guidance on the process of identifying and evaluating remedial alternatives is set forth in the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1988).

Section 3.1 provides an overview of the environmental laws governing the Hot Spot sediments including the general steps in completing a Remedial Investigation/Feasibility Study (RI/FS). These steps are described in detail in the National Contingency Plan (NCP) 40CFR Part 300. Section 3.2 will identify the applicable or relevant and appropriate requirements (ARARs) that may apply to the remedial alternatives. The development of remedial action objectives and potential sediment target treatment goals are presented in Sections 3.3 and 3.4, respectively.

3.1 Environmental Laws and Governing Response

Remedial actions, as defined by 300.5 of the NCP, are actions consistent with a permanent remedy, taken instead of or in addition to removal actions to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare, or the environment.

Section 121 of CERCLA requires EPA to select a remedy that is protective of human health and the environment, is cost-effective, and utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable. Section 121 also establishes a statutory preference for remedies that employ treatment which permanently and significantly reduce the toxicity, mobility or volume of hazardous substances over remedies that do not use such treatment. Furthermore, Section 121 requires that, upon completion, remedies attain Federal and state ARARs unless specified waivers are granted.

Section 300.430 of the NCP, in conjunction with the RI/FS Guidance, sets forth the remedial alternative development and remedy selection process. This process consists of the following steps:

- Identification of the nature and extent of contamination and threat presented by the release (300.430(d)(2)).
- Identification of general response objectives for site remediation (300.430(e)(2)(I)).
- Identification and screening of remedial technologies potentially applicable to waste and site conditions (300.430(e)).
- Development of a range of alternatives to achieve the site-specific response objectives (300.430(e)(3)).

- Initial screening of alternatives (300.430(e)(7)).
- Detailed analysis of alternatives (300.430(e)(9)).
- Selection of remedy (300.430(f)).

3.2 Project-Specific ARARs

Section 121(d) of CERCLA as amended by SARA and Section 300.430(f) of the NCP requires that remedial actions under CERCLA comply with all Federal and state ARARs. ARARs are used to determine the appropriate extent of site cleanup, to scope and formulate remedial action alternatives, and to govern the implementation and operation of the selected action. According to CERCLA Section 121(d)(4), ARARs may be waived by EPA under six specific conditions, provided that protection of human health and the environment is still assured. These conditions include the following:

- The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed;
- Compliance with such requirement at that facility will result in greater risk to human health and the environment than alternative options;
- Compliance with such requirement is technically impracticable from an engineering perspective;
- The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criterion, or limitation, through use of another method or approach;
- With respect to a state standard, requirement, criterion, or limitation, the state has not consistently applied (or demonstrated the intention to apply consistently) the standard, requirement, criterion, or limitation in similar circumstances at other remedial actions within the state; or,
- In the case of a remedial action to be undertaken solely under Section 104 using the Fund, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration, and the availability of amounts from the Fund to respond to other Sites which present or may present a threat to public health or welfare or the environment, taking into consideration the relative immediacy of such threats.

In the following subsection, ARARs are defined and the approach to identifying ARARs is discussed. Potential chemical-, location-, and action-specific ARARs for the cleanup and remedial action alternatives evaluation are defined and identified.

3.2.1 Definition of ARARs

A requirement under CERCLA may be either "applicable" or "relevant and appropriate" to a site-specific remedial action, but not both. A two-tiered approach may be applied: first, determine whether a given requirement is applicable; then, if it is not applicable, determine whether it is relevant and appropriate. These terms are defined in the NCP as follows:

Applicable Requirements: "Applicable requirements" refer to those cleanup standards, standards of control and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. An example of an applicable requirement would be Maximum Contaminant Levels (MCLs) for a site that causes contamination of a public water supply system which provides water service to 15 or more service entrances or 25 or more people. Only those state standards that are identified by a state in a timely manner and are more stringent than Federal requirements may be applicable.

Relevant and Appropriate Requirements: "Relevant and appropriate requirements" are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or state environmental siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. For example, while Resource Conservation and Recovery Act (RCRA) regulations may not be applicable to closing undisturbed hazardous waste in place, the RCRA regulation for closure by capping may be deemed relevant and appropriate. Only those state standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate. During the FS process, relevant and appropriate requirements are intended to have the same weight and consideration as applicable requirements.

Other Requirements To Be Considered (TBC): These requirements are non-promulgated advisories or guidance issued by the Federal or state government that are not legally binding and do not have the status of potential ARARs. Where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to be protective, guidance documents or advisories may be considered in determining the necessary level of cleanup for protection of human health or the environment.

3.2.2 Development of ARARs

Under the description of ARARs set forth in the NCP and SARA, many Federal and state environmental requirements must be considered. These requirements include ARARs that are triggered by the presence or emission of a chemical, by a vulnerable or protected location, or by a particular action, and are divided into three categories:

- Chemical-specific (i.e., govern the extent of site cleanup);
- Location-specific (i.e., pertain to existing site features); and

- Action-specific (i.e., pertain to proposed site remedies and govern implementation of the selected site remedy).

A separate document, published for the New Bedford Harbor site has identified potential chemical-, location-, and action-specific ARARs (Ebasco, 1990a). This document identifies project-specific Federal and state ARARs and summarizes the procedural and technical requirements of these regulations.

3.2.2.1 Chemical-Specific ARARs

Chemical-specific ARARs govern the extent of site cleanup and provide either actual clean-up levels or a basis for calculating such levels. These requirements are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for the proposed remedies at the site. Cleanup levels are based on Action-specific standards under the Toxic Substances Control Act (TSCA). Two federal guidances are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

3.2.2.2 Location-Specific ARARs

Location-specific ARARs are restrictions relating more directly to the geographical or physical setting position of the site. These locations include natural site features such as wetlands and floodplains, as well as manmade features including existing landfills, disposal areas, and local historic buildings. Location-specific ARARs are generally restrictions on the concentration of hazardous substances or the conduct of activities solely because of the site's particular characteristics or location. These ARARs provide a basis for assessing existing site conditions and subsequently aid in assessing potential remedial alternatives.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs address floodplain management, protection of fish and wildlife resources, and coastal zone management. Alternatives located in a floodplain may not be selected unless a determination is made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The U.S. Fish and Wildlife Service must be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs address coastal zone management, work within flowed and filled tidelands, and wetlands protection. The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

3.2.2.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based limitations or requirements that control actions at CERCLA sites. After remedial alternatives are developed, action-specific ARARs pertaining to proposed site remedies provide a basis for assessing the feasibility and effectiveness of the remedies. These requirements generally define acceptable treatment, storage, and disposal procedures for PCB-contaminated and hazardous substances during the response action. The ARARs and TBCs that apply to each of the remedial alternatives are discussed within the Detailed Analysis of Remedial Alternatives (Section 6 of this document). This information is also presented in tabular form in Appendix B to this document.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. Four of the alternatives (Solvent Extraction and Off-Site Incineration, HS-2C; Thermal Desorption and Off-Site Incineration, HS-3C; Off-Site Landfilling, HS-6, and Off-Site Incineration, HS-7) satisfy one of the first two approved disposal methods. The other seven proposed remedies (involving either in-place permanent disposal or on-site treatment) entail alternative disposal remedies that require approval by the Regional Administrator, based on the requirements of TSCA.

The two proposed in-place disposal remedies (No Further Action, HS-1 and In-Place Capping, HS-5) must comply with relevant and appropriate TSCA chemical waste landfill standards, which apply to the permanent disposal of PCB contaminated dredge spoil. TSCA allows for specific requirements for the landfill ARAR to be waived upon a finding by the Regional Administrator that the facility will not present an unreasonable risk of injury to health or the environment. To use the present CDF facility as a permanent disposal facility, waivers are required regarding hydrologic conditions, flood protection, and leachate collection. The present facility's design that includes double impermeable bottom and side liners, a monitoring system for leak detection, and top-of-berm elevation two feet higher than the 100-year flood elevation should meet waiver standards for the prevention of injury to health or the environment.

The remaining nine remedies (involving either removal of contamination off-site or on-site treatment) all require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived through "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. The nine removal or on-site treatment alternatives will require storage

periods estimated between two to five years before completion of the final remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable for all alternatives that involve the disposal of treated sediments (Alternatives HS-2A. 2B and 2C; HS-3A, 3B, and 3C; and 4), containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction and treatment technologies, and handling/dewatering of the sediments before off-site removal or on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling, dewatering, and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment may be required because of surface run off becoming contaminated by the stored sediments or from dewatering and/or process discharges. Every proposed alternative potentially may produce contaminated water that will require treatment at the facility's on-site water treatment plant. Operation of the treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC.

This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised TEF and the air dioxin guideline will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

3.3 Remedial Action Objectives

The remedial action objectives for this FS Addendum are taken directly from the 1990 ROD (EPA, 1990). The remedial action objectives are based on the public health and environment risks posed by the Hot Spot sediment and the ARARs for the site. The objectives have been modified to reflect EPA's actions to date including removal of the Hot Spot sediment from the harbor and isolating them in a double-lined storage facility at the site. These initial remedial actions have served to protect public health and the environment while EPA, the state and the local community evaluate other potential long term solutions.

The remedial action objectives have also been modified to reflect inclusion of an additional exposure pathway, inhalation. The remedial action objectives for the Hot Spot sediment are listed below:

1. Protect public health by preventing direct contact with the Hot Spot sediments and
2. Protect marine life by preventing direct contact with the Hot Spot sediments.

In developing remedial alternatives to address these remedial action objectives, the FS Addendum will explore potential solutions that fall into two general categories of response actions, "removal" and "non-removal." These two categories will encompass the complete range of alternatives including no further action and on-site containment under the non-removal category. The removal category will include a wide range of alternatives including off-site containment, off-site treatment and on-site treatment. In evaluating the range of alternatives to achieve these remedial action objectives, CERCLA requires the alternatives use permanent solutions and innovative treatment technologies to the maximum extent practicable. In addition, preference should be given to alternatives that reduce the toxicity, mobility or volume of the contaminants through treatment. Additional details regarding the development and screening of the remedial alternatives is presented in Section 5 of this FS Addendum with the detailed analysis of the remedial alternatives presented in Section 6.

3.4 Potential Sediment Target Treatment Goals

The initial cleanup step of removing the Hot Spot sediment from the marine environment is complete and so the issue of cleanup levels is no longer relevant. However, the range of potential remedial alternatives developed and evaluated in Sections 5 and 6 of this FS Addendum will include some treatment alternatives, and so the issue of target treatment goals is relevant to those particular alternatives.

The applicability of the treatment goals is limited to remedial alternatives which employ on-site treatment technologies. Off-site treatment technologies would treat the sediment in a manner which is consistent with the applicable federal, state and local regulations. The treatment process would be reflected in the facility specific operating permits. For example, a permitted off-site incineration facility would have to comply at a minimum with the applicable TSCA regulations including but not limited to the incineration requirements in Section 761.70. Included within these regulations is the requirement for 99.9999% destruction. Also, the target treatment goals that are developed herein do not apply to the on- and off-site containment alternatives (e.g., capping the sediment in-place or disposal in a permitted off-site landfill).

The results of the treatability studies demonstrated that the sediment treatment technologies were all effective in treating the sediments to varying degrees. The solvent extraction and thermal desorption separation technologies demonstrated on-site appear capable of separating the PCBs from the sediments to the 50 ppm level. Vitrification appeared capable of reducing PCB concentrations in the sediment to very low levels. The goal for PCB destruction for the on-site treatment technology is dependent on the method of destruction. Under TSCA, alternative disposal technologies for PCB contaminated dredge spoil are required to provide adequate protection of health and the environment.

Heavy metals remain in the sediments after treatment for all of the technologies tested at the site. However, results of TCLP tests conducted on the treated sediments did demonstrate that leachate concentrations are within regulatory limits for all of the listed constituents.

4. TREATABILITY STUDIES

4. HOT SPOT SEDIMENT TREATABILITY STUDIES

The overall treatability study goal was to find a safe viable treatment technology for the Hot Spot sediments currently contained in the shoreline CDF just north of the Coggeshall Street Bridge in New Bedford, MA. This goal was developed by the forum group including representatives of EPA, the State DEP, other federal resource agencies, local community leaders and several community interest groups. The results of the treatability studies are being used by EPA to support selection of a remedy for the Hot Spot sediments. This remedy will be selected by EPA with input from other members of the forum group on a full range of remedial alternatives including no further action and several treatment and non-treatment (containment) approaches.

4.1 Treatability Study Test Program Overview

The treatability study program was initiated in early 1995 with the field testing occurring in late fall 1995 through 1996. The range of technologies tested during the treatability study program included: (i) solidification/stabilization (S/S); (ii) contaminant destruction; and (iii) contaminant separation and destruction processes. The two stage contaminant separation and destruction technologies were selected for two of the studies to evaluate the contaminant removal and the subsequent chemical destruction processes separately. It was also recognized that a final treatment step of S/S may be required to immobilize the heavy metals in the treated solids that may not be treated by the separation and/or contaminant destruction processes which often only treat the PCBs and other organics.

4.1.1 Treatability Study Objectives

The overall approach for the treatability studies was developed by members of the community forum group discussed above. This group was established to support development of a cleanup solution for the Hot Spot sediments. The test objectives for the treatability testing program were based on the group's overall project goals and included:

1. Evaluate/quantify the effectiveness of chemical destruction and/or separation with chemical destruction technologies to treat PCBs and heavy metals present in contaminated Hot Spot sediments.
2. Quantify the disposition of key constituents to support mass balance evaluations.
3. Identify potential environmental and/or engineering constraints related to the use of destruction and/or separation with chemical destruction technologies to remediate site sediments.
4. Produce data of sufficient quality such that different treatment processes can be evaluated relative to each other. If required, data may be used to assess the risks associated with treatment system operations and the disposal/storage of treatment residuals.
5. Evaluate the viability of chemical destruction and/or separation with chemical destruction processes to be scaled-up to full-scale operations including the overall development time-frame and estimated full-scale treatment costs.
6. Characterize the operational hazards associated with full-scale implementation of the chemical destruction and/or separation with chemical destruction process.
7. Evaluate the performance of chemical destruction and/or separation with chemical destruction processes against the nine detailed evaluation criteria contained in the National Contingency Plan (NCP), including the ability of chemical destruction and/or separation and chemical destruction to reduce the toxicity, mobility, and volume of the hazardous constituents.

4.1.2 Treatability Study Program

The contaminant destruction, and contaminant separation and chemical destruction technologies were tested on-site with pilot scale treatment units. For technical approaches that combined separation and subsequent contaminant destruction, the processes were tested together as a single test. This provided information as to the completeness of the treatment approach and was designed to highlight any potential difficulties that could be encountered in trying to combine the treatment processes.

Foster Wheeler selected three firms to participate in the pilot scale test program. The potential opportunity to participate in this test program was nationally advertised in the Commerce Business Daily (CBD). Sixty firms requested the bid documents from Foster Wheeler. The selection of the three firms was primarily based on technical approach and relevant experience. One of the initial three firms later withdrew the proposal and a second procurement was initiated to secure an alternate third pilot scale vendor. This second procurement was quite similar to the first and resulted in the award of a subcontract.

In addition to the three proprietary technologies mentioned above, several S/S technologies were tested on-site at the bench scale using two proprietary admixtures and a mixture consisting primarily of Portland cement and absorbent clay. The two proprietary admixtures were chosen from several proposals which were submitted in response to a nationally advertised opportunity in the CBD. Again, the primary basis for selection was technical approach and experience.

The details of the treatability study program are discussed in the following subsections. Section 4.1 discusses the test objectives and summarizes how each process was evaluated. The technologies that were tested are briefly summarized below. The details of operation and the findings of each pilot study are discussed in the subsection referenced in parentheses. A summary of the pilot study findings is included in Section 4.2.

- Ionics RCC and CRTI - a two stage process involving contaminant removal using solvent extraction, and the subsequent chemical destruction of chlorinated organics, including PCBs, using sodium and ammonia as reducing agents (Section 4.4)

- Geosafe - a single stage contaminant destruction process using pyrolitic vitrification (high temperature melting in the absence of oxygen) to destroy and demobilize organic and inorganic contaminants (Section 4.5)

- SAIC/Eco Logic - a two stage process involving the thermal desorption of organics from the sediment and subsequent gas phase reduction using high temperature in a reducing (hydrogen) atmosphere (Section 4.6)

- Solidification/stabilization - sediment was mixed with various reagents, allowed to solidify and tested to determine whether the mobility of contaminants was reduced (Section 4.7)

The evaluation process for each technology was based on the analytical chemistry results for the various process outputs and engineering evaluations of the process mechanics and operations. To maintain consistency in evaluating the processes and to ensure that the quality of data were acceptable for the project objectives, a rigorous analytical and quality control program was implemented. This analytical program is

discussed in Section 4.3. Results of some of the quality control measures are also discussed in Section 4.3. An overall discussion of the treatability study testing, including a summary of the strengths and limitations of each process and specific implications for full-scale application is included in Section 4.2.

This section (Section 4) includes significant detail for each of the technologies tested during the treatability studies. The discussions in Sections 4.4 through 4.7 include significant details on the process descriptions, pilot scale testing procedures and findings, as well as assumptions for full-scale implementation. This level of detail may not be of interest to all readers. Accordingly, Section 4.2 includes a summary overview of each of the technologies. Similarly, Section 4.3 includes a fairly detailed discussion of the analytical methods and quality control procedures implemented to ensure that the data collected during the treatability studies were representative and comparable. This level of detail regarding analytical methodology and QC results may not be of interest to all readers.

4.2 Summary of Treatability Study Results

The following subsections briefly discuss and summarize each of the treatability studies and highlight the strengths and limitations of each process. It is important to note that many of these limitations are not necessarily inherent in the technical approach. Rather, many of the limitations noted are in areas where pilot scale testing indicated that additional process engineering, development and testing would be required. The results are discussed at a summary level relative to the overall objective of finding a safe, viable non-incineration technology effective for treating the Hot Spot sediment. Where appropriate, the subsections identify further work required during the pre-design and design phases of work before full-scale implementation could be satisfactorily realized.

This section is intended to provide an overview and summary level discussion of the treatability study testing relative to the remedial technology and remedial alternative considerations discussed in Sections 5 and 6, respectively. At a summary level, this section may suffice for some readers to provide a basis for the discussions and conclusions presented in Sections 5 and 6. For those who are interested in the specific details and pilot study testing, refer to the appropriate subsections (4.4, 4.5, 4.6 and 4.7) below. Similarly, detailed discussions of full-scale costing is provided in the appropriate full-scale implementation subsection with only summary level discussion included in this section.

4.2.1 Solvent Extraction/Solid Phase Chemical Destruction (Ionics RCC/CRTI)

Both the Ionics RCC and CRTI processes were effective in treating the PCB contaminated Hot Spot sediment. The Ionic RCC solvent extraction process effectively treated the Hot Spot sediment to PCB concentrations less than 50 ppm with five to six extraction cycles. With additional extraction cycles (eight to nine), the process appears capable of treating the sediments to concentrations below 10 ppm. The residual solids from the solvent extraction process passed TCLP testing for heavy metal contaminants and would, therefore, require no further treatment for metals prior to disposal. The solvent extraction process is a non-thermal process and does not appear to produce undesirable organic by-products, nor does it require an extensive off-gas treatment system.

The scale up plan for the Ionics RCC process looks positive and includes many pieces of equipment that are routinely available, It is noted that one of these items (the dryer) is a long lead item which can take six months to obtain. As a result, it may take up to 18 months to design and fabricate a solvent extraction unit. This is not seen as a serious limitation.

The CRTI Solvated Electron Technology process effectively destroyed PCBs in the concentrated oil product generated from the solvent extraction process. Given enough sodium, the reaction appears to destroy the PCBs to the 1 to 5 ppm range. This solid phase chemical destruction process is chemical in nature rather than thermal. As a result, the undesirable organic by-products, such as dioxins and furans, which can be generated by the thermal processes, do not appear to be a significant concern for this chemical treatment process.

The pilot study testing did identify materials handling issues associated with the CRTI solid phase chemical destruction treatment process and equipment. During the pilot test, the feed mechanism difficulties were partially mitigated by over-dosing with sodium. This resulted in treated material containing reactive untreated sodium and caustic sodium amides. Resolution of these issues would be required prior to implementing full-scale treatment using this technology. These issues are briefly summarized as follows:

- The CRTI pilot unit feed mechanism required modification in the field to handle the semi-solid material generated during the solvent extraction process. Similar modifications or methods to keep the oil extract in liquid form will have to be developed and tested to ensure effectiveness for the full-scale unit. Difficulties with the feed mechanism caused cross contamination of the treated product. This cross-contamination was addressed with additional sodium and modifications to the quenching (to stop the chemical reactions) sequence.

- During the pilot study testing, the material was over-dosed with sodium in order to obtain the desired PCB results (non-detect). The treated residual had unreacted sodium and sodium amides, making the residual material both reactive and caustic. The reactive and caustic properties were effectively neutralized with the addition of an acidic aqueous solution. However, the resulting material was an aqueous slurry rather than the anticipated, easier to handle, inert solid. Additional testing should assist in determining the appropriate amount of sodium relative to the concentration of PCB in the untreated material. Whether the material can be effectively treated to trace levels of PCBs without being reactive or caustic needs to be formally demonstrated.

- As a result of the difficulties associated with the amount of sodium required to treat the PCBs, the chemical and physical composition of the CRTI treated product cannot be accurately determined. Without this characterization, it cannot be determined whether the CRTI post-treatment product will require additional treatment prior to disposal or whether the material can be disposed of on-site without additional treatment.

The CRTI treated material handling issue is significant because it could impact the ultimate viability of the CRTI process. In summary, the reactive dry solid product produced during the pilot study may not be appropriate for disposal in an on-site CDF and may pose a potential risk to worker health and safety. The neutralized aqueous slurry mixture of salt and oil produced during the pilot study was similarly not suitable for on-site disposal. In fact, the only acceptable disposal method for this material may be off-site incineration.

The information required to address these issues can be gathered during the design process. Also, the design of the Ionics RCC and CRTI processes should include a detailed hazard plan and analysis given the hazardous nature of the various process and reagents used. These reagents include diisopropylamine,

sodium, and ammonia. While these materials are routinely used in industry, their application to hazardous waste cleanup is still somewhat new.

4.2.2 Vitrification (Geosafe)

Pilot scale testing demonstrated that vitrification can successfully "melt" Hot Spot sediment into an essentially inert block of glass. Analysis of the resulting glass product indicates that PCBs and other organics are no longer present in the glass matrix and that the remaining inorganics are not leachable in quantities above relevant regulatory criteria.

The vitrification pilot study did identify some specific matrix related difficulties in treating the Hot Spot sediment which would require resolution and additional testing prior to full-scale implementation. Specifically, the process off-gas data from the pilot study indicate that a significant portion of the PCBs were desorbed from the sediment rather than destroyed or immobilized in the vitrified product. The data also indicate that the process produced organic by-products, including dioxins and furans, that required treatment in the off-gas system.

It appears that the operational difficulties experienced during the pilot test were directly related to the sediment matrix. That is, the sediment contains a large proportion of water (approximately 50 percent) and is very finely grained. This caused the sediment to become "fluidized" during the melting process, releasing significant amounts of steam and particulate to the off-gas stream. Under these circumstances, organic compounds were released with steam from the perimeter of the melt rather than remaining entrained in the sediment matrix. The organic compounds in the steam/particulate phase were then no longer available for treatment in the melting process and were subsequently transferred and treated within the off-gas treatment system.

Geosafe believes that these operational difficulties can be successfully overcome by dewatering the sediments to a moisture content on the order of 10 percent and staging the sediment prior to full-scale treatment. Foster Wheeler similarly agrees that steps can be taken to improve destruction and removal efficiencies and to minimize the generation of undesirable organic compounds such as dioxins and furans in the vent gas stream. However, the ability of the dewatering techniques to reduce the sediment moisture content to the desirable level and whether dewatering the sediment will be sufficient to resolve the matrix related difficulties have yet to be determined.

Geosafe recommended that full-scale implementation of this technology would require, at a minimum, a dewatering system that could reduce the moisture content of the sediment to the range of 10 percent. Foster Wheeler believes the most effective means of reaching this moisture content is through the use of a thermal dryer. In addition, an off-gas treatment system including a thermal oxidation unit may also be required to destroy any remaining organic compounds prior to releasing the gas from the vitrification process to the atmosphere. The off-gas system would also be used to treat off-gas from the thermal dryer unit.

The full-scale implementation scenario presented in Section 4.5 was developed by Foster Wheeler with initial input from Geosafe. The approach contained in Geosafe's report did not account for the methods that would be required to dewater the sediment to the 10% moisture range, the high potential for volatilization of PCBs from the sediment during material handling operations, and the potential need for an enhanced off-gas treatment system. Given the nature of these potential concerns, Foster Wheeler has included an enhanced off-gas treatment system in the full-scale treatment approach. This off-gas treatment system would

potentially apply to both the dewatering and vitrification process units. Additional pilot scale testing during the design phase, not the remedial action phase, would ultimately determine the level and type of off-gas treatment system required for full-scale implementation.

The amount of pre-design testing that would be required is an area of technical difference between Foster Wheeler and Geosafe. In summary, Geosafe believes their experience in implementing vitrification provides them with a reasonable basis for the conceptual full-scale plan presented in their report. Foster Wheeler does not question the number of times Geosafe has implemented vitrification at the bench, pilot and full-scale. Rather, we believe the results of the Hot Spot treatability study should be weighted heavily in considering potential full-scale application of vitrification to the Hot Spot sediments. Until proven otherwise in a comprehensive design scale testing program, a conservative technical approach is warranted. The pilot study testing that would be conducted during the design process should address the following data gaps prior to considering full-scale implementation:

- The effects of dewatering the sediment on the production of dioxins and furans.
- Process treatment (contaminant destruction) within the vitrification process versus through the off-gas collection and treatment system.
- Off-gas treatment equipment that will be required to meet emissions criteria.

This additional pilot scale testing could be conducted during the design phase of the clean-up prior to full-scale implementation. However, additional testing does not guarantee that vitrification will prove to be a viable alternative for the Hot Spot sediment. Should vitrification be selected as the proposed remedy, it may be advisable to have a back-up or contingency plan in place in the event that design scale vitrification testing were to be unsuccessful.

4.2.3 Thermal Desorption/Gas Phase Chemical Destruction (SAIC/Eco Logic)

Pilot scale testing demonstrated that the Eco Logic treatment process was successful in: (i) separating the PCBs from the Hot Spot sediment with the thermal desorption unit and (ii) destroying the PCBs (separated by thermal desorption) in the gas phase using the reactor system. The thermal desorption unit did not perform as well as expected; however, it was demonstrated as being capable of treating the sediments to an average residual PCB concentration of 52 ppm from an average initial PCB concentration of 5,700 ppm. The treated sediment PCB concentrations were higher than SAIC/Eco Logic had initially expected. Several difficulties were encountered in operating the thermal desorption unit that may have contributed to lower treatment efficiencies. These difficulties included:

- Initial difficulties reaching the design operating temperature
- Sediment throughput at 40% of the design capacity
- Particulate buildup within thermal desorption unit
- Loss of molten tin during treatment operations
- Mechanical breakdown of the exit system for the treated solids

The gas phase reactor and off-gas treatment systems performed well during the treatability study, both mechanically and from an effectiveness perspective. The gas phase reactor, in combination with the downstream off-gas treatment system, was capable of achieving a gas phase PCB destruction efficiency

of approximately 99.999 to 99.99989%, depending on the calculation method. The DREs are slightly less than the 99.9999% (6 nines) required of incinerators.

Sampling of the system gases was performed at several locations to assess whether the TRM and reactor processes were creating dioxins and/or furans. The vent gas data from the TRM suggest that, despite the hydrogen atmosphere within the TRM, the process may generate dioxins and furans during the desorption process. Sampling limitations precluded fully assessing this possibility during the pilot scale test. Should the production of dioxins and furans during the process require a complete quantitative assessment, additional testing would be recommended.

Sample data from the thermal oxidizer off-gas (collected isokinetically and therefore, not limited by sampling constraints), were used to evaluate the degree to which dioxins/furans were ultimately treated within the overall system. The overall system DRE for these compounds indicate that the processes were effective in treating these compounds (99.9996% DRE on Toxicity Equivalency basis, and 99.9925% DRE on a total mass basis).

It is important to note that the size of the Eco Logic pilot scale treatment system did not allow for the collection of isokinetic (flow representative) samples at intermediate gas phase process points (e.g., before the reactor and after the reactor and scrubbers). The treatment system was modified by SAIC/Eco Logic to collect grab type samples (non-isokinetic) of the gas at these intermediate locations. This was done to gather as much information as possible with the hope that, at a minimum, the data could be used in a qualitative manner. Given the limitations of these intermediate sampling locations, the data collected cannot be used to support absolute conclusions regarding such issues as dioxin/furan production within and/or downstream of the thermal desorption unit. More importantly, the data collected at the point of release to the atmosphere (collected isokinetically) does indicate that the overall processes are effective in treating these compounds, and that the process only released trace amounts of dioxin/furans during the course of the New Bedford Harbor pilot scale treatability study (approximately 15 pg/hr). The concentration of dioxin TEQ at the vent gas outlet was 0.10 pg/dsm^3, only slightly higher than the DEP ambient air guideline of 0.045 pg/m^3 TEQ. It is expected that dispersion at the stack outlet will be sufficient such that ambient concentrations will not exceed the guidance level.

The gas phase reactor was determined to produce naphthalene and benzene during the chemical destruction process. A multi-component gas phase treatment system downstream of the process reactor would be required to treat the off-gas for full-scale operations. While a portion of the process off-gas could be recycled through a catalytic steam reformer, an excess gas burner operated in conjunction with a process boiler would be used to provide final treatment of the gas prior to atmospheric release. The excess gas burner would have to be designed to comply with applicable air standards. Thermal energy from the excess gas burner could also be used within the overall process to reduce treatment costs.

The Eco Logic technology also has potential application to the PCB residuals from other separation processes, including the solvent extraction process tested earlier in the treatability study program. A combination of the two technologies would eliminate the initial Eco Logic thermal desorption step on the wet sediment. Rather, the Eco Logic process would only be applied to the oily residue that is the end product of the solvent extraction process. Eco Logic would use either the Sequential Batch Vaporizer or direct injection into the reactor system to introduce the concentrated oil for treatment. This approach may rate higher on the implementability scale, given the difficulties encountered for the thermal

desorption process during the New Bedford Harbor treatability study, and that Eco Logic's experience base is more heavily weighted to this type of application.

Eco Logic is continuing the testing of a full-scale TRM at a site in Canada. The results presented by Eco Logic to date indicate the process has treated 1,500 tons of sediment type waste over the past several months. The process has reportedly been used to treat waste solids contaminated with PCBs up to 170 ppm, down to levels on the order of 1 to 5 ppm.

4.2.4 Solidification/Stabilization

Based on the data received from the bench scale treatability study, it does not appear that stabilization/solidification is a viable treatment method for the Hot Spot sediments. At the mix ratios tested, the admixtures did not significantly lower the leachability of the PCBs and, in most cases, increased the leachability. A high reagent to sediment ratio may decrease the leachability of the PCBs, however, the treatment cost would also increase as well as the volume of material which must ultimately be disposed.

Solidification/stabilization may be an appropriate treatment technology to consider for heavy metals contamination. Available data indicate that TCLP metals concentrations are not likely to be of concern in untreated sediment or in the treated material resulting from the PCB treatment processes. However, should heavy metals be of concern at a later date, solidification/stabilization appears to be a viable treatment option for further consideration.

4.2.5 Summary of the Treatability Study Findings

The technologies tested during these treatability studies included separation using solvent extraction and thermal desorption, contaminant destruction using vitrification, solid phase chemical destruction and gas phase chemical destruction. Solidification and stabilization of the sediment was also tested and found to be unsuccessful. The solvent extraction and solid phase chemical destruction processes were the two technologies that did not involve thermal processes to treat the sediment.

With the exception of the solidification, each technology was found to be somewhat successful in treating the Hot Spot sediment. Each technology appears to be capable of producing a treated product with less than 50 ppm PCBs and that passes TCLP leaching criteria. Note that the average treated sediment concentrations were slightly greater than 50 ppm for the thermal desorption process, this appears to be related to operational difficulties encountered during the treatability studies and can likely be improved with additional engineering controls.

The vitrification process desorbed significantly more PCBs to the vent gas stream than initially anticipated and also produced dioxins and furans. A thermal dryer and an off-gas treatment system could potentially reduce these difficulties. However, significant additional testing would be required to ensure adequate resolution of these issues prior to full-scale implementation.

The thermal desorption process could not be definitively assessed with respect to the creation of dioxins and furans due to sampling limitations. The available data do indicate that the formation of dioxins and furans is a strong possibility using this thermal process. To obtain additional quantitative data, additional testing would be required. Not withstanding this, if there is a zero tolerance for the creation of dioxin

and/or furans, as opposed to thermal separation of the trace levels that are present in the Hot Spot sediment, then thermal separation is likely to be somewhat problematic during full-scale implementation. It is also important to note that, from a technology perspective, if these compounds are present in the off-gas, effective means are available to significantly reduce their concentrations. These control technologies are well developed, readily available and would also be used, in many cases, to control particulate and/or heavy metals that will be emitted in the off-gas stream during thermal desorption.

The treatability study program was successful in finding treatment technologies capable of treating the Hot Spot sediments. The program was also effective in highlighting specific areas where processes required further development to ensure that implementation could be conducted in a safe and environmentally compliant manner.

This testing program also provided an indication of cost for treatment and demonstrated that it would take several years to implement each technology. The "treatment" only costs for Geosafe are estimated at $1,149 per ton and would take 5 to 6 years to implement. The costs for treatment only for the combination of Ionics RCC and CRTI ($721/ton) is not dramatically different than the estimated costs for treatment with the Eco Logic process ($617/ton). Both treatment processes would take approximately three years to implement from the date of contract award.

It is also important to look at the total estimated costs for treatment in Section 6 as there are other cost components in terms of site facilities, materials handling and air monitoring that significantly influence the overall treatment cost. In doing so, the apparent cost advantage for treatment only is greatly narrowed by these other costs as the total remedial alternative costs for Ionics RCC/CRTI and Eco Logic are $27.1M and $26.3M, respectively. It is also important to note that the level of accuracy used in the Feasibility Study costing process is plus 50 percent, minus 30 percent. As a result, these two costs are essentially the same and other evaluation factors should play a larger role than cost in the evaluation of the remedial alternatives.

In summary, there are several viable treatment approaches that can be constructed out of the mix of technologies tested. However, each of these approaches has its own particular limitations that will require time, money and effort to resolve prior to and during implementation.

4.3 Analytical Methods and Quality Control

Much of the treatability study evaluation process was based on the results of laboratory analyses of the various treatment process outputs. In order to ensure that the data were comparable and of known quality, standard analytical methodologies were used for sample analyses and a rigorous quality control (QC) program was implemented to quantitatively measure laboratory performance. The following subsections discuss the analytical methods and the quality control procedures. Differences in analytical methodology and their specific application to the treatability study are discussed below. Specific QC findings relative to the overall treatability study program are also discussed in this section. Individual data points and how they were used in the evaluation process are discussed in the individual vendor reports included in the Data Compendium. Laboratory data for the samples collected during the program are also included in the Data Compendium.

In general, the analytical results were found to be comparable and acceptable for the purpose of assessing process performance. Differences in methodology, where noted, do not appear to be significant relative

to the overall test conclusions (summarized in Section 4.2). The results of the QC program confirmed that, overall, results were comparable and accurate for their intended use in an engineering evaluation. As discussed in more detail below, some quality control results exceeded established criteria, resulting in some data being considered "estimated". Although, these estimated results do not pose a significant concern from an engineering point of view, the potential variability associated with individual data points should be understood prior to using the data to assess human or ecological risk. Should the data be used for risk assessment purposes, a more thorough review of each data point is recommended.

4.3.1 Analytical Methods

The analytical methods used for the samples collected during the pilot study testing are summarized below. Several analyses were considered more heavily in the evaluation process, specifically, PCBs, dioxins and furans, and in some matrices, TCLP metals. These analytical methods are discussed in more detail below.

With the exception of those routine matrices analyzed for semivolatiles and metals using the EPA Contract Laboratory Program (CLP), samples were analyzed by subcontractor laboratories selected based on their expertise with the specific methodology and/or matrix.

In addition to the analytical program described in this section, an on-site laboratory was used to perform screening level analyses for PCBs, percent solids, and pH. An off-site laboratory provided fast turnaround analyses of approximately 10 percent of the on-site samples to confirm the screening level results. On-site screening and off-site fast turnaround results were used to optimize operating parameters in the field and were not used in the overall process evaluations. However, where the on-site data provide additional summary level information on the process performance, they are presented in the individual evaluation sections. Data used in the evaluation of the pilot processes were considered "Performance" level data and are further discussed below.

4.3.1.1 Solid and Liquid Analytical Methods

Solid and liquid matrices were analyzed by the methods listed in Table 4-1. Subcontractor laboratories are also listed in Table 4-1. Where possible, the analytical methods were intended to be similar to the EPA CLP program. The CLP program was designed to standardize the analytical methods and reporting requirements regardless of which laboratory performed the analysis. Such standardization was useful in maintaining consistency throughout the duration of the treatability study testing (approximately May through November, 1996) and also facilitated data validation in accordance with EPA Region I guidelines. Where necessary, due to analytical requirements or matrices, CLP guidelines were modified. Where no CLP method was directly applicable, EPA approved methodology was used, as noted in Table 4-1. PCBs, dioxins and furan, and TCLP were key analyses used in the treatability study evaluation process. These key analytical methods are discussed in more detail below.

Table 4-1
Summary of Analytical Laboratory Methods for Solid and Liquid Matrices

Analysis	Method	Laboratory[1]
PCBs	OLM03.0 modified to analyze for PCBs only	Ceimic, IEA-CT
SVOCs*	OLM03.0	CLP, Ceimic, IEA-CT
TAL Metals*	ILM03.0	CLP, Ceimic, IEA-CT
Dioxins and Furans	EPA Method 8290	Triangle, Alta
PCB Isomers	EPA Method 680, modified to report total mono through deca isomers	Triangle, Alta
TCLP (conventional)	EPA Method 1311/OLM03.0/ILM03.0	CompuChem
TCLP (steel cage)	40 CFR Part 268, Proposed Rule - similar to EPA Method 1311 modified with a steel cage to leach solidified samples whole rather than pulverizing first	CompuChem
Oil and Grease	EPA Method 413.1 (gravimetric) modified to use methylene chloride as the extraction solvent	CompuChem, IEA-CT
DIPA	EPA Method 8000, (GC/FID) Modified for DIPA	Ceimic
Moisture in Oil	ASTM Method D4377 (Karl Fischer)	NUS
Ammonia	EPA Method 350.2	Ceimic
Percent Solids	ASTM Method D2216	All
Chloride	EPA Method 325.2	IEA-CT
Sulfate	ASTM Method 1757, A	IEA-CT
Extractable Organic Halide (EOX)	EPA Method 9020	IEA-CT
Total dissolved, and suspended solids (TDS/TSS)	EPA Method 160.1, 160.2, 160.3	IEA-CT
pH	EPA Methods 9040 and 9045	Ceimic, IEA-CT

**Soil and aqueous samples were analyzed through the EPA CLP program. Analyses for non-routine matrices were analyzed by a subcontractor laboratory and the methods modified for the unusual matrices.*
[1]Complete laboratory names and locations are given below.

The Foster Wheeler subcontractor laboratories used during this study and their location are listed as follows:

Ceimic Corporation (Ceimic) Narraganset, RI
IEA Corporation (IEA-CT) Monroe, CT
Triangle Laboratories Inc. (Triangle) Research Triangle Park, NC
Alta Analytical Laboratory (Alta) El Dorado Hills, CA
CompuChem Environmental Corporation (CompuChem) Research Triangle Park, NC
Halliburton NUS Corporation (NUS) Pittsburgh, PA
Air Toxics Ltd. (Air Toxics) Folsom, CA

Solid and liquid matrices were analyzed primarily to evaluate the disposition of PCBs, metals, and to a lesser extent, semivolatiles. TCLP and wet chemistry results were used to assess potential disposal

options for the various process outputs. Samples of sediment were also analyzed to provide input data for mass balance closure.

4.3.1.2 Vent Gas Sampling and Analytical Methods

Vent gas samples were collected by TRC using the stack gas sampling methodology summarized in Table 4-2. Where required by the method, the laboratory prepared the glassware, and prespiked the collection media prior to shipping to the field. TRC subsequently collected the samples, packaged and shipped the samples to the laboratory. Additional information on TRC's field procedures is provided in their reports included in the Data Compendium. Sample results corrected to the volume collected and to the total stack flow rates are also included in these reports. Collection and laboratory analytical methods are summarized in the Data Compendium.

Table 4-2
Summary of Sampling and Analytical Methods for Vent Gas Samples

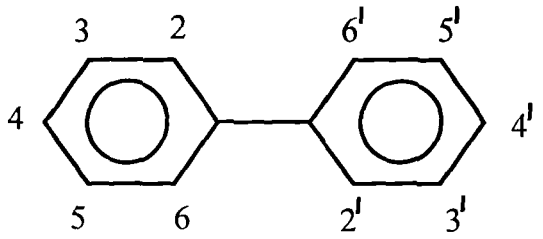
Analysis	Method	Laboratory
PCB Isomers	EPA Method 23/CARB Method 428	Alta
Dioxins and Furans	EPA Method 23/EPA Method 1613A	Alta
PAHs	EPA Method 23/8270/TO-13	Alta/Air Toxics
Metals (As, Cd, Cr, Cu, Pb, Hg, Zn)	EPA Modified Method 29	Triangle
Particulate	EPA Modified Method 26A	Triangle
HCl/Chloride	EPA Modified Method 26A	Triangle
Benzene	EPA Method TO-14 modified for vent gas sampling	Air Toxics

Complete laboratory names and locations are given in Section 4.3.1.1 above. Vent gas samples were collected and analyzed to assess process performance and to measure gaseous releases to the atmosphere.

4.3.1.3 PCB Analyses

The primary objective of the Hot Spot treatability study was to measure process effectiveness at removing and/or destroying PCBs. Accordingly, the PCB data were the most critical to the evaluation process. PCBs were analyzed using two different procedures, the first being the more conventional Aroclor analysis, the second being analysis for PCB isomer groups. In order to understand the different analytical methods, a limited understanding of the chemical structure of PCBs is needed. PCB is an abbreviation for polychlorinated biphenyl. The biphenyl group consists of two connected phenyl rings, with ten positions available for either hydrogen or chlorine atoms. The biphenyl group is illustrated in Figure 4-1, the numbered positions indicate where chlorine atoms may be attached.

Figure 4-1
Chemical Structure of a PCB Molecule



The number of chlorine atoms attached to the biphenyl group define the chlorination level of the biphenyl. For instance, two chlorine atoms attached to the biphenyl group would be a dichlorobiphenyl. The position of the chlorine atoms on the biphenyl molecule define the specific PCB compound or congener, for instance, 2,4-dichlorobiphenyl. Because ten positions are available on the biphenyl group, there are 209 different configurations for attaching one to ten chlorine atoms. Each specific chlorinated biphenyl compound (e.g., 2,4-dichlorobiphenyl) is referred to as a PCB congener.

Each congener has its own unique chemical structure (specific number and arrangement of chlorine atoms) and therefore can be separated from other congeners on a gas chromatography column, based on its unique physical characteristics. Aroclors are specific mixtures of PCB congeners named after the average molecular weight of the mix (e.g., Aroclor 1242). PCB "oils" were mixtures of PCBs in solvent and were typically manufactured and used as Aroclor mixtures. These are mixtures of different PCB congeners that, when analyzed using a gas chromatograph (GC) equipped with an electron capture detector (ECD), provide a characteristic "fingerprint" pattern. Routine laboratory analysis looks for the characteristic Aroclor "fingerprint" pattern to identify and quantify PCBs. This is the most routinely used (and most inexpensive) method of PCB analysis. Total PCB concentrations are typically reported as the sum of the detected Aroclor concentrations. For New Bedford Harbor sediment, this convention has worked well. Aroclors 1242 and 1254 have been routinely detected in samples of harbor sediment and results from various sampling rounds conducted over the years have been reasonably comparable.

A group of compounds with the same molecular weight and formula but different chemical structures (i.e., the same number of chlorine atoms, but in different positions on the phenyl rings) are called isomers. For PCBs, the isomer groups are named by the chlorination level (mono through deca). Because each isomer group has its own characteristic molecular weight, a mass spectrometer (MS) can be programmed using selected ion monitoring (SIM) to search for only that molecular weight. Results are reported as total monochlorobiphenyl through decachlorobiphenyl. Total PCBs are calculated as the sum of the detected isomer groups. The calculated concentration is reported as a total for that chlorination level or isomer (e.g., total dichlorobiphenyls). Selected treatability study samples were analyzed for PCB isomers. Results were reported for each mono through deca isomer group and as total PCB isomers.

The isomer group analysis provided information relative to the distribution of PCB isomer groups irrespective of the Aroclor composition. The isomer group method of analysis was also useful for evaluating various intermediate and end point products from the pilot study treatment processes. Specifically, the data were evaluated to ensure that the treatment processes were actually removing or destroying PCBs, rather than rearranging their chemical configuration. Isomer group data were also useful

in reviewing air (stack sample) results, which are conventionally reported on a total isomer basis rather than by Aroclor, due to the potential for speciation in the gaseous phase.

In addition to the Aroclor and isomer methods of analysis, it is possible to analyze samples for individual PCB congeners using gas chromatography in conjunction with the mass selective detector. This is a highly specialized analysis performed by only a few laboratories, usually in association with risk assessment, where the toxicity of individual congeners is of concern. Typically a subset of the 209 possible congeners is selected, based on toxicity, for this analysis. During this treatability study, selected samples were analyzed for PCB isomer groups. PCB congener specific analysis was not performed on samples collected during this treatability study.

Where possible, Aroclor data were used in the treatability study evaluation process. These data were consistent and comparable with the available historical data. The Aroclor analysis is also the analysis typically performed under the CLP program. Therefore, consistent data sets could be relatively easily obtained from more than one laboratory throughout the duration of the testing program. In cases where there was the possibility that the process might be changing the PCB "fingerprint" pattern rather than actually destroying the PCB molecules, samples were also analyzed for PCB isomer groups. For the most part, the processes were not found to change the PCB (Aroclor) pattern in the solid and liquid outputs and the Aroclor data were used in the data evaluation process.

PCB isomer group analysis is the approved EPA methodology for the analysis of vent gas samples. Aroclor analyses were not conducted for vent gas samples. Where it was useful to compare solid material PCB results with air sample PCB results, it was sometimes useful to consider the solid material isomer results in addition to the Aroclor data in the evaluation. Where this was done, both sets of results are presented for comparison. Isomer group data and Aroclor data were not sufficiently different to change conclusions regarding process performance.

4.3.1.4 Dioxin and Furan Analyses

Polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans) are groups of compounds that are chemically similar to PCBs in that they are large organic molecules with many possibilities for chlorinated congeners. As with PCBs, the toxicity of the chemical is related to its specific chemical composition, with the 2,3,7,8 substituted congeners being more toxic than the others and 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) being the most toxic. The chemical compositions of dioxin and furan are shown in Figures 4-2 and 4-3, respectively.

Figure 4-2
Chemical Structure of the Dioxin Molecule

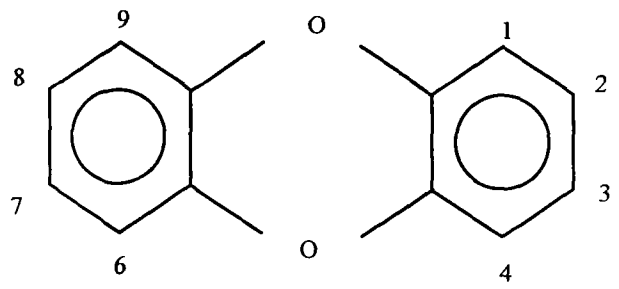
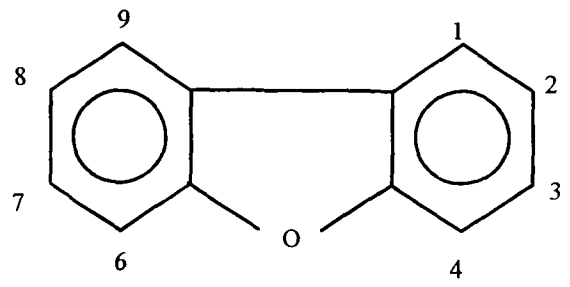


Figure 4-3
Chemical Structure of the Furan Molecule



The analysis for dioxins and furans is similar to that described above for PCB isomers and congeners. Samples were analyzed using gas chromatography in conjunction with high resolution mass spectrometry. Sample data were reported and used in the following three ways:

- Fifteen individual 2,3,7,8-substituted congeners were reported for each sample.
- Toxicity equivalents (TEQs) were calculated for each 2,3,7,8-substituted congeners based on EPA toxicity equivalent factors (TEFs). This calculation reports a 2,3,7,8-TCDD TEQ for each 2,3,7,8-substituted congener based on the relative toxicity of the congener to 2,3,7,8-TCDD.
- Total concentrations were reported for each isomer group (e.g., total tetrachlorodibenzofurans).

Similar to the analysis for PCB isomer groups, total dioxin and furan isomer groups (e.g., total TCDD) were identified by specific masses eluting from the GC column within a given retention time window. Total concentrations were calculated based on the response of a single congener within the isomer group. The identification and quantitation of the fifteen 2,3,7,8-substituted congeners were based on SIM mass ratios and specific retention time. TEQs were calculated by multiplying the concentration of the specific 2,3,7,8-substituted congener by the TEF factor given in Table 4–3.

Table 4–3
2,3,7,8-TCDD Toxicity Equivalent Factors

2,3,7,8-Substituted Congener	Toxicity Equivalent Factor (TEF)
2,3,7,8-TCDD	1.0
1,2,3,7,8-PeCDD	0.5
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.001
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.5
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.001

Based on the definition of TEQ, the TEQ of a sample is related to the concentration of 2,3,7,8 substituted congeners and is not directly related to the total concentration of dioxin and furan in the sample.

4.3.1.5 TCLP Analyses

TCLP analysis is intended to simulate the leaching of contaminants from a material under landfill conditions. The leaching process involves mixing the sample in a slightly acid aqueous solution for a twenty four hour period. The resulting leachate is filtered and analyzed for contaminants of concern. Leachate from the samples collected during the treatability study were analyzed for PCBs, semivolatiles and metals using CLP protocol. As discussed above, the CLP analyses were chosen to provide a well documented, consistent analytical procedure, similar to the analyses conducted for the raw (not leached) samples.

Samples were analyzed for TCLP primarily to evaluate the effectiveness of the process(es) at reducing the mobility of contaminants in the treated product. Accordingly, the samples analyzed for TCLP were primarily untreated and treated sediment. Results were compared against each other and, where appropriate, against the TCLP regulatory criteria. Several analytes are included on the CLP analyte list that do not have TCLP regulatory criteria, including PCBs. These are noted accordingly on the TCLP data summary tables included in Sections 4.4, 4.5, 4.6, and 4.7. Treatability study samples were not analyzed for TCLP volatiles, herbicides, or pyridine, as these were not of concern in the raw Hot Spot sediment.

To fully evaluate the treatment processes, samples were leached using two methods. The first leaching method was in accordance with EPA Method 1311, where the samples is ground or pulverized to pass

through a 9.5 mm sieve and subsequently leached. The second method was used only for the solidified samples generated from the vitrification and solidification processes and involved suspending the sample whole inside of a steel mesh cage. The steel cage method is intended to simulate disposal of the solidified product in its unpulverized condition. The steel mesh cage allowed the surface of the sample to come in contact with the leaching solution to measure the effect of chemical leaching without physical weathering of the product. The steel cage leaching also provides some data regarding the integrity of the solidified material under leaching conditions. It is also important to note that the conventional EPA Method 1311 is the promulgated method for waste disposal, whereas the steel cage method is in draft form only.

TCLP Method 1311 required that the sample be pulverized prior to leaching and was expected to give more conservative results than the steel cage method. In actuality, the results using the two different methods were not significantly different for the majority of analytes. Some metals results were higher for the steel cage than the conventional Method 1311, presumably due to contamination or interference from the cage material. Based on these findings, and the fact that Method 1311 is the promulgated method for waste, the data evaluation process focused on the results from the conventional (1311) analysis.

4.3.2 Quality Control Procedures

Several quality control (QC) procedures were implemented to quantitatively assess the quality of the data and to ensure that the data were acceptable for use, as determined by project objectives. These procedures are discussed in more detail in the following subsections. Quality control results and the overall findings relative to the treatability study program are discussed in this section. These following procedures were used to measure data quality:

- Replicate (duplicate and triplicate) field sample collection to assess variability within pilot scale batches.
- Replicate batch runs for each pilot scale process (see Sections 4.4, 4.5, 4.6 and 4.7 for additional detail).
- Laboratory quality control measures, including calibrations, blanks, matrix spikes, matrix spike duplicates (duplicate samples for inorganics), internal standard spikes, surrogate spikes, and serial dilutions.
- Performance evaluation (PE) samples.
- Data validation.
- Split sample analysis by the EPA Region I Office of Environmental Measurement and Evaluation (EPA-OEME).

The results of these QC measures and the impact to the data used in the treatability study evaluations are discussed below. Specific data points and how they were used to evaluate the treatment processes are discussed in the vendor reports included in the Data Compendium and to a lesser extent in the data evaluation subsections of 4.4 through 4.7.

4.3.2.1 Replicate Batches and Replicate Samples for Each Batch

Each pilot scale test conducted a series of batches referred to as optimization or acclimation and performance. The specific operating conditions for these batches are included in the individual vendor reports included in the Data Compendium. In general, the optimization/acclimation batches were used to adjust operating parameters in support of developing "optimal" conditions. Analytical results were used by the vendors in cause and effect analyses as discussed in the reports. Optimization data were not used in the overall process evaluation.

Performance testing was conducted by operating the process(es) under the same conditions for several batches to assess reproducibility. The exception was the Geosafe process which, due to the time required for a batch, had only one performance batch. Performance testing data were used in the overall evaluation of process effectiveness. Results from the different performance batches were used to evaluate the consistency and reproducibility of the process.

To assess variability within each batch, replicate (duplicate or triplicate) samples were collected where material volumes permitted. The results of sample and replicates of each performance batch are presented and discussed in the vendor reports. In summary, the data between and within batches indicated some variability that was attributed to the inherent variability in the initial feed sediment and to operating and sampling limitations. Results for some vent gas sampling locations were highly variable due to the inability to collect isokinetic (flow representative) samples.

4.3.2.2 Data Validation

Approximately 20 percent of the off-site analytical data were validated according to Region I Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses, Modified November 1, 1988 and Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, Modified February 1989. Validations were conducted at the Tier I and Tier II level in accordance with Region I Tiered Organic and Inorganic Data Validation Guidelines, July 1, 1993. Validation of the dioxin and furan data was conducted by Lockheed Environmental in accordance with EPA Region I's Environmental Service Assistance Team Dioxin Data Validation SOP ESAT-01-0007 (12/20/95). In accordance with the SOP, the dioxin and furan validation was in accordance with Tier III guidelines. The validation guidelines were modified, as appropriate, to consider the elevated PCB concentrations in some samples, and the non-routine matrices and analyses. The validation process includes a detailed review of the various laboratory and field QC results, including PE samples.

The data selected for validation were chosen based on its overall significance in the evaluation process. An emphasis was placed on data from performance batches and on key analyses for significant process outputs (treated sediment, process off-gas). In addition, data packages were selected from each subcontractor laboratory to provide an overall indication of laboratory performance for each matrix and analysis requested.

The results of the data validation are detailed in memoranda (one memorandum per data package) submitted to EPA under separate cover. In summary, the data were found to be acceptable for the engineering calculations used to determine the effectiveness of the pilot processes. In several instances, the data were estimated due to difficulties associated with the specific sample matrices.

Data were qualified as "estimated" primarily due to matrix related analytical difficulties. Elevated concentrations of PCBs in some samples caused interferences with the semivolatile analyses, resulting in elevated detection limits. The oil matrices and the DIPA and ammonia used in conjunction with the Ionics RCC/CRTI processes caused other interferences and required matrix specific method modifications. In some instances, samples were extracted outside of holding times. The delay in analysis was caused by the need to develop sample specific analytical methodology.

Overall, the validation results indicated that the data were acceptable for achieving project objectives; that is, the data were found to be acceptable for the engineering calculations conducted to support the evaluation of the effectiveness of the treatability study processes. The level of validation conducted for this effort (20% using Tier II guidelines) was appropriate for the intended use of the data. Should the data be used for quantitative risk assessment purposes, Tier III validation for each required data point (100%) would be recommended.

4.3.2.3 EPA-OEME Split Sample Results

To provide an additional measure of quality control, samples were selected for analyses at the EPA Region I Office of Environmental Measurement and Evaluation (EPA-OEME) laboratory in Lexington, Massachusetts. This provided an independent analysis of samples for comparison with those analyzed by the Foster Wheeler subcontractor laboratories. Samples analyzed through the CLP (i.e. the laboratory was not subcontracted to Foster Wheeler) program were not split with EPA-OEME. The samples to be split were selected based on their importance in the overall evaluation process. The majority of samples chosen for splitting were the feed and treated sediment for PCBs as these were critical in the evaluation process. The frequency of split samples was greater at the beginning of the program and was decreased over time as the split sample results confirmed that subcontractor laboratory performance was acceptable.

In some cases, especially with the vent gas samples, it was not physically possible to split samples. In these instances, the samples were extracted by the Foster Wheeler subcontractor laboratory and the extracts were split and shipped to EPA-OEME for analysis. In this manner, the subcontractor analytical methodology was confirmed. In addition, the Foster Wheeler subcontractor laboratory analyzed air samples for PCBs, dioxins, and furans using GCMS in SIM mode. Because EPA-OEME was not equipped to analyze samples using this methodology, other, more conventional analyses were selected for splitting. In this instance, samples were split for metals and PAHs instead of PCBs. The samples split from each pilot study are summarized in Table 4–4.

Table 4-4
Summary of EPA-OEME Split Samples

Process	Number of Samples	Matrix Description	Analysis	Subcontractor Laboratory
Ionics RCC/CRTI	6	Feed sediment	PCB	Ceimic
	5	Treated sediment	PCB	Ceimic
	2	Polished oil (feed to CRTI)	PCB	Ceimic
	3	CRTI treated material	PCB	Ceimic
Total:	16			
Geosafe	2	Feed sediment	PCB	Ceimic
	4	Partially treated (adjacent and beneath) sediment	PCB	Ceimic
	2	Vent gas condensate (aqueous)	PCB	Ceimic
	1	Air	Metals	Triangle
	1	Air	PAHs	Alta/Air Toxics
Total:	10			
SAIC/Ecologic	1	Feed sediment	PCB	IEA - CT
	1	Treated sediment	PCB	IEA - CT
Total:	2			

The results of the split sample comparisons are discussed in the following sections. The results are discussed for each analysis and, where appropriate, by sample matrix. In determining acceptability of split sample results, results were compared using Relative Percent Difference (RPD). RPD is calculated as follows:

$$RPD = 100 \times \left[\frac{\text{(Subcontractor Laboratory Result)-(EPA-OEME Result)}}{\text{Mean of Results}} \right]$$

In calculating RPD, the subcontracted laboratory result was used first in the equation. Therefore, a negative RPD indicates that the EPA-OEME result is the greater of the two. A positive RPD indicates that the off-site laboratory is the greater of the two.

Samples selected for split sample analysis were chosen primarily to evaluate laboratory performance. The emphasis was on the crucial analysis (PCBs) for the Hot Spot sediment. For air samples, where the EPA-OEME laboratory was not able to perform the highly specialized PCB isomer analysis, other analyses were chosen (metals and PAHs) to provide an overall measure of laboratory accuracy.

Solid and aqueous split samples were collected by homogenizing the sample and apportioning aliquots into separate jars for the different laboratories. The analysis of split samples was primarily intended to assess laboratory performance. Therefore, samples were chosen based on the potential for positive results and the need for sufficient sample volume for the desired analysis and reanalysis, if needed.

PCBs

PCB split sample results are summarized in Tables 4–5 (Ionics RCC/CRTI), 4–6 (Geosafe) and 4–7 (Eco Logic). In order to assess precision, RPDs were calculated and are presented in the tables. To assess the acceptability of split sample data, an initial criterion of 50 percent RPD was chosen as acceptable, requiring no further investigation. This 50% RPD criterion was based on the EPA data validation criteria for field duplicate samples analyzed by the same laboratory. It was expected that the 50 percent criterion would be too stringent for Hot Spot samples for several reasons.

- The split samples were analyzed by different laboratories that may have used slightly different extraction and analytical methodology.
- PCB analysis is sometimes slightly subjective especially where more than one Aroclor pattern is detected and requires quantitation.
- The samples had high concentrations of PCBs and required several dilutions for quantitation, introducing additional potential for variability.

Table 4–5
PCB Split Sample Results for Ionics RCC/CRTI

Tracking No.	Batch No.	Matrix/ Description	Ceimic Total	OEME Total	Ceimic-OEME RPD (%)
FW49	Ionics # 1	Feed sediment	2,700	20,880	-154
FW63	Ionics # 2	Feed sediment	2,520	5,100	-68
FW80	Ionics # 3	Feed sediment	2,470	5,200	-71
FW110	Ionics # 4	Feed sediment	2,430	4,500	-60
FW109	Ionics # 4	Feed sediment	2,430	4,800	-66
FW129	Ionics # 5	Feed sediment	2,430	4,500	-60
FW60	Ionics #1	Treated sediment	12.8	10.3	22
FW68	Ionics # 2	Treated sediment	18.7	20	-6
FW126	Ionics # 4	Treated sediment	5.1	3.6	35
FW127	Ionics # 4	Treated sediment	4.5	3.7	20
FW151	Ionics # 5	Treated sediment	4.1	4.3	-6
FW104	Oil polishing optimization	Raw oil	45,000	81,000	-57
FW168	Oil polishing verification	Raw oil	32,800	62,000	-62
FW193	CRTI #5	Treated product	5.1	38	-153
FW208	CRTI #6	Treated product	1.3	33	-185
FW210	CRTI #7	Treated product	3.0	ND	NC

Results are reported in units of mg/kg.
ND = Not Detected
NC = Not Calculated

Accordingly, the 50 percent RPD criteria was used only as a preliminary measure of acceptance. To further evaluate split sample results, especially those with RPDs greater than 50 percent, Foster Wheeler considered previous project experience involving over 1,000 PCB split samples analyzed by two different laboratories. In that study, approximately 75 to 90 percent of the split sample results had RPDs less than 75 percent. PCB split sample results are discussed in that context below.

Table 4–6
PCB Split Sample Results for Geosafe

Tracking No.	No.	Matrix/ Description (Units)	Ceimic Total	OEME Total	Ceimic-OEME RPD (%)
FW317	Geosafe batch #1	Condensate (ug/L)	4,860	6,400	-27
FW335	Geosafe batch #2	Condensate (ug/L)	2,850	5,900	-70
FW300	Geosafe batch #1	Feed sediment (mg/kg)	1,820	4,800	90
FW303	Geosafe batch #1	Feed sediment (mg/kg)	2,890	4,600	-46
FW307	Geosafe batch #1	Adjacent sediment (mg/kg)	3.47	5.4	-44
FW322	Geosafe batch #1	Beneath sediment (mg/kg)	440	312	-34
FW337	Geosafe batch #2	Adjacent sediment (mg/kg)	132	210	-46
FW341	Geosafe batch #2	Beneath sediment (mg/kg)	404	402	0

Table 4–7
PCB Split Sample Results for Eco Logic

Tracking No.	Batch No.	Matrix Description	IEA-CT Total	OEME Total	IEA-CT-OEME RPD (%)
FW520	Eco Logic P3	Feed sediment	5,600	12,000	-73
FW534	Eco Logic	Treated sediment	43	107	-85

Results are reported in units of mg/kg

PCBs in Treated Material

Treated material results from the three treatability studies had relatively low PCB concentrations. Nine out of ten treated material results had RPDs less than 50 percent. Four of these had negative RPDs, four had positive RPDs, and one comparison was essentially the same for both laboratories, indicating that neither laboratory was repeatedly higher than the other.

One treated sediment sample (FW534) had an RPD of -85%, with the OEME result being the higher of the two. This single discrepancy for treated sediment is consistent with the premise that 10 to 25 percent of the split sample data will exceed 75 percent RPD. Furthermore, this particular split sample result may be, in part, due to sample variability. Field duplicate samples (analyzed by the same laboratory)

collected from the Eco Logic batches exceeded 50 percent RPD in two out of four batches (A3 - 65%, P2 - 102%), indicating that the PCB concentration within the treated material may be more variable than initially anticipated. This material was expected to be well homogenized as a result of being treated inside of the TRM ball mill. It may be that PCBs were selectively condensing back on to treated material or other operational difficulties were causing incomplete mixing/treatment of material.

PCBs in High Concentration Samples

Results for other matrices, including feed sediment, oil, and condensate, where the concentration of PCBs was typically greater than 1,000 ppm (1,000 ppb for condensate) did not agree as well as those with lower concentrations. One split sample (FW49) RPD was -154%. This difference is attributed to a non-homogeneous sample and may be indicative of variability within the CDF, as discussed below. Excluding this unusual result, RPDs for the high concentration samples typically ranged from -27% to -90%, and averaged approximately -62%. These results are consistent with the expectation that 75 to 90 percent of the results will have RPDs less than 75%. This indicates that, in general, the data are in agreement and acceptable for use. It was noted that RPDs for these split samples were consistently negative, indicating that the EPA-OEME laboratory results were consistently the greater of the two. This clearly indicates a bias in the data, although which laboratory reported the more accurate results was not determined.

Potential sources of bias are numerous, although, based on the relatively good agreement for samples with low concentrations, the bias does appear to be matrix/concentration related. It is interesting to consider that the EPA-OEME results were higher than both subcontractor laboratories (Ceimic and IEA-CT), although IEA-CT split sample data were limited. In conducting such a comparison, it is equally important to note that Ceimic and IEA-CT were using essentially the same method for analysis (modified CLP protocol). It is possible, that by using the same method, the laboratories introduced a similar bias. Bias may be introduced by extraction or cleanup procedures, instrument calibrations, or other variables.

The actual source for the bias in high concentration samples was not determined as the RPDs were generally reasonable and did not appear to be a source of concern. RPDs were typically only slightly higher than the 50 percent RPD criteria used by the EPA to validate duplicate samples analyzed by the same laboratory. Furthermore, because the significant split sample differences involved samples with relatively high concentrations of PCBs, the effect on the overall pilot scale evaluation was minimal. The ability of the pilot scale processes to successfully treat the sediment or oil did not appear to be directly related to the concentration of PCBs in the feed material. The potential that the high concentration samples could be biased low does not significantly affect the conclusions regarding pilot scale performance. The potential bias in feed sample data could result in underestimating destruction and/or removal efficiencies for the studies. However, such a bias would apply equally to the three processes, which, for the purposes of this study, were not significantly different from one another.

Based on the split sample data for the feed material, it is possible that the Hot Spot chemical characterization discussed in Section 2.2 may be biased slightly low for PCBs. The bias does not appear to be large relative to the concentration of PCBs in the sediment and is not likely to be a factor in determining full-scale design parameters. As discussed in Section 2.2, the slightly higher PCB results determined for the third pilot study feed material were used for the full-scale analysis for each technology, thus eliminating attributing bias to one particular technology over another. The slightly higher results for the third study were more consistent with available historical data and were sufficient

for the purpose of developing full-scale implementation requirements. As discussed in Section 2.2, historical data and the results for split sample FW49 (2,700 / 20,800 ppm, RPD=154%) support the premise that "hot spots" exist within the CDF (possibly up to 200,000 ppm). This potential was considered in each treatment technology evaluation and does not significantly affect the conclusions regarding treatment effectiveness.

PCBs in CRTI Treated Product Samples

Three CRTI treated product samples were split for PCB analysis (FW193, FW208, and FW210) and are summarized in Table 4-5. The split sample results and the associated RPDs for these samples did not agree well. These samples were an aqueous slurry resulting from the neutralization of the oily solid matrix generated by the CRTI process. If left standing, this product would separate with a floating oil layer. The difference in split sample concentration is attributed to two different approaches to the analysis by the laboratories. The subcontractor laboratory mixed the sample and took a homogenous aliquot for extraction. The EPA-OEME laboratory allowed the sample to stand and extracted the floating oily layer. The PCBs remaining in the CRTI treated product following dechlorination are likely to be concentrated in the oily fraction of the sample, accounting for the difference in reported concentrations. Results from both laboratories support the conclusion that PCBs were destroyed by the CRTI process.

Vent Gas Split Samples

Results from the vent gas split sample comparison are presented in Tables 4–8 (metals) and 4–9 (PAHs). True split samples (same point in time) could not be taken of the vent gas due to sampling limitations. As an alternative, the samples were prepared by the Foster Wheeler subcontractor laboratory and the prepared extract/digestate was shipped to EPA-OEME for analysis.

Metals split sample data are provided in Table 4-8. The mercury sample consisted of five separate samples for analysis:

- A portion of the digestate from the front half (FH) of the sample train. The front half consisted of a sample filter and associated acetone rinse.
- The impinger solution from the back half (BH) of the sample train.
- The impinger solutions from three mercury specific impingers containing 1) potassium permanganate/sulfuric acid ($KMnO_4/H_2SO_4$), 2) hydrochloric acid (HCl), and 3) nitric acid/hydrogen peroxide (HNO_3/H_2O_2).

Table 4–8
Summary of Metals in Air Split Sample Data
Sample ID - G1-2-S5

Parameter	Sample Type	Triangle	OEME	RPD
Hg	Digested F-H	43	72	-13
	KMnO4/H2SO4	60	84	-8.3
	IMP3-BH	64	186	-24
	HCl	0.94 U	2.4 U	NC
	HNO3/H202	28	16	13
As	Digestate-FH/BH	499	518	-1.0
Cd	Digestate-FH/BH	1,960	2,034	-0.9
Cr	Digestate-FH/BH	2,330	2,484	-1.6
Cu	Digestate-FH/BH	616	709	-3.5
Pb	Digestate-FH/BH	106,300	115,200	-2.0
Zn	Digestate-FH/BH	74,900	81,180	-2.0

Results are reported in units of ug/sample.
U = not detected
NC = not calculated

A combined front half and back half digestate was analyzed for six other metals (arsenic, cadmium, chromium, copper, lead, and zinc). The results from the two laboratories agree well, RPDs for each metal were significantly less than 50 percent.

PAH split sample data are summarized in Table 4-9. The Method 23 sampling train was prepared and extracted by Alta Analytical. A portion of the extract was sent to Air Toxics for PAH analysis using EPA Method 8270. A second portion of the extract was sent to EPA -OEME for confirmatory analysis. Samples were analyzed for the eighteen PAHs summarized in Table 4-9. Split sample results agree well, RPDs were significantly less than 50 percent.

In summary, the results of the vent gas split samples agreed well. The RPDs for each analyte were less than 25%. Results for only three mercury fractions exceeded 10 percent. Based on these results, it appears that the analytical procedure used by the different laboratories produce similar results. Sample variability is expected to be more a function of the sample collection and/or extraction process rather than the instrumental analysis.

Table 4–9
Summary of Semivolatiles in Air Split Sample Data
Sample ID - G1–1–S7

Parameter	Air Toxics	OEME	RPD
Naphthalene	110	110	0%
2-Methylnaphthalene	33	NA	NC
2-Chloronaphthalene	4.7	NA	NC
Acenaphthylene	2.4	2	0%
Acenaphthene	4.3	4	2%
Fluorene	6.3	5	8%
Phenanthrene	39	27	9%
Anthracene	4.9	5	-1%
Fluoranthene	38	31	5%
Pyrene	21	22	-1%
Chrysene	5.3	4	7%
Benzo(a)anthracene	3.5	3	2%
Benzo(b)fluoranthene	<2	1	NC
Benzo(k)fluoranthene	<2	1	NC
Benzo(a)pyrene	<2	1	NC
Indeno (1,2,3-c,d)pyrene	<2	ND	NC
Dibenz(a,h)anthracene	<2	ND	NC
Benzo(g,h,i)perylene	<2	ND	NC

Results are reported in units of ug/sample
ND = Not Detected
NC = Not Calculated

4.3.2.4 Summary of Quality Control Results

This section provides a summary level discussion of the analytical quality control program, the associated results, and the implications for data usage for the Hot Spot treatability study testing program. A more detailed discussion of the analytical methods, the quality control program, and the results are provided in the above subsections. The analytical data generated during the treatability study testing are included in the Data Compendium.

Analytical data collection was a large portion of this treatability testing program and the sample results played a significant role in the evaluation of the individual processes. In order to fully assess the performance of each technology in achieving the overall treatment goals, it was crucial that the data be comparable and representative. In order to provide data of known and acceptable quality for assessing the performance of the treatment techniques, several quality control measures were implemented. These measures, the results, and their impact on the data evaluation process are summarized below:

- Where available, samples were analyzed using CLP methodology to provide consistent analytical procedures and reporting from several different subcontractor laboratories. Where CLP (or modified CLP) could not be conducted, the samples were analyzed using EPA or ASTM approved methods.

- Where sample volume allowed, replicate samples were taken from each key sampling point. These replicate analyses were used during the evaluation process to provide an indication of variability within process batches.
- Each treatability process conducted replicate batches to evaluate the reproducibility of the operating process.
- Each analytical chemistry laboratory used specific analytical quality control procedures that assess method performance. The results from these procedures were reviewed in the data validation process and used to qualify data, as needed, based on the validation.
- A split sampling program was conducted to provide an independent assessment of the analytical chemistry laboratories selected by Foster Wheeler. The results of this split sample program provide an overall indication of subcontractor laboratory performance and potential bias.

Results from replicate analyses within and between batches are provided and discussed in the individual vendor reports included in the Data Compendium. Overall, results for the solid and liquid matrices within and between batches, including feed and treated sediment materials, agreed reasonably well and provide an adequate basis for drawing conclusions regarding the process performance at treating Hot Spot sediment. Vent gas samples from some locations could not be sampled isokinetically due to sampling port locations. As expected, results from these locations were highly variable. Accordingly, these data points were used to provide summary level information only. The data from isokinetic sampling locations agreed reasonably well and were used as the basis for definitive conclusions. The limitations of the data and the subsequent conclusions are discussed in each process evaluation section.

A Region I Tier II validation was conducted for approximately 20 percent of the data generated during this treatability study. Dioxin data were validated using EPA Region I Tier III guidelines. The validation included a review of laboratory quality control measures with respect to method specific criteria. The validation memoranda discuss individual sample results and the effect of quality control exceedences on the data. Overall, the validation determined that the data were acceptable for the intended purpose of evaluating the effectiveness of different treatment process. Some data were considered estimated due to quality control exceedences. The validation actions (estimation) were not severe enough to affect the use of the data for its intended purpose. It is important to note that the level of rigor associated with a Tier II validation is appropriate for the level of data quality needed to assess engineering process performance. This validation effort was not completed with the purpose of using the data for quantitative risk assessment. Should the data be used for quantitative risk assessment purposes, a Tier III level validation would generally be required.

As an additional measure of quality control, a split sampling program was implemented where samples were split between the Foster Wheeler subcontractor laboratory and the EPA Region I Office of Environmental Measurement and Evaluation (OEME) laboratory. The split sample comparison indicated that results for samples with relatively low concentrations of PCBs agreed well. Approximately 90 percent of these split sample results had RPDs less than 50 percent. Sample results for feed material and concentrated PCB oil samples were more variable, with an average RPD of 62 percent. In general, OEME sample results were greater than the Foster Wheeler subcontractor results. The cause for this trend was not determined and it cannot be assessed which laboratory was the more accurate. However, these split sample results identify the potential for the Foster Wheeler laboratory results to be biased low. This potential bias for the high concentration samples is not likely to have a significant effect on the conclusions that were drawn based on this data and the studies as a whole.

4.4 Ionics RCC/CRTI Test Program

The Ionics RCC/CRTI test program was the first of three processes tested at the pilot scale for the Hot Spot sediment. The test involved two processes, the Ionics RCC solvent extraction process and the CRTI chemical destruction process. The Ionics RCC process is a solvent extraction method for removing organic contaminants from the Hot Spot sediment. The resulting organic product is a condensed, highly contaminated (approximately 50,000 ppm or more PCB) waxy product (referred to as "oil") that is solid or semi-solid at ambient temperatures. The CRTI process involves the chemical dechlorination of the PCBs in the Ionics RCC organic product. The following subsections describe the pilot study process, the testing that was conducted, the results of the testing, a discussion of the potential full-scale treatment at the conceptual level, and an estimate of the associated full-scale treatment costs.

4.4.1 Process Description

The pilot scale testing of the Ionics RCC/CRTI processes was conducted by using a combination of the two treatment technologies operated in series. Solvent extraction of the contaminants from the sediment was conducted with the patented Ionics RCC Basic Extractive Sludge Treatment (B.E.S.T.®) solvent extraction process. The resulting high concentration PCB oil product was chemically treated using the CRTI Solvated Electron Technology (SET®). The following subsections describe the equipment and processes in more detail. Section 4.4.2 describes the pilot study testing program, and Section 4.4.3 discusses the results of the program from a chemical and materials handling perspective. Sections 4.4.4 and 4.4.5 discuss full-scale application of the processes and the associated costs.

4.4.1.1 Ionics RCC Solvent Extraction Process

The Ionics RCC B.E.S.T.® solvent extraction process uses a unique property of certain amine solvents to extract hazardous contaminants from soil, sludge, and sediment. For this pilot study, diisopropylamine (DIPA) was used as the extraction solvent. Hazardous organic contaminants in the sediment such as PCBs concentrate in the organic (oily) portion of the material.

The key to the success of amine extraction is the property of inverse miscibility. At temperatures below about 27°F, the DIPA is miscible with water, i.e., DIPA and water are mutually soluble. Above this temperature, DIPA and water are only partially miscible. In the B.E.S.T.® process, inverse miscibility allows the feed sediment material and the solvent to create a single phase extract solution. That extract solution is a homogenous mixture of solvent, organics, and water found present in the feed sediment. Once extraction of the feed material is complete, the solids (sediment) are separated from the homogeneous extract solution by gravity settling and/or centrifugation. The clean treated solids (sediment) are then dried to remove residual solvent.

The solvent (DIPA) and water are removed from the organic oily extract solution containing PCBs by evaporation and subsequent condensation. After condensing, the solvent/water mixture temperature is maintained in the range where the solvent and water are only partially miscible. With the specific gravity of the solvent being 0.72, as compared to the water specific gravity of 1.0 (heavier), the solvent and water are easily separated by gravity. Both solvent and water are removed from the homogeneous extract solution and can be reused because of their low PCB content. The solvent is recycled for use in subsequent extractions. Traces of residual solvent that remain in the water are removed by steam stripping. The water

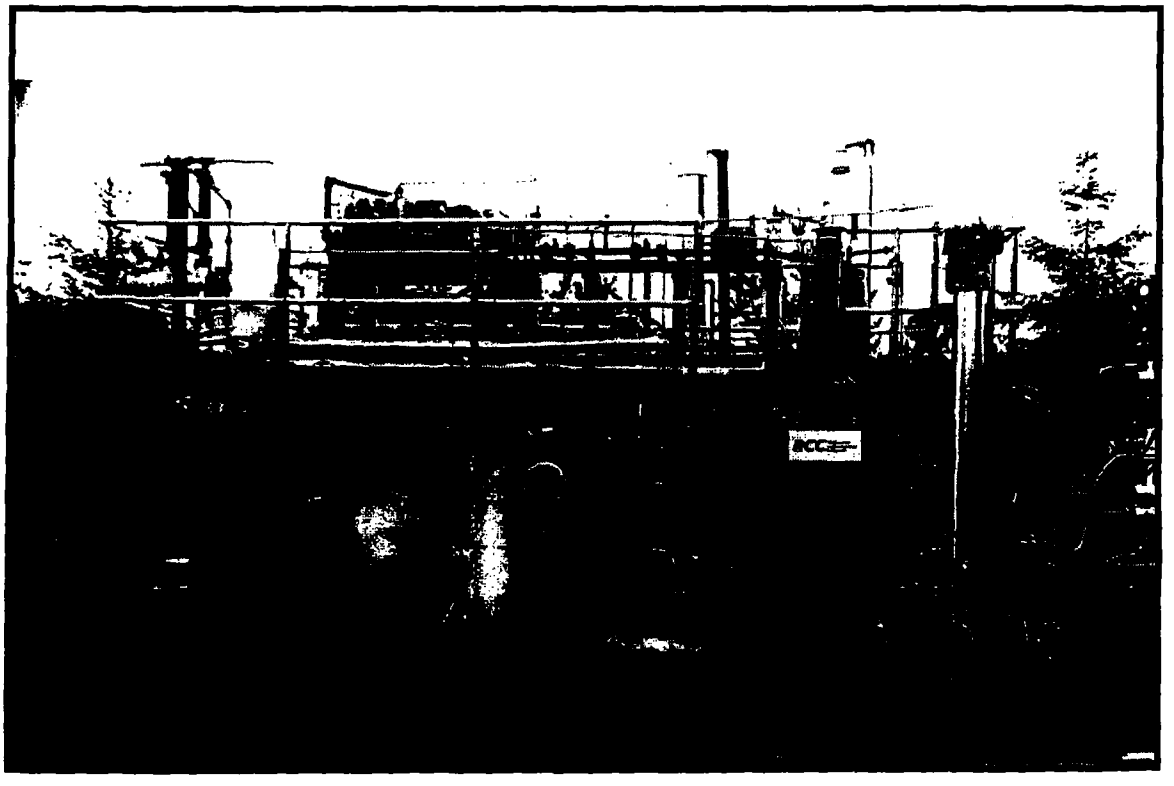
can then be re-used within the treatment process or discharged to a public water treatment facility as sewerage.

The organics in the extracted solution remain in a concentrated form as the solvent and water are removed by evaporation. After removal of the solvent and water, the concentrated organics are transferred to the CRTI Solvated Electron Technology (SET®) process equipment for non-thermal chemical destruction of the PCBs.

B.E.S.T.® Pilot Unit Operations

The B.E.S.T.® process pilot unit is a solvent extraction system capable of processing contaminated sediment, sludge, and soil. The pilot unit's main function is to demonstrate the process fundamentals through the use of scaled-down versions of actual full-scale equipment components; namely, the extraction vessels (Extractor/Dryer, and Premix Tank), the solid bowl fines centrifuge, the decanter, and the solvent evaporator. The pilot unit allows on-site testing of contaminated feed material in larger quantities than is practical to process in laboratory glassware. It also generates operational data for each unit operation during processing of specific feed material. This operational information allows the development of accurate full-scale design and operation projections. A photograph of the pilot scale unit is included as Exhibit 4-1

Exhibit 4-1
Ionics RCC Pilot Scale Unit



The pilot unit is designed for batch operation of the extraction cycles. While each of the major process operations can be operated in a batch mode, some unit process operations (such as fines centrifugation) are

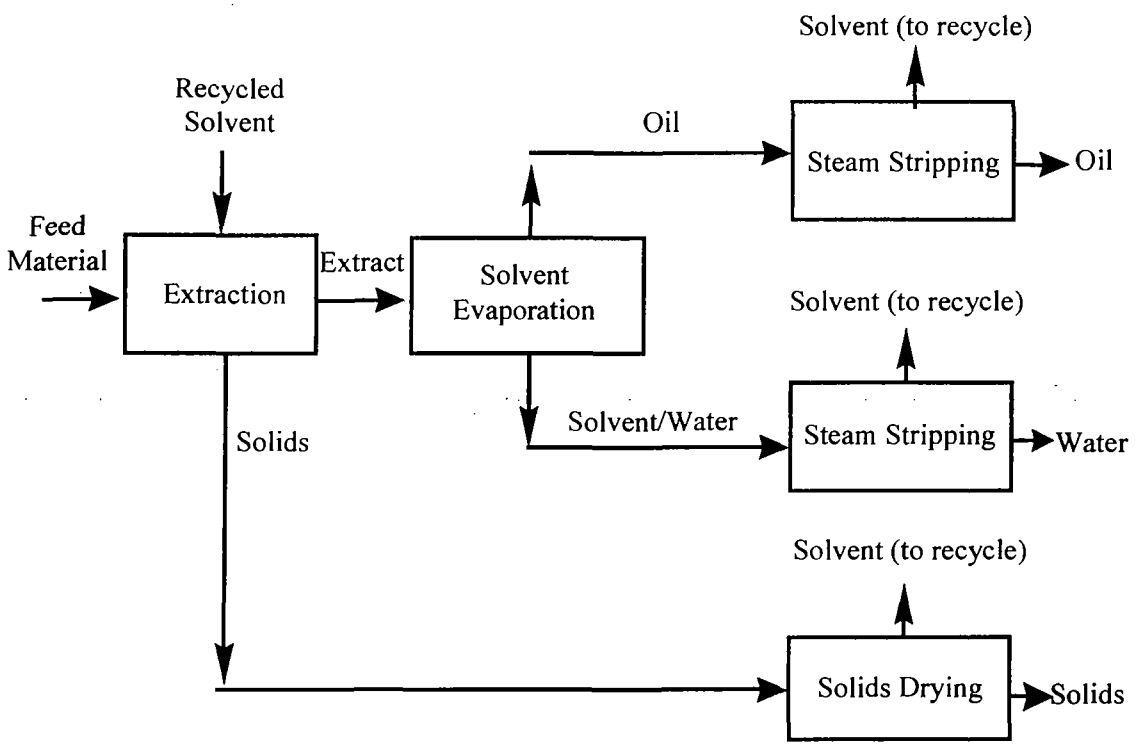
normally operated continuously. The pilot unit has a nominal feed volume of about one cubic foot (8 gallons, or approximately 130 pounds) of feed sample per batch.

For purposes of system description, the B.E.S.T.® pilot plant operations have been divided into the following five steps:

1. Feed Material Preparation
2. Extraction
3. Solids Drying
4. Solvent Recovery
5. Solvent/Water Separation

Each of these steps is discussed in more detail below. A block diagram summarizing the overall B.E.S.T.® process is included as Figure 4-4.

Figure 4-4
B.E.S.T.® Process Block Diagram



Feed Material Preparation

Preparation of feed material for pilot unit testing involves screening to remove materials greater than 1/4 inch in size. This ¼-inch feed size requirement applies only to the smaller pilot scale test equipment. Material less than approximately one inch in diameter can be treated with the full-scale B.E.S.T.® process equipment. Oversize material requires independent treatment.

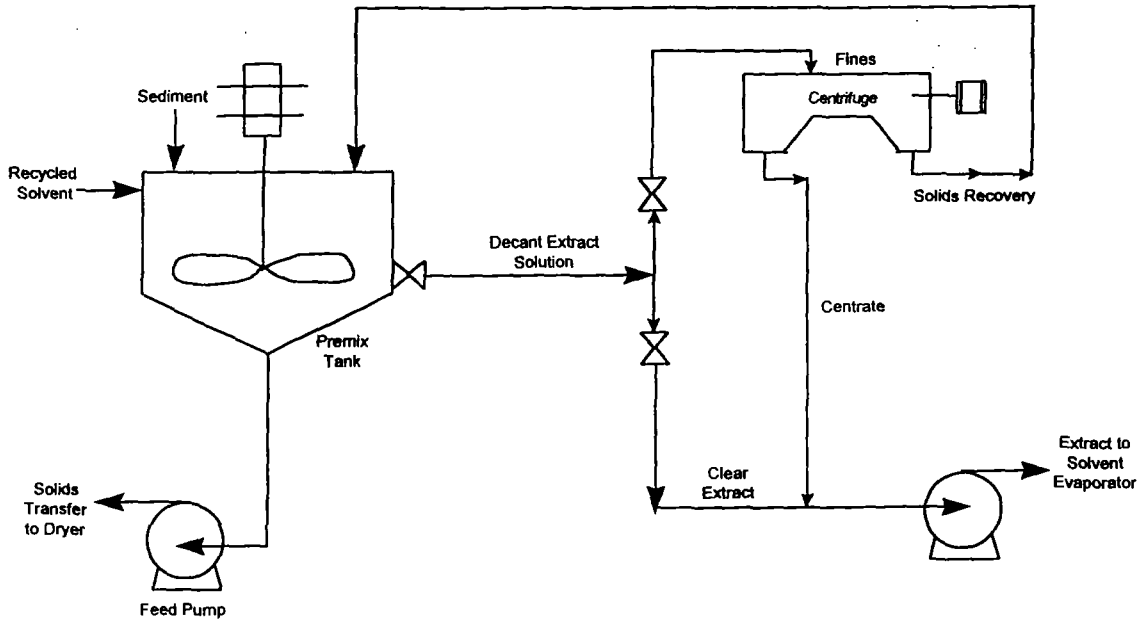
Extraction

The vessel used for the first extraction cycle depends on the nature of the feed material. Feed materials that have a high organic and/or water content are extracted first in the Premix Tank. The Premix Tank is a larger vessel and allows using more solvent volume relative to the volume of feed. This gives more efficient initial extraction of water and organics. Other feed materials with low water and/or organic content are extracted first in the Extractor/Dryer. Due to their relatively high moisture content, the Hot Spot sediment feed materials treated during this test were processed first in the Premix Tank.

The Premix Tank is a vertically mounted cylindrical vessel. The Premix Tank has a mixer shaft penetrating the top of the vessel and extending to near the bottom of the vessel. The shaft has paddles mounted on it to mix the Premix Tank contents.

The extraction process is illustrated in Figure 4-5. The feed material is loaded into the Premix Tank through a capped opening on top of the Premix Tank. Solvent is then added to fill the Premix Tank and mixing is started to begin the first extraction cycle. Mixing continues for several minutes, then is stopped to allow for settling of the solids by gravity.

Figure 4-5
Solvent Extraction Process Diagram



After a period of settling, the homogenous extract solution is decanted (drained off the top) from the solids. After all extract solution has been decanted, the Premix Tank is again filled with solvent for the next extraction cycle. Additional extraction cycles, including fill/mix/settle/decant, are repeated as required.

The extract solution (solvent/organics/water) from the Premix Tank is either transferred to the fines centrifuge or sent directly to solvent recovery. If the decant solution contains fine solids that did not settle effectively by gravity, the decant solution is routed to the centrifuge for mechanical removal of those fine solids. The solids-free decant solution from the centrifuge (centrate) is routed to the solvent evaporator for solvent recovery. If the decant solution does not contain fines, it is pumped directly to the solvent evaporator without going through the centrifuge.

Solids Drying

The Extractor/Dryer is a horizontally mounted, cylindrical vessel outfitted with a shaft running the length of the cylindrical axis. The shaft has paddles mounted on it to aid in the mixing of the Extractor/Dryer contents. A steam jacket surrounds the Extractor/Dryer to provide the heat necessary to dry the solids and remove residual solvent. Exhibit 4-2 is a photograph of the Extractor/Dryer. The solids remaining in the Premix Tank after the final extraction cycle are pumped to the Extractor/Dryer and dried. The solids drying unit operation is depicted in Figure 4-6.

Exhibit 4-2
Ionics RCC's Extractor/Dryer

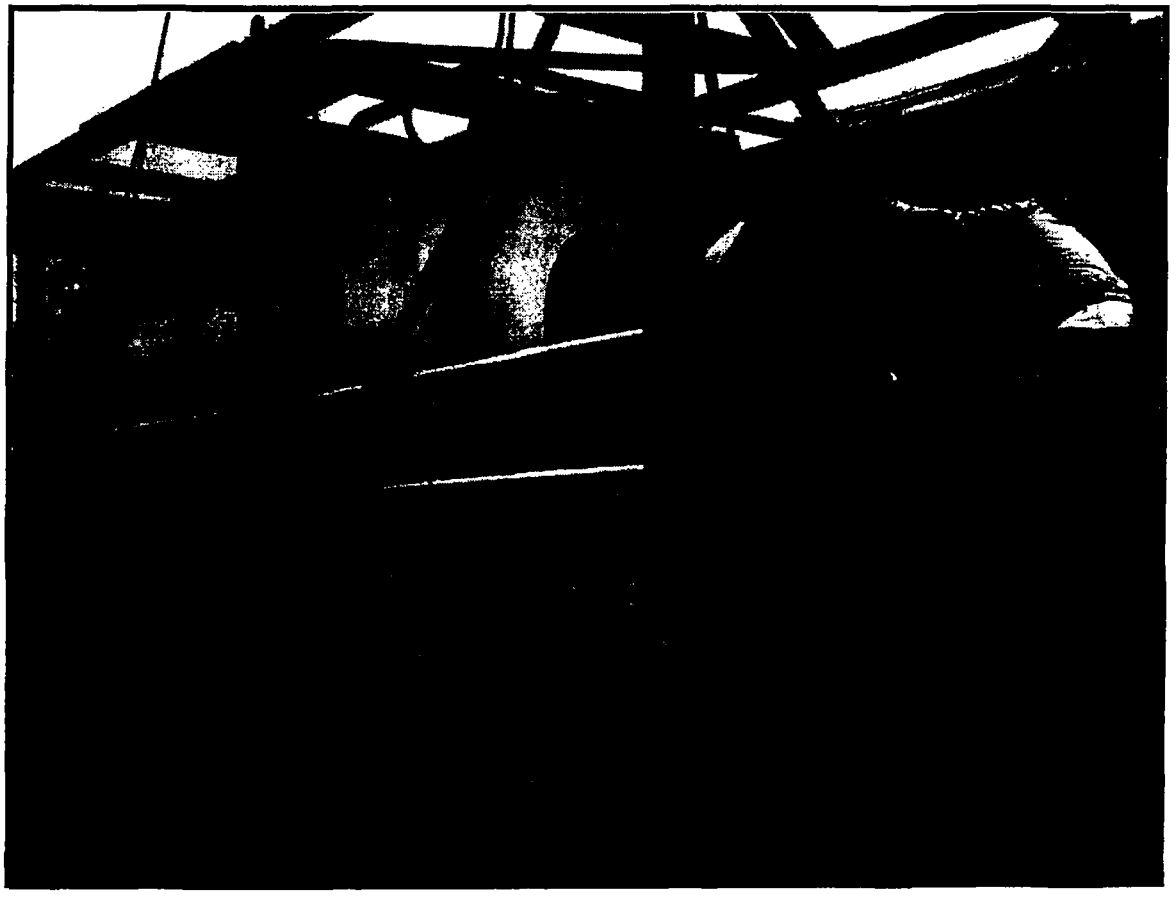
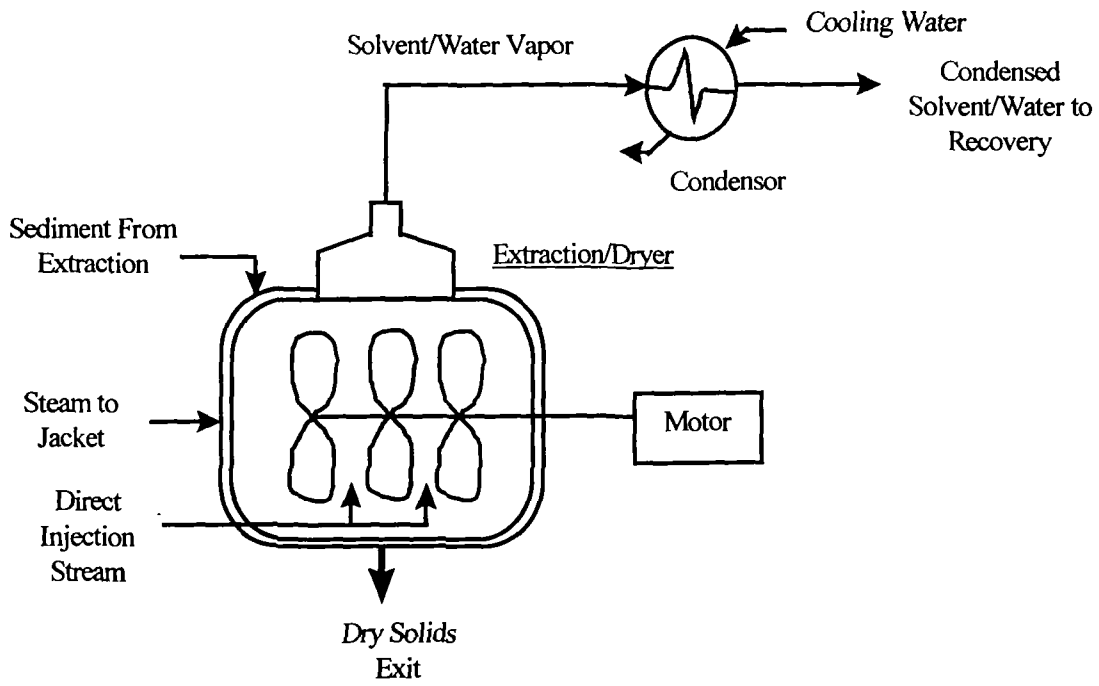


Figure 4-6
Solids Drying



The Extractor/Dryer is equipped with direct steam injection ports as well as the previously described steam jacket. Steam is added to the jacket to indirectly heat the Extractor/Dryer and its contents to about 77°C. After the bulk of solvent is driven off by evaporation, steam is injected directly into the Extractor/Dryer. The entire drying process is done with the Extractor/Dryer mixing paddles rotating. This mixing increases the heat transfer and reduces the solids drying time.

The remaining solvent and direct injection steam form an azeotrope mixture with a boiling point lower than either the solvent or the water. Additional direct injection steam drives the azeotrope vapor out of the Extractor/Dryer. The evaporated solvent driven off earlier and the azeotrope mixture driven out of the Extractor/Dryer are routed to the dryer condenser.

The condensed solvent/water mixture from the dryer condenser is routed to the normal solvent recovery path for re-use. After all the solvent is removed from the Extractor/Dryer, the temperature of the vapor rises from the low boiling point of the azeotrope to the boiling point of water. The drying is continued past this point for a short time to ensure that all residual solvent is removed. The direct injection steam condenses in the Extractor/Dryer and helps to minimize dusting. After the drying process is complete, the solids are removed through the discharge port on the bottom of the Extractor/Dryer.

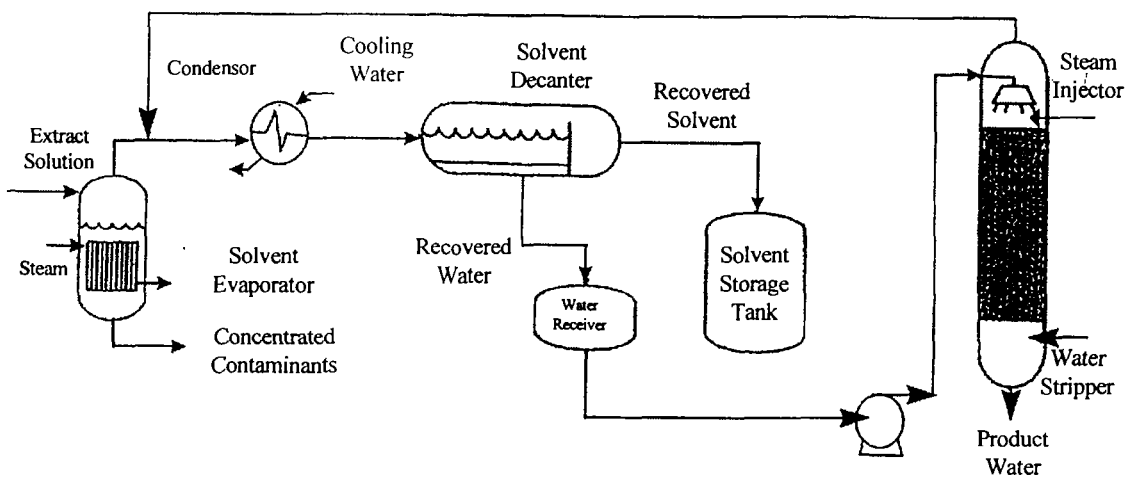
Solvent Recovery and Oil Polishing

The decanted extract solution (or centrate) from the extraction process is pumped to the solvent evaporator. In the solvent evaporator, the centrate is heated to its boiling point and evaporated forming an azeotrope of solvent and water. The solvent/water azeotrope is continuously produced and is directed through a rectifier

to the main condenser. The rectifier is installed to limit the carry-over of semi-volatile compounds from the solvent evaporator into the recycled solvent. The condensed vapor from the main condenser (solvent and water) forms a non-homogenous condensate consisting of a solvent phase and a heavier water phase. This mixture is directed to the solvent decanter, where the water and solvent phases are separated by gravity.

The solvent decanter is maintained at about 65°C. At this temperature, the water and solvent are only partially miscible. The lighter solvent phase retains about 5% water and the heavier water phase retains about 5% solvent. The recovered solvent, with its 5% water, is recycled back to the solvent storage tank for reuse. The recovered water, with its 5% solvent, drains by gravity into the water storage tank where it is stored for residual solvent removal. Solvent recovery and water recovery are shown in Figure 4-7.

Figure 4-7
Solvent and Water Recovery



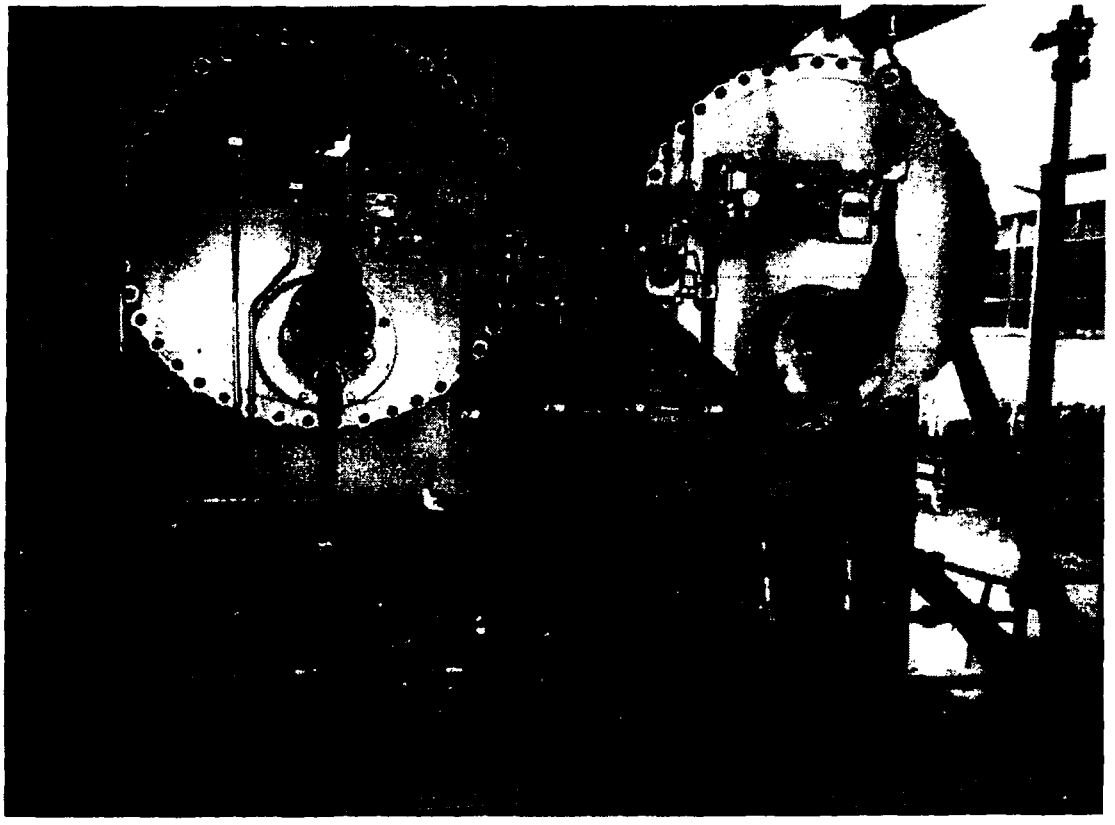
The organic fraction from the sediment concentrates in the evaporator. A continuous bleed of concentrated organics and solvent is diverted from the evaporator to one of the two oil polishers. The two oil polishers operate in both continuous and batch mode to concentrate and steam strip the concentrated organic oil product. One of the two oil polishers continuously receives the bleed of organics/solvent from the solvent evaporator and is referred to as the concentration phase. The second other oil polisher is "polishing" concentrated organics in batch mode and is referred to as the steam stripping phase.

The concentration phase oil polisher receives a continuous bleed of organics/solvent from the solvent evaporator. Indirect steam heating continuously evaporates solvent from the organics/solvent mixture, concentrating the organics in the oil polisher. When organics have reached sufficient concentration in the oil polisher, organic/solvent feed to the oil polisher is stopped and the oil polisher is switched to the steam stripping phase and operated in batch mode.

In the steam stripping phase, the organics are steam stripped to remove residual solvent. When the steam stripping phase is complete and the residual solvent has been removed, the remaining B.E.S.T.® organics

fraction is pumped out of the oil polisher to the CRTI process for PCB destruction. Exhibit 4-3 is a photograph of the Ionics/RCC oil polishers.

Exhibit 4-3
Ionics RCC Full-Scale Oil Polishers



Solvent/Water Separation

The water originally contained in the feed material is separated from the extracted organic fraction by evaporation, and then separated from the solvent by decanting, as described above in Solvent Recovery. However, the water still retains about 5% residual solvent.

The residual solvent is removed from the water by steam stripping. The water recovered from the solvent decanter is heated to about 60°C and injected into the top of a stripping column. Steam is injected directly into the bottom of the column and flows upward through the water that is traveling down the column. The steam heats the water and strips the residual solvent from it. The stripped solvent and steam exit the column at the top and are directed to a condenser. Condensed solvent is routed to the solvent decanter for normal solvent recovery operations. The stripped water is collected at the bottom of the column and set aside for sampling.

4.4.1.2 CRTI Chemical Destruction Process

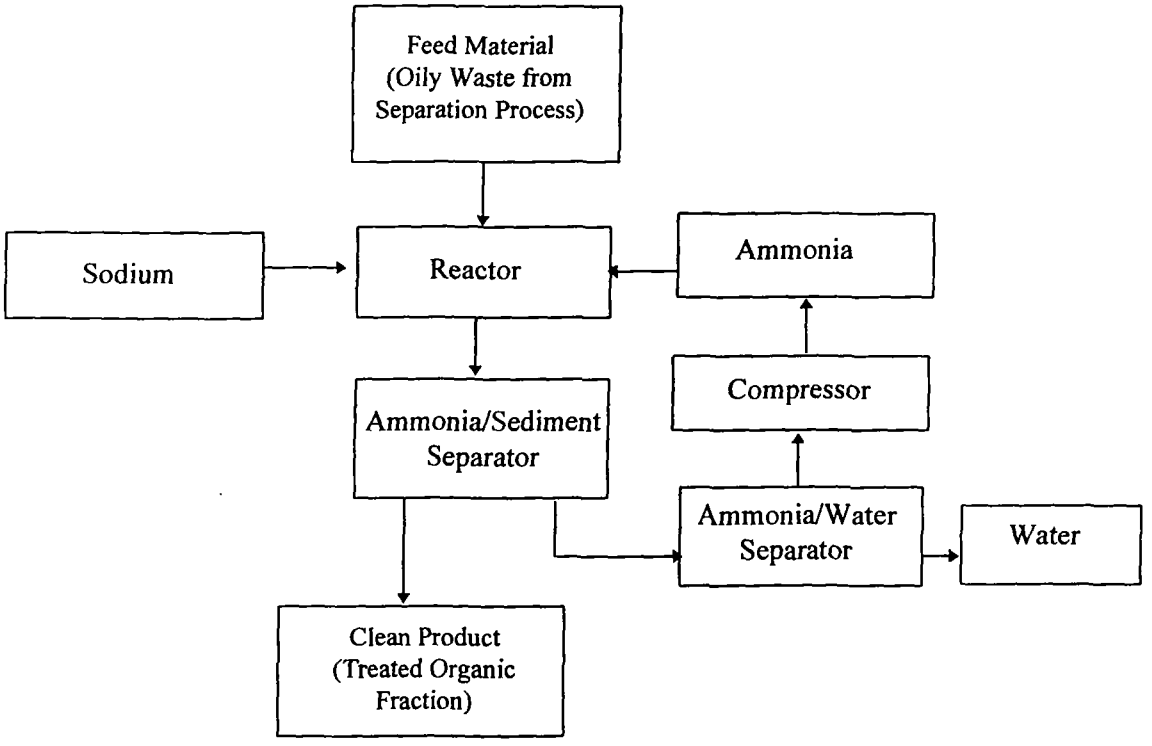
Solvated Electron Technology (SET®) is a chemical destruction process based on solvated electron chemistry, which has been known for some time. Dissolving an alkali metal, such as calcium or sodium, in an appropriate solvent, chemically generates a solvated electron solution. Solvated electron solutions are powerful reducing agents that can be used to destroy PCBs by removing the chlorine atoms from the PCB molecule. These electrons are effectively detached from alkali and alkaline earth metals by several solvents, including ammonia, amines, and ethers. For the New Bedford Harbor treatability study, sodium was the active metal of choice, and anhydrous ammonia was the solvent of choice. The bright blue color that is visible immediately upon introduction of the alkali metal is indicative of an abundance of free electrons in the solution. The dissolution may be shown as follows:

$$Na^{o} \xrightarrow[NH_3]{\text{Liquid}} Na^{+} + e^{-}$$

Although the reducing power of the solvated electron solution is known chemistry, the solution's reactions with many common constituents, such as iron oxide and other metal oxides, water, oxygen, nitrogen, nickel, and copper, result in removing free electrons from solution. This can reduce the solution's power to dechlorinate PCBs.

In application, the process employs a reactor vessel in which contaminated material and liquid ammonia are mixed. The ammonia mixes with the contaminated organic material (the organic fraction from the B.E.S.T.® process) forming a solution. After brief additional mixing, sodium is added. Electrons are freed from the sodium by the ammonia, and the free electrons chemically remove the chlorine atoms from the contaminants, in this case, PCBs. When the process is complete, ammonia is retained in the system for re-use, and the treated (dechlorinated) organic material is removed. By-products of the process consist primarily of metal salts (sodium chloride, *i.e.*, ordinary "salt"), biphenyls, and trace amounts of ammonia. Figure 4-8 illustrates the basic SET® process.

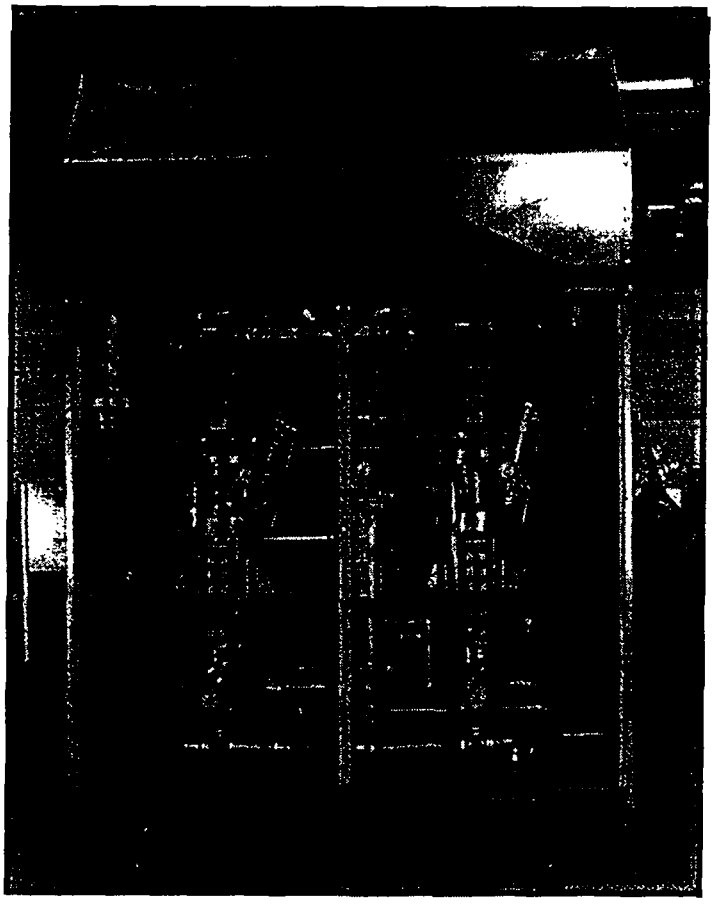
Figure 4-8
Solvated Electron Technology (SET®) Process Summary



SET® Pilot Unit Operation

A mobile pilot scale SET® unit, capable of processing approximately 1 gallon of concentrated organic per day, was employed for the New Bedford Harbor Treatability study. The unit consisted of a reactor pressure vessel, a zero discharge holding vessel for treated product, and a storage pressure vessel for recycling liquid ammonia (this vessel is identical to and interchangeable with the reactor vessel). Concentrated organic material (extracted from the sediment during the B.E.S.T. process) was introduced into the reactor vessel, where it was mixed with liquid anhydrous ammonia. A calculated amount of metallic sodium was added through a special port in the top of the vessel. As the sodium dissolved, electrons were released to the solution, and these electrons, or free radicals, destroyed PCBs through a chlorine substitution process. When the reaction was complete (approximately 15 minutes), the contents of the reactor vessel were emptied to the zero discharge holding vessel. Ammonia was transferred to the storage vessel using a common heating and cooling operation. After ammonia removal, the treated material was manually removed from the zero discharge holding vessel. A photograph of the CRTI pilot unit is included as Exhibit 4-4.

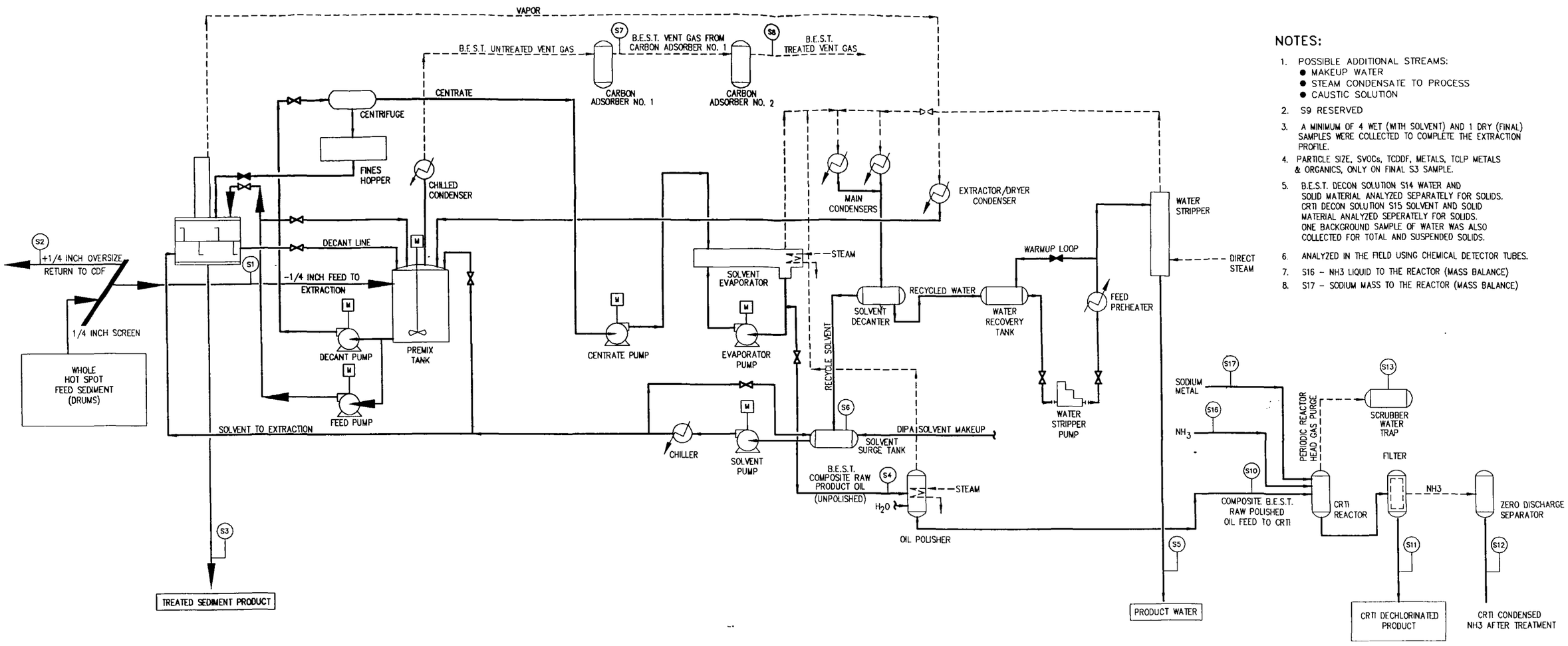
Exhibit 4-4
CRTI's Pilot Scale SET® Unit



4.4.2 Ionics RCC/CRTI Pilot Test Program Elements

The Ionics RCC/CRTI test program, the first of three pilot study tests, is discussed in this section. Schedule, process optimization, and sampling points are presented in the following subsections. Analytical results and an overall process evaluation, full-scale applications analysis, and associated costs are discussed in Sections 4.4.3, 4.4.4, and 4.4.5, respectively.

A flow diagram, summarizing the Ionics/RCC and CRTI processes, is included as Figure 4-9. A summary of the sampling locations and the analytical parameters is also included on this figure. The sample matrix and a brief description of the sampling point are included in Tables 4-10 (Ionics RCC) and 4-11 (CRTI). Where sample volume allowed and the data were intended for performance evaluation purposes, samples were collected in replicate (duplicate or triplicate), from each batch (see Section 4.4.2.1). The Ionics RCC/CRTI test program is discussed in detail in their vendor report, included in the Data Compendium. Complete analytical results are also included in the Data Compendium. A summary of the results and an evaluation of process performance is included in Section 4.4.3.



NOTES:

1. POSSIBLE ADDITIONAL STREAMS:
   - MAKEUP WATER
   - STEAM CONDENSATE TO PROCESS
   - CAUSTIC SOLUTION
2. S9 RESERVED
3. A MINIMUM OF 4 WET (WITH SOLVENT) AND 1 DRY (FINAL) SAMPLES WERE COLLECTED TO COMPLETE THE EXTRACTION PROFILE.
4. PARTICLE SIZE, SVOCs, TCDDF, METALS, TCLP METALS & ORGANICS, ONLY ON FINAL S3 SAMPLE.
5. B.E.S.T. DECON SOLUTION S14 WATER AND SOLID MATERIAL ANALYZED SEPARATELY FOR SOLIDS. CRTI DECON SOLUTION S15 SOLVENT AND SOLID MATERIAL ANALYZED SEPERATELY FOR SOLIDS. ONE BACKGROUND SAMPLE OF WATER WAS ALSO COLLECTED FOR TOTAL AND SUSPENDED SOLIDS.
6. ANALYZED IN THE FIELD USING CHEMICAL DETECTOR TUBES.
7. S16 – NH3 LIQUID TO THE REACTOR (MASS BALANCE)
8. S17 – SODIUM MASS TO THE REACTOR (MASS BALANCE)

PARAMETERS	S1 -1/4 INCH FEED TO EXTRACTION	S2 +1/4 INCH OVERSIZE RETURN TO CDF	TREATED SEDIMENT PRODUCT S3a (NOTE 3) AFTER X EXTRACTIONS	TREATED SEDIMENT PRODUCT S3b (NOTE 4) FINAL AFTER 8 OR 10 EXTRACTIONS	S14 (NOTE 5) B.E.S.T. DECON SOLUTION TO CLOSE MASS BALANCE	S4 UNPOLISHED B.E.S.T. RAW COMPOSITE PRODUCT OIL AND SOLVENT	S5 PRODUCT WATER	S6 DIPA SOLVENT TO EXTRACTION	S7 B.E.S.T. VENT GAS FROM CARBON ADSORBER NO. 1	S8 B.E.S.T. TREATED VENT GAS	S10 COMPOSITE B.E.S.T. RAW POLISHED OIL FEED TO CRTI	S11 CRTI DECHLORINATED PRODUCT	S12 CRTI CONDENSED ANHYDROUS NH_3 AFTER TREATMENT DISSOLVED IN WATER	S13 SCRUBBER WATER	S15 (NOTE 5) CRTI DECON SOLUTION TO CLOSE MASS BALANCE
PCBs (24 HR TURNAROUND)	✓		✓	✓		✓					✓	✓			
PCBs	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	
SVOCs	✓			✓		✓	✓	✓			✓	✓	✓	✓	
PCDD/F	✓			✓		✓	✓	✓			✓	✓	✓	✓	
METALS	✓			✓		✓	✓	✓			✓	✓			
O&G	✓			✓		✓	✓	✓			✓	✓			
TCLP ORGANICS	✓			✓											
TCLP METALS	✓			✓											
PARTICLE SIZE	✓			✓											
MOISTURE (WT%)	✓	✓	✓	✓	✓										✓
TSS					✓	✓	✓	✓			✓	✓			✓
DS							✓								
TS					✓	✓	✓	✓			✓	✓			✓
BULK DENSITY	✓	✓	✓	✓											
SP. GRAVITY								✓			✓	✓			
DIPA				✓		BY TSS/TS	✓		✓ (6)	✓ (6)	✓	✓			
WATER CONTENT								✓			✓	✓			
pH	✓			✓			✓								
NH3												✓		✓	
MASS	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
VOLUME	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓

LEGEND

- SOLID/SEMI-SOLID
- VAPOR
- LIQUID

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470 ATLANTIC AVENUE
BOSTON, MA. 02210

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

IONICS RCC/CRTI PILOT SCALE
PROCESS SCHEMATIC WITH SAMPLING LOCATIONS

SIZE D

FIGURE 4-9

REV –

SCALE: NONE PLOTDATE 9/25/97 SHEET 1 OF 1

Table 4-10
Summary of Samples Collected During the Ionics RCC Pilot Test

Sample ID	Matrix of Sample	Description
S1	sediment	Composite of grab samples from feed sediment per batch
S2	soil/sediment > 1/4"	+ 1/4 inch oversize whole sediment, composite of grab samples from 1/4 inch screen (total of all batches)
S3(x)	sediment wet with DIPA	Interstage treated solids after x extractions, solids are mixed with DIPA, composite of grab samples per batch
S3(x)	dry soil/ sediment	Final treated solids after x extractions, solids are steam dried, composite of grab samples per batch
S4	approx. 90% DIPA/ 4% PCB in oil	B.E.S.T.® raw un-polished product oil and solvent, one grab sample from oil accumulated following the three optimization batches and one grab sample following the two verification batches
S6	solvent (DIPA)	Solvent grab samples, one at beginning of study and one at the end of each batch
S7	gas in reaction tubes	B.E.S.T.® vent gas from first carbon treatment, at least one per day (twice per extraction batch, twice per solvent recovery batch and twice per oil polish)
S8	gas in reaction tubes	B.E.S.T.® treated vent gas samples, at least one per day (twice per extraction batch, twice per solvent recovery batch and twice per oil polish)
S10	wax-like solid at ambient temp.	Composite raw polished oil (grab sample of composite). Note this is the feed material for the CRTI process.
S5	aqueous	Product water, grab sample at end of three optimization batches and after two verification batches
S14	water/settled solids	B.E.S.T.® decontamination fluids
Replicate samples were collected from each batch where appropriate.		

Table 4-11
Summary of Samples Collected During the CRTI Pilot Test

Sample ID	Matrix of Sample	Description
S10	wax-like solid at ambient temp.	Composite raw polished oil (grab sample of composite). Feed material for the CRTI process.
S11	aqueous slurry with an organic (oil) layer	CRTI dechlorinated product, grab sample at end of batch
S12	aqueous/hexane	CRTI condensed NH_3 after treatment dissolved in water, grab sample at end of batch. Hexane rinse at end of batch.
S13	aqueous	CRTI scrubber water
S14	solvent/settled solids	CRTI decontamination fluids

4.4.2.1 Test Program Schedule

A summary of the pilot study testing schedule is included in Table 4-12 and briefly discussed below. As summarized in Table 4-12, testing was divided into optimization and verification batches. The purpose of the optimization testing was to identify the optimum process parameters required to maximize extraction of PCBs from the contaminated sediment feed material. The purpose of verification testing was to collect data from tests (batches) operated under consistent/reproducible optimum process conditions. Data generated from the verification testing was used in the overall process evaluation (see Section 4.4.3).

Ionics RCC performed five B.E.S.T.® extraction runs (E1-E5) on Hot Spot sediment and two oil polishing runs (OP1 and VP1) as summarized in Table 4-12. Three extraction runs (E1-E3) were optimization tests and two (E4-E5) were verification runs. The extractions were run in batch mode except for E2 which was run in a continuous mode. Oil product from optimization batches E1 through E3 was combined and polished in oil polishing batch OP1. Oil product from verification batches E4 and E5 was combined and polished in oil polishing batch VP1.

CRTI performed seven runs (C1-C7) on the polished oil that was recovered from the solvent extraction pilot test. The CRTI runs are also summarized in Table 4-12. Four runs (C1-C4) were optimization tests using polished oil from Ionics RCC batch OP1 as feed material and three (C5-C7) were verification tests using polished oil from Ionics RCC batch VP1 as feed material. Each run was operated in batch mode. Data from the verification runs were used to evaluate the treatment process (see Section 4.4.3).

Table 4-12
Ionics RCC/CRTI Pilot Tests Program Schedule

Test Date	Day	Ionics RCC Batch No.	CRTI Batch No.	Test Description
6/6/96	1	E1		Extraction optimization run
6/7/96	2	E1		Extraction optimization run
6/8/96	3	E2		Extraction optimization run
6/9/96	4	E2		Extraction optimization run
6/10/96	5	E3		Extraction optimization run
6/11/96	6	E3		Extraction optimization run
6/12/96	7	OP1		Oil polishing optimization run
6/13/96	8	OP1		Oil polishing optimization run
6/14/96	9	E4		Extraction verification run
6/15/96	10	E4	C1	Extraction verification run / SET® optimization run
6/16/96	11	E4	C2	Extraction verification run / SET® optimization run
6/17/96	12	E5	C3	Extraction verification run / SET® optimization run
6/18/96	13	E5		Extraction verification run
6/19/96	14	VP1	C4	Oil polishing verification run / SET® optimization run
6/20/96	15	VP1		Oil polishing verification run / SET® optimization run
6/21/96	16		C5	SET® verification run
6/22/96	17		C6	SET® verification run
6/23/96	18		C7	SET® verification run

Batch Identification:

E = Ionics RCC B.E.S.T.® process extraction, sediment drying, and solvent recovery. All were conducted in
OP, VP = Oil polishing and water stripping (OP = optimization batch, VP = verification batch), continuous
C = CRTI Solvated Electron Technology (SET®) processing, batch operation.

4.4.2.2 Ionics RCC Pilot Scale Testing Program

As mentioned above, the pilot test batches were divided into optimization and verification batches. Optimization testing was conducted to determine optimum operating parameters for treating the Hot Spot sediment. Verification testing was conducted to collect evaluation data from the process under consistent, reproducible conditions. The pilot scale testing program is described in the following subsections. Additional detail on the field operations is included in the vendor report included in the Data Compendium.

Optimization Testing

Three optimization tests (batches) were conducted with the feed sediment material. The expected optimum process parameters for the sediment were determined based on prior bench scale testing, engineering analysis, and computer modeling of sample characterization results. These parameters were used, and adjusted, during optimization testing. The optimum process parameters, as identified during this optimization testing, were then used during the verification testing.

Feed Preparation and Loading

Whole Hot Spot sediment from the Confined Disposal Facility (CDF) was screened to remove oversize material greater than ¼-inch. The screened feed material was then homogenized and stored in covered 5-gallon buckets. The less than ¼-inch material represents about 93 percent by weight of the whole Hot Spot sediment. Analytical samples of the feed were collected during the transfer to the buckets. The amount of feed material loaded into the Premix Tank was determined by the solids content of the feed material, bulk density of the solids, and solids settling characteristics. Sufficient feed material was added to the Premix Tank such that later, during the drying step, the Extractor/Dryer was at least one-quarter (8 gallons) full of dried solids when complete. This minimum volume of solids in the Extractor/Dryer allowed for proper heat transfer and mixing in the Extractor/Dryer during drying.

Solvent Extraction Testing

Five major extraction parameters were optimized:

- extraction temperature
- extraction time
- solids settling time
- decant level
- number of extraction cycles

By varying one or more of these parameters, the optimum combination of extraction variables was determined.

Batch E-1

The feed sample load used for batch 1 was 130 pounds. Three cold (less than about 27°C) extraction cycles were used for batch 1 processing. The optimum extraction temperature for treating this feed material was determined to be near the complete miscibility point of the solvent/water mixture in the Premix Tank.

For batch 1, the optimum extraction time ranged from 5 minutes for the first extraction cycles to 15 minutes for the final extraction cycles. Longer extraction times were required for the final extraction cycles due to the lower extraction efficiency encountered when the contaminants reach lower levels.

The decant level was at 62 percent (upper port) of the Premix Tank full volume for the first 3 extractions, and then at the 32 percent (mid port) for subsequent extractions. After the water was removed in the initial extractions, the solids settled to a lower level and this allowed a greater fraction of the remaining contaminants to be decanted with each extraction. The feed material settled quickly. This resulted in a clear solids-free extract solution (solvent/contaminants/water). Therefore, fines centrifugation was not required during batch one. The extract solution was decanted directly into the solvent evaporator.

The solids and solvent heel remaining in the Premix Tank were pumped over to the Extractor/Dryer and dried to remove the residual solvent. The caustic addition required to achieve the desired treated solids solvent residual for batch 1 was 18 ml of 50% sodium hydroxide in water (NaOH) per kilogram of dry solids. This caustic load was added to the Extractor/Dryer just prior to the drying step.

Batch E-2

Batch 2 was processed in continuous mode by deliberately allowing fines to carry over to the centrifuge. The solids/liquid separation is very effective in the centrifuge when compared to that achieved by gravity settling. This increased separation allowed a greater extraction efficiency. The feed load used for batch 2 was 132 pounds. This feed material was loaded directly into the Extractor/Dryer.

Extraction was started by adding solvent to the material in the Extractor/Dryer. The material was mixed while solvent was continually added. A mixture of solvent, water, organics, and fines was allowed to flow out of the vessel. This mixture was transferred to the centrifuge for liquid-solids separation. The solids were continually returned to the Extractor/Dryer, while the extracted centrate was routed to the normal solvent recovery system for recovery and re-use.

The caustic addition required to achieve the desired pH and treated solids solvent residual for batch 2 was 18 ml of 50% NaOH per kilogram of dry solids. This caustic load was added to the Extractor/Dryer just prior to the drying step.

Batch E-3

Batch 3 processing was conducted similarly to batch 1. The feed material load used for batch 3 was 124 pounds. Three cold extraction cycles were conducted in the Premix Tank during batch 3. The optimum extraction temperature for treating this feed material was determined to be near the complete miscibility point of the solvent/water mixture in the Premix Tank.

For batch 3, the optimum extraction time ranged from 5 minutes for the first extraction to 30 minutes for the final extraction. Longer extraction times were used for the final extraction due to the lower extraction efficiency encountered when the contaminants reached lower levels.

The extract solution was decanted from the mid port of the Premix Tank for each extraction during batch 3. As for batch 1, the extract solution was free of fines, and thus was not centrifuged. The extract solution was routed directly to the solvent evaporator. The solids and solvent heel in the Premix Tank were then pumped over to the Extractor/Dryer for drying.

The caustic addition required to achieve the desired pH and treated solids solvent residual for batch 3 was 18 ml of 50% NaOH per kilogram of dry solids. This caustic load was added to the Extractor/Dryer just prior to the drying step.

The concentrated organics (PCBs and oil) remained in the evaporator throughout the processing of the optimization batches. After the third batch of feed sediment was processed, (the final optimization batch), the solvent/organic solution in the solvent evaporator was concentrated to about 30 liters, and pumped into the oil polisher.

The oil polisher is a smaller, isolated solvent evaporator. Since the volume of organics present in the feed material was relatively low, the volume of concentrated contaminant was too small for effective concentration in the main solvent evaporator. The oil polisher is smaller, so it allowed a smaller volume of material to be circulated and heated without a large percentage of the material adhering to the inner surfaces. The extracted contaminants were concentrated in the oil polisher and then pumped into sample

containers for subsequent treatment with the Solvated Electron Technology PCB destruction process. The solvent and water recovered during oil polishing was returned to the pilot unit for re-use.

Optimization Testing Conclusions

The performance of the first three batches was used to determine the parameters to be used during verification testing. Based on observations of the testing, it was determined to use Premix Tank extractions as was done for batches 1 and 3. A feed batch load of about 140 pounds was determined to be optimum. The extraction temperature, extraction time, solids settling time, and decant level from the third batch were observed to be optimum, so they were repeated during verification testing.

The only parameter in question was the number of extraction cycles to use. Based on screening data, it appeared that a significant amount of PCBs were removed after eight extractions. To collect additional data on the efficiency of the process at lower concentrations, ten extractions were performed during verification testing.

Verification Testing

The purpose of verification testing was to collect data from tests (batches) conducted under consistent and optimum process conditions. Data generated during these verification tests was used in the overall evaluation of the process (see Section 4.4.3). The following process parameters were selected for operation of the B.E.S.T.® process during verification testing:

- A feed load of about 140 pounds was used for each batch.
- Extraction temperature was less than 27°C for the first extraction then increased with each extraction. The temperature was greater than 55°C for extractions 7 through 10.
- Extraction mixing times were set at 10 minutes for extraction cycles 1 through 3, and 15 minutes for extraction cycles 4 through 10.
- The settling time was set at about 30 minutes for extractions 1 through 3. The settling time was set less than 15 minutes for extractions 4 through 10, and was often less than 5 minutes. The solids settled to a lower level for extractions 4 through 10 than for extractions 1 through 3, and thus more extract was removed during the later extractions.
- Ten extraction cycles were conducted with the feed material.
- The fines centrifuge was not used.
- Caustic addition during drying of the sediments was 18 ml of 50% NaOH per kilogram of dry treated solids.
- The PCB contaminated organic fraction remained in the evaporator throughout the processing of both verification batches. After the second verification batch was processed, the solvent/organic solution was concentrated to about 30 liters, sampled, and transferred to the oil polisher for further

concentration. After polishing, the organic fraction was placed in containers for sampling and treatment with the Solvated Electron Technology.

- The recovered water was stripped to remove residual solvent and then sampled.

4.4.2.3 CRTI Pilot Scale Testing Program

The CRTI Solvated Electron Technology (SET®) process was tested in seven batches. As was done for the Ionics RCC process, the first SET® batches were conducted to optimize parameters. Verification testing was conducted to collect representative data under optimal operating conditions. The CRTI pilot scale testing is described below.

Optimization Testing

The concentrated organic fraction generated from RCC's optimization test phase (batches 1, 2, and 3) was used as the feed for CRTI's SET® process optimization tests. Optimization testing was conducted to determine the parameters necessary to achieve chemical destruction of the PCBs and generate data which would be used to provide an estimate of the full-scale treatment costs. The CRTI equipment used for the Hot Spot sediment was capable of treating up to one gallon of contaminated matrix per twelve hour day.

Feed Sample Preparation and Loading

At the start of testing, the CRTI pilot unit was configured to pump heavy liquids as feedstock. The concentrated organic fraction from the B.E.S.T.® unit discharged as a liquid when warm. However, after cooling to ambient temperature, the organics solidified due to the constituency of the organic contaminants in the original sediment. The B.E.S.T.® process removes all the contaminant organics from the sediment, including heavy organics such as wax, not just the PCBs.

When RCC and CRTI discovered that the organic fraction had cooled to a waxy solid that could not be pumped, the CRTI pilot unit was adapted to receive the solid matrix. The organic fraction was then fed into the reactor vessel through a side access port. This feed method was not representative of available full-scale equipment. Therefore, the expected method of loading materials into the full-scale SET® unit could not be demonstrated in pilot scale.

Optimization Parameters

Four parameters were optimized; these included:

- sodium mass
- ammonia volume
- premix time
- treatment mix time

Sodium Mass

The sodium metal added to the solvated waste solution was the primary focus of optimization. The ratio of sodium metal to PCBs had to be sufficient to ensure that enough solvated electrons were present in solution

to achieve destruction of the PCBs. If the amount of electrons was insufficient, additional metal had to be added. The addition of excess metal causes the treated product to be reactive and caustic, due to unreacted sodium metal and sodium amides. These hazardous characteristics require the treated residuals to receive additional post treatment conditioning to facilitate safe handling by site workers. For these reasons, it is desirable to achieve complete PCB destruction with as little metal as possible.

CRTI's first optimization batch run was made with a high sodium dosage, namely, approximately 80% (by weight) sodium to the mass of the waste treated. During the following two runs, the sodium to waste ratio was lowered to 50% and 40%, respectively. Cross-contamination of the treated residual with input material lodged in the feed mechanism during the second and third runs encouraged the decision to use more sodium during the remaining verification runs. As a result, excess sodium and sodium amides were present in the treated organics. Therefore, an additional post-treatment step was required to react the excess sodium metal and to reduce the pH to below 12.

Ammonia Volume

The first optimization run determined that ammonia volume required between 8 and 9 liters. This amount of ammonia allowed adequate mixing of the product oil and sufficient contact with the solvated solution. There was little expansion or contraction of the treatment matrix during operations, and sight glass monitoring of fluid level was possible.

Mix Time

The first optimization run also determined that approximately 10 minutes of pre-mix time was sufficient to slurry the product oil in the ammonia completely prior to sodium addition. After this pre-mix was completed, sodium aliquots were dropped through the reactor vessel entry port, and after each, a 2 to 5 minute solvation mix time elapsed.

Optimization Testing Results

The treated material from CRTI batches 2 through 4 contained significantly more PCBs than originally anticipated. The source of PCBs in these samples was identified to be contamination from feed material in the loading port becoming dislodged during transfer of the treated material from the reactor vessel to the zero discharge holding vessel. During the transfer process, the treated (quenched) material was re-contaminated by the high concentration input feed. When discovered, on-site operations were modified to transfer the treated product in a solvated condition before quenching, rather than quenching the solution in the reactor. Thus, the solvated electron reaction was not stopped (quenched) prior to the transfer and material dislodged from the feed port during transfer was effectively treated in the discharge piping or the discharge vessel. Subsequent performance test runs verified the identification of and the solution to the cross contamination.

Verification Testing

Feed loads of 606, 619, and 646 grams of the B.E.S.T.® concentrated PCB contaminated organic (oil) fraction were used for verification batches 5, 6, and 7, respectively. The material was received in a solid state, and was chopped into small pieces for inserting into the reactor vessel. No other pretreatment was

performed. The material was loaded into an empty, ambient pressure and temperature reactor vessel, then the vessel was closed and filled with anhydrous ammonia.

After a nominal ten minute mixing period, sodium was added at a 65% by weight ratio of sodium to oil. Solvation was indicated both by color and conductivity, and after approximately twenty minutes of reaction time, the material was discharged to the zero discharge vessel for ammonia removal. One liter of quench water was added to this vessel after ammonia recovery to react any remaining sodium metal. The combined treated materials and water were removed from the zero discharge vessel and stored in five-gallon plastic pails.

4.4.3 Ionics/CRTI Effectiveness Evaluation

The analytical results for the Ionics RCC/CRTI pilot study program are presented and discussed in this section. The solvent extraction (B.E.S.T.®) and the chemical destruction (SET®) results are discussed separately, as the processes may be operated independently at full-scale, if desired. The sampling points and the associated analyses are summarized in Figure 4-9 and in Tables 4-10 and 4-11. The Ionics RCC/CRTI report and available laboratory data are included in the Data Compendium. A discussion of the analytical methods and associated quality control results is provided in Section 4.3.

For the purposes of this evaluation, data from verification runs were used. Optimization runs were intended to develop optimum operating parameters and were not intended for use in evaluating overall effectiveness of the process. Optimization data are presented in some cases, as it provides a larger data set for the purposes of evaluating possible trends.

4.4.3.1 Ionics RCC Process Performance

The results for key process outputs are summarized and discussed in this section relative to overall process performance. The primary focus of this evaluation is to consider the effectiveness of the solvent extraction process effectiveness at removing PCBs from the sediment. Secondary considerations include evaluating disposal options for the various process outputs, including treated sediment.

Feed and Treated Sediment Results

Section 2.2 discusses the chemical and physical characteristics of the Hot Spot sediment. PCB results for feed material for the Ionics RCC pilot test were lower than the expected average CDF concentration. Results for feed material for the pilot test are used in this evaluation. While the average PCB concentration from the CDF is expected to be a slightly higher concentration than was treated by Ionics RCC/CRTI during the pilot scale study, the relatively small difference in PCB concentration is not likely to significantly alter the conclusions of the testing results.

Table 4-13 summarizes the PCB results for treated solids with respect to the concentration in the feed material. Removal efficiencies were slightly greater for the verification runs, presumably because operating parameters were optimized and, in part, because ten extractions were performed rather than eight.

Table 4-13
Ionics RCC PCB in Sediment Results

Parameter	Optimization Testing			Verification Testing	
	E1	E2	E3	E4	E5
Feed Sediment (S1)	2,100	2,500	2,500	2,360	2,515
Final Treated Sediment (S3F)[1]	13	19	7.5	4.8	6
Removal Efficiency (%)	99.38	99.24	99.70	99.79	99.76

PCB values are reported in units of mg/kg and are an average of detected Aroclor results.
[1] Final solids were collected following 8 extractions for the optimization batches and after 10 extractions for the verification batches.

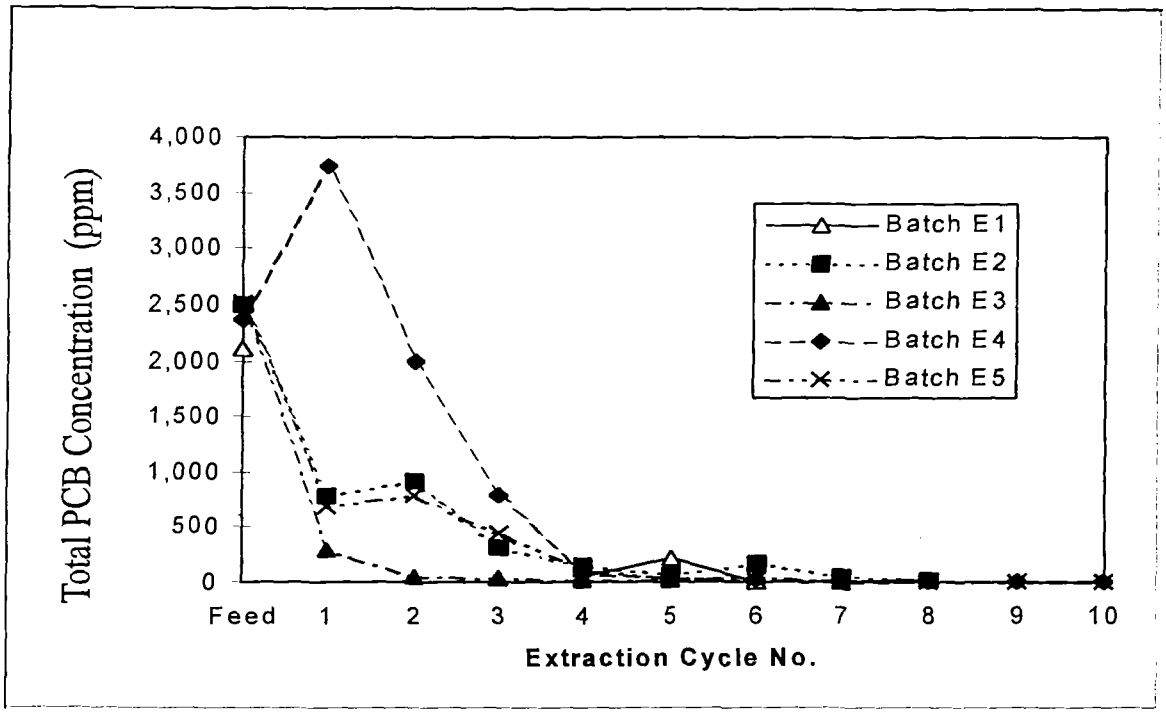
In addition to sampling the dry solids at the end of the batch, the solids in the Premix Tank were sampled in between the extraction cycles. These interstage solids samples were screened for PCBs in the on-site laboratory to monitor process performance. To illustrate the effectiveness of each extraction cycle, the results of interstage solids analyses after each extraction are presented in Table 4-14, and are graphically depicted in Figure 4-10. Results from the off-site laboratory are used for the feed (S1) and the final (S3 final) data. The final extraction (S3 final) material was the last sample collected during each batch and was dry treated solid. The interstage solids (S3x, denotes the number of extraction cycles) samples were of solvent saturated sediment collected after each extraction cycle and analyzed by the on-site screening laboratory.

Table 4-14
Solvent Extraction Interstage and Treated Solid PCB Results

Parameter	Optimization Testing			Verification Testing	
	E1	E2	E3	E4	E5
Feed (S1):	2,100	2,500	2,500	2,360	2,515
Extraction Cycle (S3)					
1st Extraction		790	290	3,700	680
2nd Extraction		910	55	2,000	780
3rd Extraction		310	36	780	430
4th Extraction	41	140	23	87	120
5th Extraction	220	68	24	40	39
6th Extraction	5.1	160	50	22	14
7th Extraction	3.9	55	7.5	6.3	8.2
8th Extraction	13	19		5.2	7.1
9th Extraction				2.8	4.2
10th Extraction				4.8	6.0

Results are reported in units of ppm.
PCB results are from the on-site screening analysis, except for S1 and the "Final" S3 for each batch which are from the off-site analysis.
If field is left blank, no data are available.

Figure 4-10
Ionics RCC Solvent Extraction Summary



As shown in the table and figure, the majority of PCBs are removed in the first few extractions. Typically, 70 to 80 percent of the PCBs were removed after three extractions. Verification testing data (E4 and E5) indicate that the sediment can be effectively treated to less than 50 ppm PCB in approximately five extraction cycles. A 10 ppm PCB concentration can likely be achieved using seven extraction cycles. Subsequent extractions may continue to remove PCBs although, based on screening data, PCB concentrations were not significantly reduced with additional extractions once a 10 ppm residual PCB concentration was achieved. The required cleanup level would ultimately determine the required number of extraction cycles and will have a significant effect on overall full-scale implementation costs (see Section 4.4.4.6).

Treated solids were also analyzed for oil & grease, total solids, diisopropylamine, metals, and TCLP analytes. Selected results of the treated solids analyses are presented in Table 4-15. TCLP results were below regulatory limits.

Table 4-15
Solvent Extraction Treated Solids (S3) Results

	Optimization Testing			Verification Testing	
Batch	**E1**	**E2**	**E3**	**E4**	**E5**
Oil & Grease (%)	0.13	0.32	NA	0.25	NA
Total Solids (%)	78	88	87	89.5	92
Diisopropylamine (mg/kg)	2.4	2.7	NA	4.8	1.1

Where replicate samples were collected, oil & grease and DIPA numbers, are an average of results.
NA - Not Analyzed

Oil Polishing Results

The final step in the B.E.S.T. process is the oil polishing step, where excess moisture and DIPA are removed (recycled) and the resulting PCB oil is concentrated prior to disposal and/or further treatment. The organic mixture of oil and DIPA prior to polishing (S4) and the polished oil (S10) were sampled and analyzed for the parameters summarized in Figure 4-9. Results of selected analyses from the verification oil polishing batch are summarized in Table 4-16.

Table 4-16
Summary of Oil Polishing Verification Batch Results

Analyte	Unpolished Oil/DIPA (S4)	Polished Oil (S10)
PCB (ppm)	9,850	49,000
PCDD/PCDF-TEQ (ppt)	2,785	15,000
Oil & Grease (%)	14.5	NA
NA = Not Analyzed		

Product Water (S5) Analyses Results

The product water resulting from the extraction and stripping process was sampled and analyzed for the parameters given in Figure 4-9. Analytical results of the product water analyses are summarized in Table 4-17.

Table 4-17
Solvent Extraction Product Water (S5) Analysis

Analyte (mg/l)	Batches 1, 2, & 3	Batches 4 & 5
PCBs	<0.002	<0.002
Oil & Grease	<10	90
Total Solids	180	310
TDS	180	290
TSS	<5	19
Diisopropylamine	2.7	<0.5
< indicates not detected above the given reporting limit		

4.4.3.2 CRTI Process Performance

The concentrated organic fraction from the solvent extraction process verification testing was the feedstock for CRTI verification testing (CRTI runs 5, 6, and 7). PCB results for feed and treated material are summarized in Table 4-18. The treatment residual from the SET® process was an aqueous slurry with an organic (oil) fraction. This non-homogenous matrix resulted in some analytical difficulties which are outlined below and discussed in more detail in Section 4.3. Despite the analytical difficulties, the data clearly indicate that the SET® process effectively treats PCBs to low ppm levels in the treated product. The average PCB destruction efficiency for the verification batches was 99.994% confirming that the CRTI SET® chemical destruction process effectively treats PCBs.

Table 4-18
CRTI Pre- and Post-Treatment PCB Concentrations

CRTI Batch No.	Untreated Oil PCB Concentration (S10)[1] (ppm)	Treatment Residual Concentration (S11) (ppm)
5	49,000	5.1
6	49,000	1.3
7	49,000	3.0

[1] Untreated oil for CRTI batches 1 through 4 was composited from Ionics RCC extraction batches 1 through 3. Untreated oil for CRTI batches 5 through 7 was composited from Ionics RCC extraction batches 4 and 5.

As discussed in Section 4.4.2.2, excess sodium and sodium amides were present in the treated product, resulting in a reactive, caustic product. To eliminate handling, shipping, and analysis difficulties, the product was neutralized using an acidic aqueous solution prior to sampling. The resulting final product was an aqueous slurry with a pH of approximately 11. If left standing, a floating oil layer would separate. This non-homogenous matrix made collecting a representative field sample difficult. Furthermore, the QC results suggest that the concentration of PCBs found in the sample was proportional to the amount of oil included in the analysis. The EPA Region I laboratory reported concentrations of 38 ppm, 33 ppm, and non-detect for samples from batches 5, 6, and 7, respectively. It appears that these results were generated by analyzing primarily the oil fraction.

It is reasonable to conclude that the majority of PCBs remaining after treatment are likely to be contained within the organic oil matrix of the treated product rather than in the aqueous fraction. Based on the data from the pilot study, the differences in reported concentrations are minimal and do not change the conclusion that the SET® process is capable of reducing concentrations of PCBs from approximately 5 percent to the low ppm levels.

Recycled Ammonia (S12) Results

For each verification batch run, a 200 ml sample of the recycled ammonia recovered from the test was collected in a one liter jar and evaporated in water. The jar was then washed with hexane, and the hexane rinsate analyzed for PCBs. PCBs were not detected in the aqueous or hexane rinsate samples, indicating that PCBs were not lost in the ammonia recovery process.

Scrubber Water (S13) Analysis

The pilot system includes a vent scrubber to remove ammonia which might escape the process by the vent. The water in the scrubber was sampled after each CRTI run to verify that PCBs were not exiting the process by the vent. After each CRTI run, a 1 liter sample of scrubber water was collected and analyzed for PCBs. Scrubber water PCB results ranged from non-detect values (<2.0 ppb) to 83 ug/L (ppb).

4.4.3.3 Ionics RCC Materials Balance

The amount of materials, by individual component, added to and recovered from the B.E.S.T.® pilot unit during verification testing, are presented in Table 4-19.

Table 4-19
B.E.S.T.® Process Material Balance

Measurement	PCBs	Dry Solids	Oil & Grease
Material Added (lbs.)	0.38	157.9	5.671
Material Recovered (lbs.)	0.34	168.4	7.95
Percent Recovery	89.5%	106.6%	140%

The balances were drawn over Batches 4 and 5 combined, and using averages. Water balance cannot be determined due to undefined retention of decontamination water in the pilot unit. However, this is not anticipated to significantly affect the results and/or conclusions of the study.

Mass balance results indicate that approximately 90 percent of the PCBs are recovered in the process and that the solids appear to be fully recovered. The measured recovery for PCBs appears reasonable, given the potential for variability in the sampling and analytical methods. The slightly elevated recovery for the oil and grease fraction may be due to residual DIPA and/or water in the polished oil product.

4.4.3.4 CRTI Materials Balance

A summary of the material balance for the verification testing for the CRTI process is presented in Table 4-20. The CRTI pilot scale materials balance results indicate that materials were accounted for within plus or minus five percent. Given the potential variability in the measurement methods, this appears reasonable. Note that this mass balance accounts for the materials added but does not address the amount of materials added relative to the amount of product oil treated. During the pilot study, an "over-dose" of sodium was used to ensure destruction of the PCBs. Because this overdose resulted in a treated product with reactive sodium and sodium amides, additional water and acid were required to neutralize the product. The increase in mass of material needed for the post-treatment was not assessed during the pilot test. Available mass balance data indicate that process streams were accounted for and support the conclusion that PCBs were effectively destroyed by the process.

Table 4-20
CRTI Verification Testing Material Balance

Measurement	Run C5	Run C6	Run C7
Material Added (grams)	3,006	2,986	3,059
Material Recovered (grams)	3,120	2,998	3,034
Percent Recovery (%)	104%	100.4%	99.2%

4.4.4 Ionics RCC/CRTI Full-Scale Application

The following subsections discuss potential full-scale application of solvent extraction and solid phase chemical destruction as a means for treating the Hot Spot sediments. The section begins with an overview of the process development and full-scale work during the past 15 or so years. Much of this information has been taken directly from the Ionics RCC/CRTI report (Data Compendium) and the claims of success are, by in large, theirs. In the course of preparing this FS Addendum, these claims were not independently verified by Foster Wheeler.

The discussion of potential full-scale treatment of the Hot Spot sediments includes an overview of the treatment system components and their operation, the estimated time to fabricate and deliver a treatment unit to the New Bedford site, the estimated cost to treat the 18,000 tons of Hot Spot sediment, a discussion of the unit's potential operational hazards and potential site specific and/or technological limitations for the process.

It is important to note that the two stages of treatment are discussed separately (i.e., solvent extraction vs. solid phase chemical destruction), with the consideration given to the fact that the pilot test was conducted with the two stages operating in conjunction with one another. In addition, it should be noted that the technical approach and cost estimate were modified by Foster Wheeler to reflect our evaluation of the treatment equipment during the pilot scale test and our engineering judgment based on direct experience with implementing innovative technologies in general, and at Superfund sites.

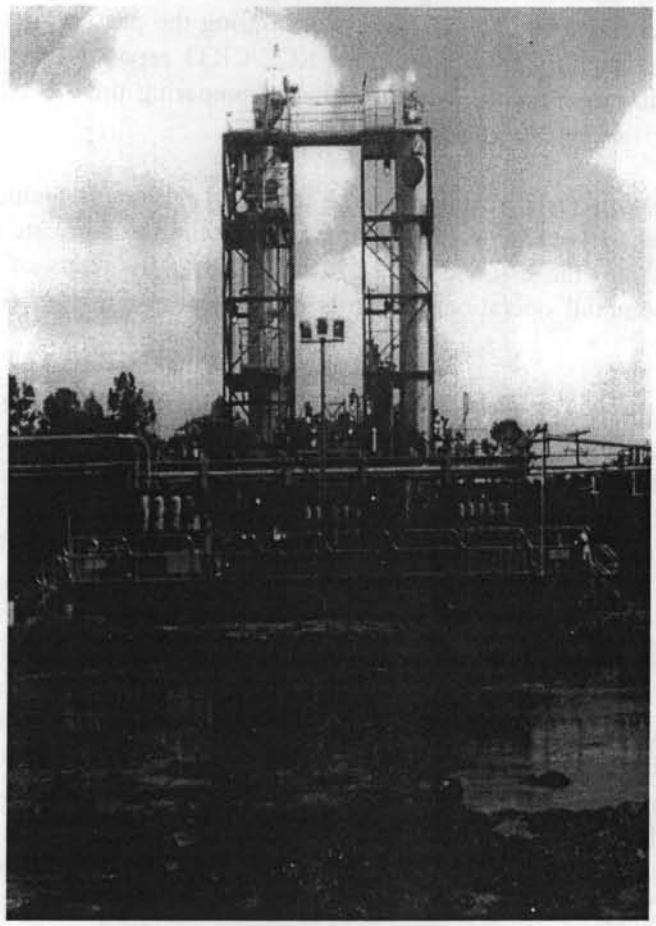
4.4.4.1 Ionics RCC/CRTI Full-Scale Experience

This section provides a summary level discussion of the process development activities that Ionics RCC and CRTI have been performing since the early 1980s. The activities include the full range of process engineering and development and include bench, pilot and full-scale applications. While the two processes were developed independently of one another over this period, they extended their work in treating contaminated sediments beyond the New Bedford Harbor on-site pilot scale study program. This includes a recent test at CRTI's research and development facility located in Marengo, Ohio. This test was conducted with PCB contaminated sediment from New Bedford Harbor. These tests were conducted independently from the treatability study program described herein and were designed by Ionics RCC and CRTI to resolve some of the materials handling difficulties that were experienced by the CRTI unit at New Bedford.

Ionics RCC Full-Scale Experience

Ionics RCC has been developing the B.E.S.T.® process since the early to mid-1980s. In the course of developing the process, they have conducted over 300 bench scale tests and over 25 pilot scale demonstrations. This work has also included design, construction and operation of a 70 ton per day unit used to treat 3,700 tons of PCB contaminated sludge at the General Refining, Inc. (GRI) site in Savannah, Georgia. A picture of the full-scale solvent extraction unit used at the GRI site is presented in Exhibit 4-5.

Exhibit 4-5
Full-Scale Ionics RCC Unit at the GRI Site in Savannah, Georgia



Ionics RCC has also recently completed design and construction of a second generation solvent extraction unit that was delivered to a site in 1996 for the treatment of soil contaminated with organic and radioactive waste. The design of this solvent extraction unit was very similar to the one that was identified to complete cleanup of PCB contaminated soils at the Norwood PCB Superfund site in Norwood, Massachusetts.

CRTI Full-Scale Experience

CRTI has been developing the SET® process since 1982. The development work has generated a significant volume of bench scale data with actual scale-up of the process beginning in 1994. Since that time, CRTI has been actively developing the technology including construction of a 400-gallon reactor system in 1995. Since that time, they have added several more reactor systems. The development of the system can be traced through the chronology of equipment presented in Table 4-21. A photograph of a CRTI full-scale system is included as Exhibit 4-6.

Table 4-21
Solvated Electron Technology Equipment Experience

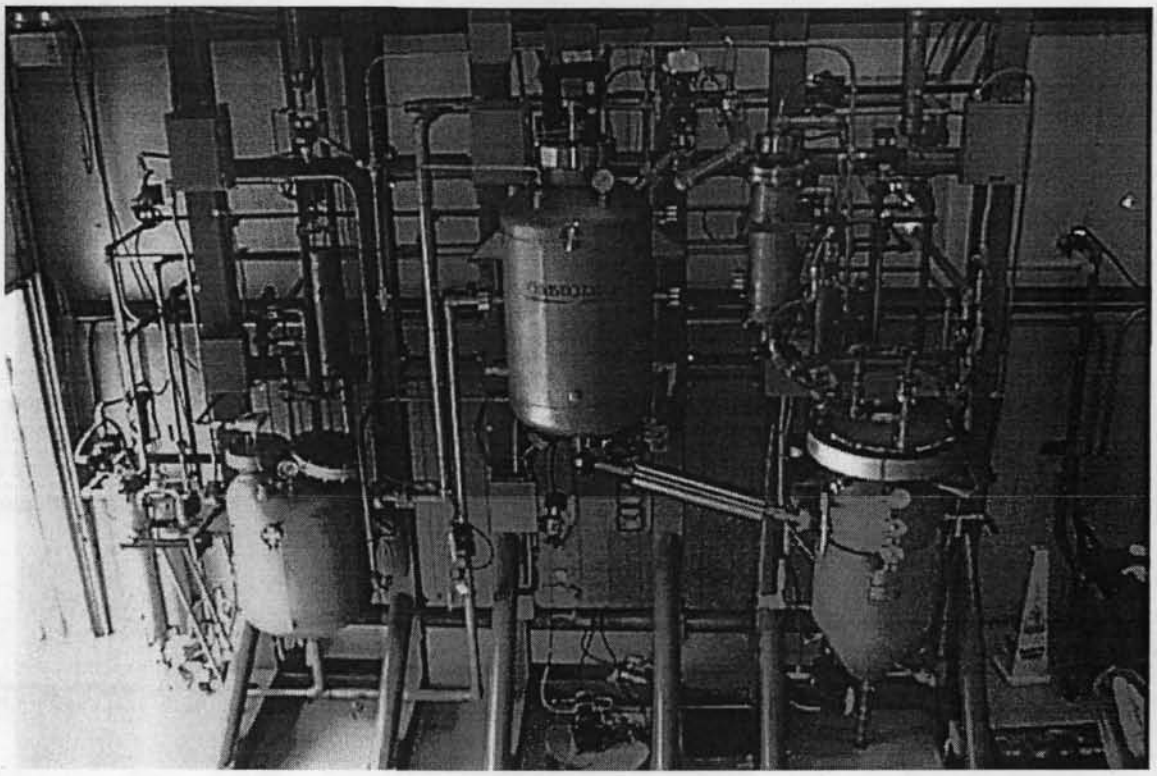
Status	Year Built	Units Built	Reactor Capacity (designation)	Through-Put	Matrix	Where Used
Retired	'82-'89	8	1 to 2 liters	½ liter/hr	Liquids/Soil	Laboratory
In use	1989	1	2 liters	½ liter/hr	Liquids/Soil	Laboratory
In use	1991	1	15 liters	2 liters/hr	Liquids/Soil	EPA R&D
In use	1993	6	2 liters	4 liters/hr	Soil	Laboratory
In use	1995	1	400 gal. (**S/4**)	200 #s/hr	Soil/Solids	R&D; EPA Demo
In use	1995	2	15 liters (**CMDU2**)	2 liters/hr	Liquids	Mobile unit; New Bedford, Port Hueneme
In use	1996	3	500 gal. (**S/2**)	400 #s/hr	Soil	R&D; EPA Demo
In use	1997	1	100 gal (**L150**)	66 #s/hr	Liquids	CFCs, commercial
In development	1997	1	100 gal. (**L200**)	100 #s/hr	Liquids	Chemical warfare agents
In development	1997	1	30 gal. (**MS10**)	1 ton/hr	Mixed Wastes	DOE/radioactive soils
In development	1997	1	30 gal. (**S10**)	1 ton/hr	Soil	Soil, commercial
In development	1998	1	Continuous (**S50**)	5 tons/hr	Soil	Soil, commercial
In development	1998	1	Continuous (**L1200**)	400 #s/hr	Liquids	Concentrates; commercial

4.4.4.2 Conceptual Full-Scale Treatment System

This section contains the conceptual full-scale solvent extraction and solid phase destruction process that could be used to treat the Hot Spot sediment. Within this section of the document these two processes (solvent extraction and solid phase chemical destruction) are discussed both separately, and together. This was done given the potential to mix and match these two processes with each other, or with other treatment approaches. Prior to discussing the potential conceptual full-scale treatment systems, a summary of the scale-up information provided by Ionics RCC and CRTI in their report is provided.

Bench scale and pilot scale treatability testing were designed to closely simulate the vessels and processes to be used in full-scale treatment. The data serves to predict full-scale performance and to estimate treatment costs. Because successful pilot testing was conducted on the Hot Spot sediment material to be remediated, both Ionics RCC and CRTI believe the model is expected to be reasonably accurate for predicting full-scale results and treatment costs. The information presented in this section provides a summary level discussion of full-scale equipment and expected treatment costs. Detailed scale-up information is contained in the Ionics RCC report.

Exhibit 4-6
Full-Scale CRTI Unit in Marengo, Ohio



Ionics RCC Scale-Up Viability

Table 4-22 presents data from two separate treatability tests and from full-scale operation for the Ionics RCC B.E.S.T.® solvent extraction process at the GRI Superfund site. These data demonstrate a close correlation between bench scale treatability test data and full-scale operating data. Ionics RCC also has a significant volume of scale-up data between their 25 plus pilot scale demonstrations and their 300 plus bench scale treatability study evaluations. Their information has been used to refine the process parameters for full-scale operations. This includes the 70 ton per day unit at the GRI Superfund site and a 50 ton per day unit that Ionics RCC recently delivered to a site to treat radioactive and organic mixed waste soil. This recent treatment system shares many of the process features with the unit recommended for New Bedford Harbor. The solvent extraction process proposed for the New Bedford Harbor site is similar to both the 70 ton per day full-scale unit used at the GRI Superfund site, and the 50 ton per day unit delivered recently. The proposed solvent extraction unit draws from the sediment handling components of the unit used at GRI, and the solids handling and drying components of the 50 ton per day unit.

Table 4-22
PCB Concentrations in Raw Sludge and Product Fractions at the General Refining Inc. Site

Parameter	Bench scale Test A	Bench scale Test B	Full-scale Processing
Raw Sludge, mg/kg, dry basis	14	12	13.5
Product Solids, mg/kg, dry basis	0.02	0.14	<0.13
Product Water, mg/L	<0.01	<0.01	<0.005
Percent Removal, %	99.9	98.8	>99

A key component for the Ionics RCC system is that they use unit process components that are routinely available in the chemical and food processing industry. An example of this is the extractor dryer system for this system. Ionics RCC uses the same pilot scale unit that a leading manufacturer (Littleford Day) uses to perform scale-up evolutions. This is important as it greatly minimizes the scale-up and performance risks of the technology.

CRTI Scale-Up Viability

Development of the SET® process has been ongoing since 1982. The development work has generated significant supporting data for the chemistry and for its application to various matrices. Scale-up of the process began in 1994, with a 400-gallon batch reactor for solid materials becoming operational in 1995. Three 500-gallon soil reactors and a 100-gallon liquid reactor have been added, with the instrumentation to monitor process parameters such as:

- Heat of reaction for various reactants
- Reaction times
- Sodium usage
- Optimum sodium concentrations
- Optimum ammonia ratios
- Ammonia recovery efficiency
- Waste stream analysis
- Conductivity repeatability
- PCB destruction efficiency

These process parameters have remained consistent throughout scaled-up versions, and provide design criteria for the L1200 unit. The most critical parameters have been adequate mixing and reaction time. Because the SET® process requires contact of free electrons with each target molecule, adequate mixing must be provided for each equipment configuration. Also, instrumentation results show that the reaction time is less than 3 seconds. Together, these features have directed scale-up activity towards smaller equipment volumes utilizing faster throughput to achieve both reliability of the process and increased treatment rates.

The unit used for the New Bedford Harbor Hot Spot sediment treatability study (CMDU2) was configured to treat liquid materials. Since the organic fraction from RCC's B.E.S.T.® process was a solid at ambient temperature, CMDU2 was re-configured at the site (after the first two optimization runs) to accommodate a solid matrix. CMDU2 best models a continuous contaminated liquid feed into a solvated solution. CRTI is currently working to overcome this and other materials handling issues experienced during the treatability

study. These issues must be addressed as part of CRTI's scale-up process for the technology to be effective and economically viable as it applies to the Hot Spot sediment.

The system proposed for New Bedford (L1200) is a refinement of the L150 and L200 units presented in Table 4-21 and uses the same basic process and process parameters.

Conceptual Full-Scale Treatment Systems

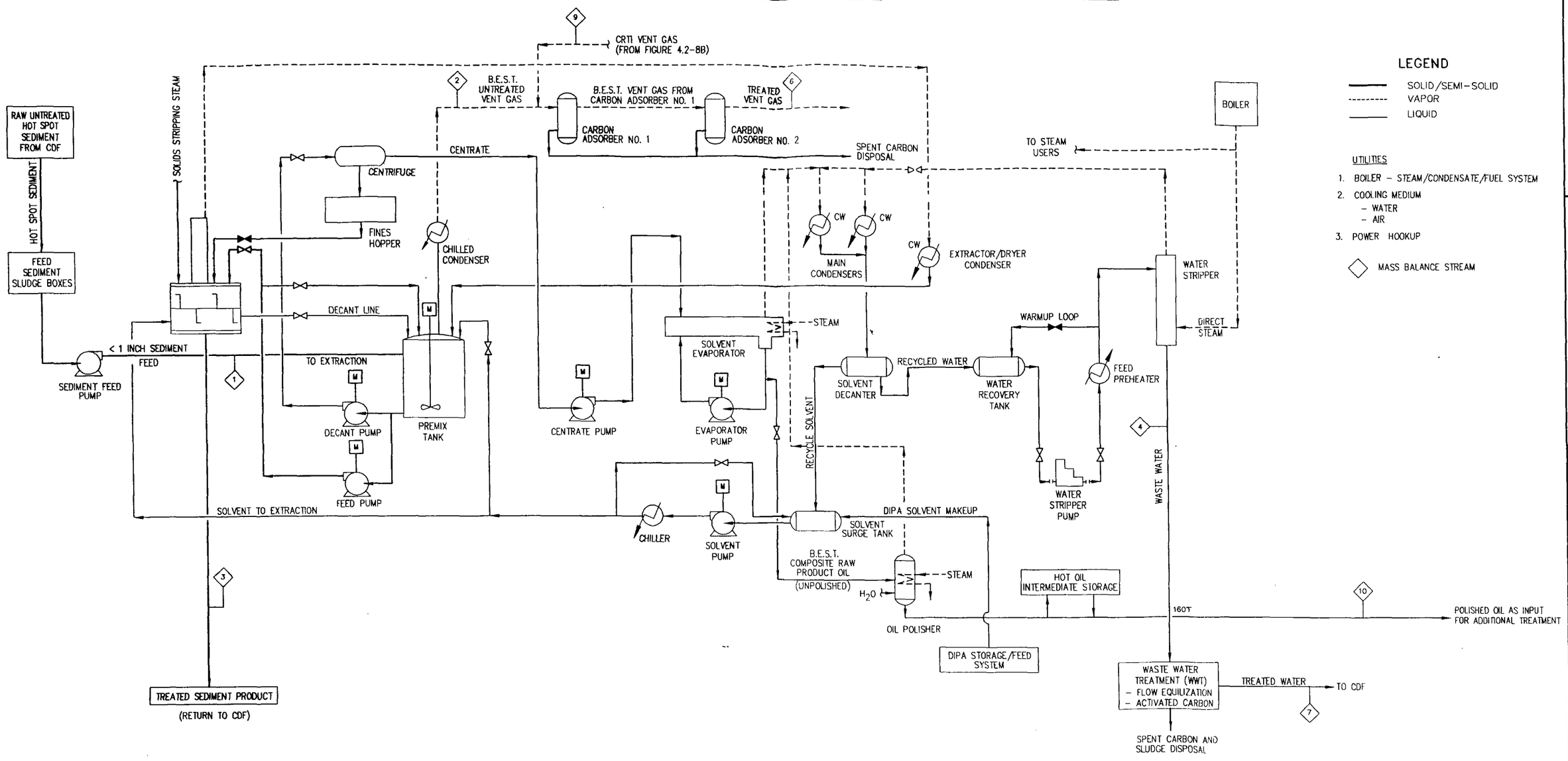
The full-scale treatment approach is based on the systems described in the Ionics RCC treatability study report. The approach includes a combination of the Ionics RCC B.E.S.T.® solvent extraction system design to process 136 tons of wet sediment per day, and CRTI's SET® L1200 unit capable of processing 3.2 tons of oily extract per day. These processing rates assume 24 hour per day operations, seven days a week. The operating assumptions also include an on-line factor of 85 percent for Ionics RCC and an on-line factor of 80 percent for CRTI. At 136 tons per day, the Ionics RCC solvent extraction unit would treat the 18,000 tons of Hot Spot sediment over a five month period. The CRTI unit would keep pace with the solvent extraction process in treating 3.2 tons of oily extract daily.

Conceptual Full-Scale Ionics RCC Treatment System

The conceptual full-scale Ionics RCC treatment system would consist of several skids which would be set-up in a treatment area approximately 180 feet by 180 feet. This would account for the treatment equipment and provide set-backs due to solvent safety regulations. The system would include all of the major process components contained in the pilot scale system. The system schematic presented in Figure 4-11 is designed to operate 24 hours a day, seven days per week with occasional periods of scheduled maintenance. The system's design capacity is 160 tons of sediment per day with an expected throughput rate of 136 tons per day. This translates into an "on-line" factor of 85% and accounts for the scheduled maintenance and other minor unforeseen interruptions.

To protect the treatment system mechanical components, the wet sediment removed from the CDF would be run through a one-inch screen to remove oversize particles. The screened sediments would be pumped to the pre-mix tanks for extraction with diisopropylamine. This was the same operating procedure used by Ionics RCC during the pilot scale test program. Following several stages of extraction, the liquid mixture of solvent, oil extract and water would be removed. The solids would be transferred to the dryer unit to remove the residual water and solvent. Following drying, the solids would be tested against the cleanup criteria to determine if additional processing was required and returned to the CDF if appropriate.

The liquid process streams would be separated through a combination of processes including stream stripping. The individual unit processes that would separate these liquid streams are discussed earlier in this section and would result in two waste streams, oil extract for subsequent treatment and water. The water stream is typically uncontaminated but may require minor polishing depending on whether it is released to a POTW, or a surface water body. It is important to note that the solvent is recovered from all waste streams within the process and is recycled.



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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

IONICS RCC SOLVENT EXTRACTION
CONCEPTUAL FULL-SCALE SYSTEM

SIZE | FIGURE 4-11 | REV

SCALE: NONE | PLOTDATE:9/25/97 | SHEET 1 OF 1

The solvent extraction process would produce approximately five and a half gallons of oil extract for each ton of wet sediment treated. This oil extract would be transferred to the CRTI SET® process for treatment. This material transfer and the solid phase chemical destruction of the PCBs and other organic contaminants process via solid phase chemical destruction unit is discussed further below. It is also important to note that the oil extract could be treated through other means such as off-site incineration.

Conceptual Full-Scale CRTI Treatment System

The conceptual full-scale CRTI SET® system for solid phase chemical destruction is based on CRTI's development of the process over the past several years, their work during the New Bedford Harbor Hot Spot Treatability Study Program and their recent work with New Bedford Hot Spot sediment at their research and development facility. The conceptual process schematic for the SET® process is presented in Figure 4-12. The unit would be transported to the site on four standard flat bed trailers and would occupy an area approximately 60 feet by 60 feet.

The oil extract would be transferred from Ionics RCC solvent evaporator at approximately 70°C and in a fluid state. Rather than allowing the material to cool to ambient temperature and solidify as was done during the pilot scale study, CRTI SET® equipment design will receive, store and process this feedstock as a fluid by maintaining its temperature. The full-scale system, unlike pilot scale, is designed to sustain near stoichiometric conditions, thus minimizing the formation of soda amides and preventing the treated product from being highly caustic. CRTI would monitor the reaction with a conductivity probe to prevent over-dosing with sodium and would neutralize soda amides formed as a result of the catalytic action of any iron compounds present.

The oil extract from the Ionics RCC solvent evaporator would be pumped through trace heated piping to a sparger which feeds a 500-gallon insulated and trace heated "tote" tank. The extract would then be pumped from the bottom of the tote tanks using a specially designed positive displacement pump. This positive displacement diaphragm type pump has been used both in the L150 SET unit and the pilot scale unit used by CRTI to process chemical warfare agents. The oil extract would then be transferred through a flow meter to Static Mixer "B" at a rate of approximately 32 gallons per hour and at a temperature to 70 to 90° C.

Sodium would be received in bulk form cast in a 55-gallon drum with nitrogen filling the void space. Four drums of sodium at a time would be stored in a drum heater box, complete with fan, electric heating elements, and controls. All four drums would be maintained at approximately 115°C, at which temperature sodium is liquid. One drum (at a time) is connected to a diaphragm type sodium pump, which feeds sodium liquid to the one of Static Mixer "A". Approximately 100 gallons per hour of liquid anhydrous ammonia from the system ammonia reservoir tank would be continuously pumped and metered to Static Mixer "A", where they rapidly solvate molten sodium. An aging section following Static Mixer "A" allows full solvation time, as confirmed by in-line conductivity probes. The organic fraction and solvated sodium solution exiting Static Mixer "B" pass through another aging section and are slightly cooled to remove reaction heat. After aging, a calculated amount of decanted process water is injected as Static Mixer "C". The process water reacts with any residual by-product sodium amides formed to release ammonia and by-product gases. Ammonia and by-product gases are removed from the

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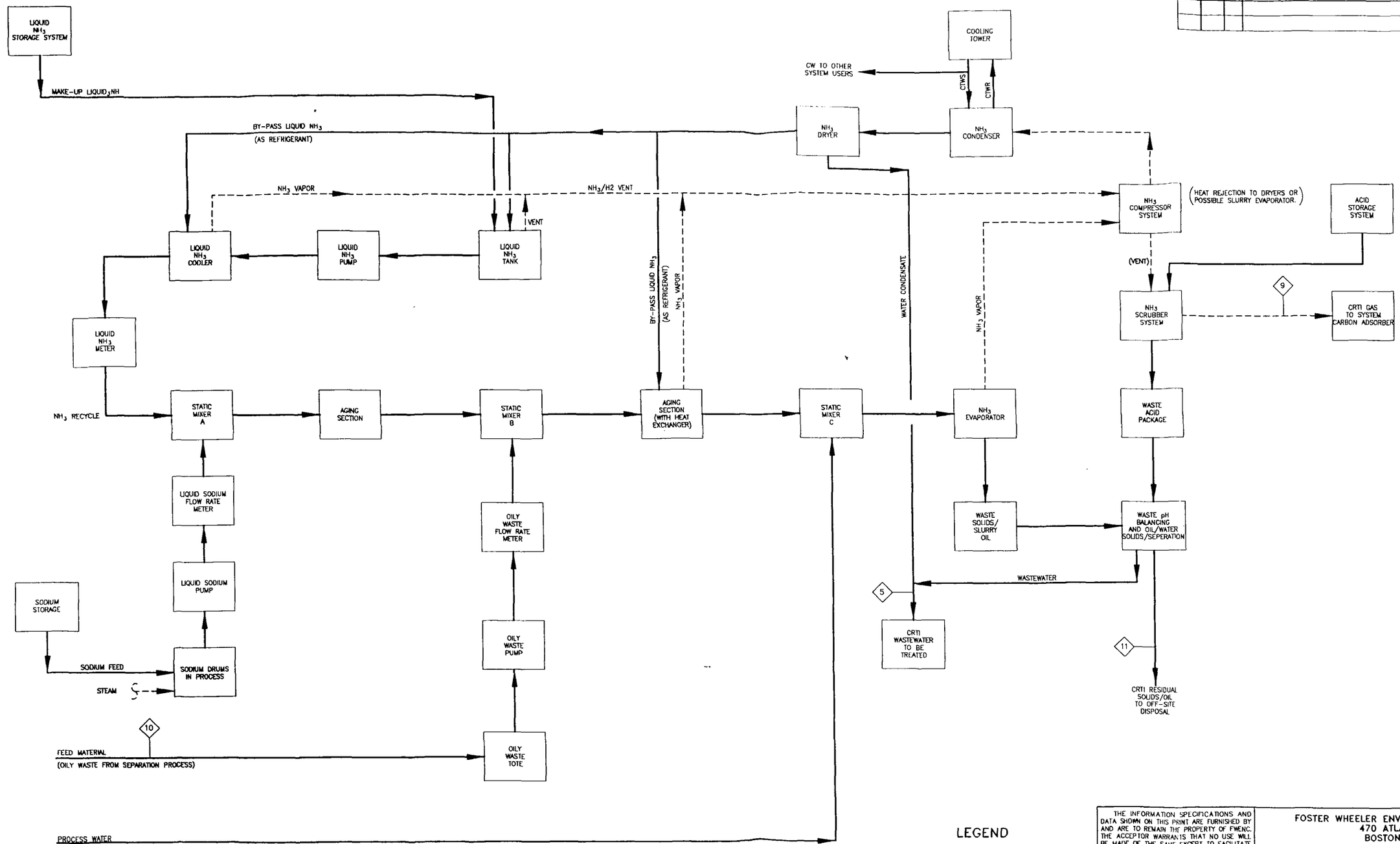
REV.	ZONE	LTR	DESCRIPTION	DATE	APPROVED



LEGEND

- SOLID/SEMI-SOLID
- VAPOR
- LIQUID
- MATERIAL BALANCE

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FOSTER WHEELER ENVIRONMENTAL CORPORATION
470 ATLANTIC AVENUE
BOSTON, MA. 02210

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

CRTI SOLVATED ELECTRON PROCESS
CONCEPTUAL FULL-SCALE SYSTEM

SIZE		REV
D	FIGURE 4-12	—
SCALE: NONE	PLOTDATE 9/25/97	SHEET 1 OF 1

organic material downstream of Static Mixer "C". Waste product is removed as a slurry and is mixed with acid waste from the scrubber system to effect neutralization.

The treated material would be containerized for on-site disposal. It is estimated that 600 cubic yards of treated waste product material would be generated from a full-scale operation. At this stage it is unclear if this material could be directly disposed of in the CDF, or whether alternative means of disposal would be required. Ammonia from the evaporator would be recovered by a compressor packaged system (employing regenerative heat recovery to the system) using a closed circuit water based cooling tower. An ammonia dryer would be provided in the ammonia recovery system to maintain the recycled ammonia at less than 0.6% dissolved in water. Makeup ammonia would be provided from a vendor supplied "nurse" tank.

An ammonia scrubber system would be included with this process to neutralize ammonia passing from the system with non-condensable by-product gases from the process. Sulfuric acid from drums would be used for the scrubber neutralization medium. The entire system would be designed to operate at a maximum of 400 psig, and at a maximum design temperature of 50°C. Maintaining this temperature optimizes reaction efficiency and allows reduced operating pressures for safety considerations.

The technology implementation schedule includes a number of components in addition to treating the sediment. The schedule must incorporate the time to design and construct a full-scale treatment system capable of treating the Hot Spot sediments. Simply having a full-scale unit in existence may not be sufficient to meet the matrix-specific materials handling challenges that the Hot Spot sediment present. This was clearly demonstrated during the pilot scale testing program. In addition, the time to mobilize to the site, set-up the treatment unit skids and perform complete checkout/start activities must also be included. Finally, time must be included for decontamination and disassembly of the treatment equipment for demobilization.

For the Ionics RCC and CRTI processes, Foster Wheeler has estimated the total time, including treatment, to be on the order of two and a half years. This includes 18 months for design and construction of the treatment equipment; six months for mobilization and set-up/checkout activities; five months for treatment; and one month for decontamination and disassembly of the treatment equipment.

4.4.4.3 Technology Limitations

The technology limitations for the Ionics RCC and CRTI processes are primarily related to materials handling issues. Three problems were encountered during the New Bedford Harbor pilot scale study and would require resolution before treatment could be carried out in an effective manner. The three problems include:

1. Transfer of the oily waste from the Ionics RCC solvent extraction unit to the CRTI solid phase chemical destruction unit.
2. Cross contamination of treated waste material within the two CRTI process cylinders.
3. The high pH and reactability of the CRTI treatment residuals.

Ionics RCC and CRTI took proactive measures in the field during the test program to try to solve the first two issues and have offered reasonable suggestions as to how they would be addressed at full-scale. The third materials handling issue is potentially more problematic as it potentially impacts the ultimate viability

of the CRTI process. In summary, the high pH, reactive waste slurry that Foster Wheeler was provided by CRTI during the pilot study may not be appropriate for disposal within the CDF and presented a potential risk to worker safety and health. The financial implications on the treatment process are also potentially significant as the only acceptable disposal method for such a waste may be off-site incineration.

Both Ionics RCC and CRTI have made efforts to address these potential issues both during the pilot study, and with their more recent efforts at CRTI's research and development facility. These latter efforts were done on their own volition and included solvent extraction of 330 pounds of Hot Spot sediment and chemical destruction of the resulting oily extract. These test efforts were also overseen by an EPA representative from EPA's Office of National Risk Management Research Laboratory. According to CRTI, the test equipment has been revised to include a conductivity probe which measures the reaction on a real-time basis to prevent over-dosing with sodium.

Preliminary reports from CRTI indicate that the material transfer between the Ionics RCC and CRTI treatment units went smoothly and that the solid phase chemical destruction process was effective in treating the PCBs in the oil extract. They also report that the waste reaction monitoring equipment operated as designed and the CRTI treatment residuals would not present a disposal problem. It is important to note that this information was verbally provided directly to Foster Wheeler and has yet to be independently verified.

4.4.4.4 Ionics RCC/CRTI Hazards Review

This Hazards Review highlights the main areas of concern to ensure these issues are factored into the overall evaluation of this technology. This review is conceptual in scope because there are no plans at this time, for implementation and therefore, no detailed P&IDs, operating instructions, etc., exist that would form the basis for an in-depth HAZOP review. Should implementation proceed at some time in the future, an in-depth HAZOP review would be performed.

Solvent Extraction Process Overview

The main hazards associated with the solvent extraction process result from the use of solvent, in this case, diisopropylamine. The primary concern with diisopropylamine is its flammability. Diisopropylamine is a volatile, flammable liquid that can release vapors forming flammable mixtures in air that are explosive when exposed to an ignition source. Its vapors are significantly heavier than air (over three times) and can travel considerable distances along the ground to an ignition source, potentially resulting in flashback. Additionally, incomplete combustion products may be toxic and should be avoided.

CRTI Process Overview

Anhydrous ammonia is used as a solvating medium for the creation of active electrons in the PCB destruction vessel. This compound is immediately dangerous to life and health in airborne concentrations greater than 300 ppm. It is irritating to the eyes, nose and throat at lower concentrations. Inhalation can cause dyspnea, broncospasm, chest pain, and pulmonary edema. Contact with skin can cause burns and vesiculation.

Sodium is an active metal source of electrons for the Solvate Electron PCB destruction process. It is used in the PCB destruction vessel. Sodium metal is water reactive and reacts rapidly with moisture in air or tissues

to form sodium hydroxide and sodium oxide. It can cause severe eye and skin burns from reactions to sodium hydroxide. Effects may be permanent. Inhalation will cause irritation of the upper respiratory passages with coughing and discomfort. Ingestion will cause abdominal discomfort characterized by nausea, severe pain, diarrhea, and collapse. A sodium release would result in a high risk of ignition.

Hazards Analysis

Major issues of concern are the following:
- the hazards associated with release of the solvent, DIPA.
- the release of ammonia vapors
- the mishandling of sodium metal.

These issues are discussed in more detail below and are divided into physical, chemical hazards and hazardous operating conditions.

Physical Hazards

The physical hazards that may be encountered include fire, noise, exposure to the cold, heat stress, sharp surfaces, falling objects, lifting, electrical shock, and those associated with work near heavy and industrial equipment. Should implementation of these processes proceed, the Site Safety Officer, or alternate (SSO/alternate) would address activity-specific safety procedures to minimize the potential for injury associated with these hazards during full-scale operations.

Fire Exposure - On-Site Fire

The active materials utilized in these processes pose significant fire potential and must be properly handled and stored. Diisopropylamine has a flash point of -6°C, an autoignition temperature of 315°C and explosive limits of 0.8% to 7.1%. The vapor pressure is such that vapor space above the liquid at ambient temperatures could be in the explosive range in the event of misoperation. Ammonia is combustible and can form explosive mixtures with air (15% to 25% ammonia). Sodium is flammable and dispersions in the solvents become pyrophoric if the solvent evaporates, thus a leak of ammonia-sodium mixture would likely ignite on exposure to air.

Normal vents and pressure relief devices should discharge to atmosphere at least 15 feet above ground level and downwind (prevailing wind) of processing equipment. CRTI equipment should conform to the safety code for mechanical ammonia refrigeration (ANSI/ASHRAE 15-1989 or later) as a minimum.

It is also noted that water is not a suitable fire fighting material for diisopropylamine or sodium fires.

Fire Exposure - Off-site Fire

The Confined Disposal Facility site is well isolated from surrounding development except for textile manufacturing activity opposite the site on Sawyer Street. The road is narrow and is a dead end; traffic appears rather low, limited to workers and deliveries to the manufacturing operations.

The potential for fire radiation from a significant building or vehicle fire activating relief valves should be considered in siting ammonia, diisopropylamine and other storage vessels or containers. Relief vents should be elevated to promote dispersion.

Chemical Hazards

The following materials associated with the process are hazardous because of toxicity and/or flammability:

- Diisopropylamine (DIPA)
- Ammonia
- Sodium metal
- Sodium hydroxide & sodium oxide
- In process materials containing PCBs
- Other toxic organics in the sediment
- Heavy metals

Raw Material Storage

Hazardous materials on site should be strictly limited. DIPA, ammonia, and sodium each pose a fire hazard and require segregated storage. Where possible, the proposed continuous recovery and recycling of these materials is desirable to minimize the amount on the site. Stored materials should be in a segregated and diked area. ANSI K61-1989 (Safety Requirements for the storage and handling of anhydrous ammonia) requires containers of 500 to 2,000-gallon be located no closer than 25 feet to adjoining property or highways. Since diisopropylamine is more flammable than ammonia its storage should be even more remote from possible ignition sources.

DIPA

The potential hazards from diisopropylamine are mitigated by strict compliance with OSHA, NFPA 36 and Fire Department regulations regarding the handling of flammable and hazardous substances. Also, a limited amount of solvent would be in use at any one time in the full-scale system.

Engineering precautions also mitigate the potential hazard of the process solvent. The solvent flammability is controlled through the use of a nitrogen blanket throughout the system and through the use of instrumentation to detect any solvent leakage. A monitoring system would be installed with numerous sensing points which detect solvent leakage from the system. Process instruments and controls also contribute to safety and health protection by allowing operators to monitor the system and by supplying automatic shutdowns for unsafe process conditions.

Ammonia

During normal operations, ammonia is vented in small amounts (estimated at 5 pounds per day) from the scrubber system, which is included to vent non-condensable gases from the system. Operation of the SET® pilot unit during the New Bedford treatability study demonstrated that ammonia emissions were not an issue, and release of this relatively small amount of ammonia is well within EPA regulatory control limits of 100 pounds per day reportable quantity. This ammonia release, through the L1200 negative pressure vent system, will not result in ambient ammonia concentrations above 25 parts per million, the American

Congress of Governmental Industrial Hygienists (ACGIH) established "no adverse effect" level for worker exposure during a normal 40 hour work week. Workers near the equipment may notice occasional ammonia odors (a human being can detect ammonia concentrations in air as low as 2 parts per million), but these odors are not at a nuisance level and would not be detectable outside the fenced boundary. As demonstrated during site operations, no off-site odors were noted, and workers within the fenced boundary did not complain of ammonia odors.

The maximum inventory of anhydrous ammonia potentially subject to release by spill is 400 gallons, well below normal quantities used for industrial refrigeration applications. Fumes from such a release would require partial site evacuation; however, site personnel would be trained and capable of quickly covering and recovering spilled material. Spills of significant amounts of liquid ammonia will remain liquid and slowly evaporate because of auto-refrigeration. Proper spill response, in accordance with the Ammonia Safety Training Institute guidelines, requires evacuation of personnel not involved in recovery operations, and trained ammonia spill response personnel to monitor and contain released volumes. For the maximum feasible spill (400 gallons), CRTI's bermed process area would be filled to less than 0.2 inches, and this amount would evaporate in less than 8 hours. Evaporation is the preferred method of dealing with ammonia volumes in open areas.

Sodium

Sodium would be stored in a fireproof vault and limited to seven 55-gallon drums; approximately a seven day supply, which appears reasonable. The full-scale implementation proposed in the preceding subsections suggests that drums be maintained in the liquid state at 115°C with one drum connected to the process supply pump. Changing the supply drum appears to present the potential for operator exposure and/or fire. Provision should be made for preservation of the nitrogen atmosphere above the in-service drum. Provisions should be made to store as few drums in the liquid state as possible (less than four at any one time).

A rigorous sodium handling system would be applied to prevent leaks of sodium and to prevent exposure of sodium to moisture. These handling requirements are routinely in use in industries employing large quantities of sodium. Handling requirements and safety features include nitrogen blankets, confined storage, guarded double piping with conductivity leak detection between the inner and outer pipe, and special fire fighting techniques. These techniques include soda ash blanketing of the burning material to shut off oxygen supply, and preclude any possibility of adding water to the fire. For the proposed system, the sodium inventory which could possibly be released is minimal because only one drum would be connected to the L1200 reaction system at any time, and no more than 7 drums would be present on site at any time.

In-Process Material

In-process material presents all of the hazards of the raw materials in addition to that of the toxicity of the sediment contaminants. Operation of the premix tank and extractor/dryer in the batch mode requires significant in-process material largely eliminating any benefit from continuous operation of the amine and ammonia recovery systems and the PCB destruction reactor.

No data have been provided on details of extraction batch size or cycle time but 2,000 gallon storage capacity (3 days supply for the destruction unit) for the organic extract is provided to permit continuing

operation of the unit in the event the extraction unit is not operating. The hazards associated with storage of this quantity of material must be balanced against those posed by the shutting down and start-up of the destruction unit.

Hazardous Operating Conditions

Hazardous Operating Conditions include equipment and process failures that would create operating temperatures and pressures that could cause release of DIPA and/or ammonia. Sodium is highly reactive and handling the quantities proposed poses the potential for a hazardous condition.

The flowrate and capacities specified indicate any piping or vessel failure in the nature of a rupture is likely to result in a toxic atmosphere and/or difficult to control fire in the processing area with severe consequences.

Processing failures such as the following do not appear to present any major hazard if detected within reasonable time other than the discharge of incompletely remediated material and operating difficulties.

- Amine decant operation fails to separate water
- Incomplete drying of recycle ammonia
- Incorrect ratio of sodium to oil
- Excess quench water

The indicated design temperature for the CRTI system is 120°C; at this temperature the vapor pressure of ammonia is approximately 1,330 psig. The proposed design pressure is not stated. The proposed CRTI continuous unit differs substantially from the batch unit utilized in the pilot test. It appears that the proposed continuous unit is a pipe reactor utilizing static mixer sections for contacting the reactants; controls and operating procedures used in the pilot test will not be generally applicable.

4.4.4.5 Estimated Treatment Costs

Treatment costs were estimated for solvent extraction and solid phase chemical destruction using input provided by Ionics RCC/CRTI. The estimates were developed for 18,000 tons of Hot Spot sediment using solvent extraction, and solid phase chemical destruction for the 423 tons of extract that would be generated by the solvent extraction process. The estimated throughput of the solvent extraction system is 136 tons per day based on an 85% on-line factor. This unit would be potentially capable of treating up to 160 tons per day. However, it would be unrealistic to assume that the unit would not experience some down-time even for routine maintenance. The estimated throughput for the chemical destruction unit is 3.2 tons of extract per day based on a 80% on-line factor. The cost estimates provided by Ionics RCC/CRTI were adjusted slightly by Foster Wheeler in some cases to reflect our experience in implementing innovative treatment technologies at Superfund sites and our overall engineering judgment. It is important to keep in mind that these are estimated costs for treatment only, and do not include the other costs that would be associated with a cleanup including: design, procurement, site facilities, sediment removal from the CDF, handling of treated materials and air monitoring.

Several major categories are included in the treatment costs: allocated capital costs such as design, fabrication and testing; mobilization and demobilization costs; and the costs to treat the sediment including labor, reagents, utilities, etc. The costs for solvent extraction (Ionics RCC) and solid phase chemical

destruction (CRTI) are presented in two forms. The first is an individual break-out of Ionics RCC and CRTI costs, separately. This is followed by a combined cost estimate that is representative of a complete treatment scenario.

Estimated Ionics RCC Costs

The Ionics RCC break-out includes the allocated capital equipment, mobilization costs, utilities, operating labor and demobilization. Within each of the categories, additional details are also provided.

Capital Equipment

The estimated capital costs for a solvent extraction treatment unit capable of treating 160 tons per day with an onstream factor of 85% results in effectively treating 136 tons per day. This size will facilitate separation of the contaminated oils from the sediment in approximately 5 months. The major cost elements of this system equipment, including design, component purchase, fabrication, and testing, are estimated as follows:

Solvent Extraction Plant Equipment (including boilers, skids, and cooling tower)	$6,800,000
Feed and Product Handling Equipment	$850,000
Subtotal, Capital Equipment	$7,650,000

Of these total capital costs, Ionics RCC has estimated that they would allocate 100%, or the entire $7,650,000, to the project.

Mobilization Costs

Mobilization of the equipment to the site, including installation of equipment and mobilization of personnel, is estimated as follows. Mobilization is expected to take 10 weeks.

Installation of Solvent Extraction Plant Equipment	$600,000
Installation of Feed and Product Handling Equipment	$150,000
Mobilization of Personnel	$ 65,000
Foundations	by others
Total Mobilization	***$815,000***

Checkout/Startup Costs

Checkout and startup, including decontamination facilities, hiring, training, commissioning, and testing, are estimated as follows.

Personnel and Small Equipment Decon Facility	$ 30,000
Hiring and Training	$ 50,000
Checkout, Commissioning, and Startup	$250,000

Testing	$ 80,000
Laboratory	by others
Permitting	by others
Total Checkout/Startup	**$410,000**

Reagents, Additives, and Utilities

The following is a breakdown of the cost estimates for reagents, additives, and utilities. The total cost for the 18,000 tons is estimated at $530,000. A per ton break-out of the various components is provided below.

Electrical Power	$4.80/ton
Steam (by natural gas)	$9.50/ton
Caustic (NaOH)	$3.11/ton
Nitrogen	$1.50/ton
Initial Solvent Fill	$10.53/ton
Solvent Consumption	negligible
Water and Sewer	by others
Total Per Ton Cost	**$29.44/ton**

Labor and Support Management

Operational costs are based on a 5 month schedule, working 24 hours per day and 7 days per week. A four person crew per shift is required, with 1/2 hour overlaps in shifts, plus site manager, safety manager, and clerk. This gives a total of 19 employees.

Assuming 44 hours per week, per employee, at an average cost of $55 per hour, this gives a labor operating cost estimate of $52.44 per ton, or a total cost of $944,000.

Post Treatment of Products

The treated solids generated by the B.E.S.T.® solvent extraction process were found to pass the TCLP test for metals contamination leaching. Therefore, costs for additional treatment of the treated solids prior to disposal in the containment cell were not included. The water product effluent generated from solvent extraction during the pilot scale study was essentially non-detect for PCBs. Therefore, only minimal water treatment is assumed.

Demobilization Costs

Cost for demobilization including decontamination of the treatment equipment was estimated at $200,000.

Ionics RCC Cost Summary

A summary of the Ionics RCC estimated treatment costs is provided in Table 4-23. Costs are included as total costs of operation and as per ton treatment costs, assuming 18,000 tons of material because of the relatively small amount of material to be treated, capital equipment, mobilization and demobilization comprise the large majority of the treatment costs.

Table 4-23
Ionics RCC Cost Estimates Summary

Category	Cost	Per Ton of Settlement Cost [1]
-	-	-
Capital Equipment Costs	**$7,650,000**	**$425.00**
Operational Costs		
Mobilization	$815,000	$45.28
Checkout/Startup	$410,000	$22.78
Reagents, Additives, and Utilities	$530,000	$29.44
Labor and Support Management	$944,000	$52.44
Demobilization	$200,000	$11.11
OPERATIONAL COSTS	**$2,899,000**	**$161.05**
TOTAL RCC COSTS	**$10,549,000**	**$586.05**

[1] The per ton costs only apply for treating exactly 18,000 tons of material. The treatment of material in excess of 18,000 tons would be performed at an additional cost of $81.88 per ton. If less than 18,000 tons is treated, $81.88 per ton can be deducted from the total cost.

Estimated CRTI Cost Breakdown

The estimated cost for the CRTI to treat the oil extract that was separated from the Hot Spot sediment is presented below. The estimated costs include allocated capital costs for design and fabrication of the treatment unit; mobilization to the site; checkout/startup costs; operational costs including labor and reagents; and finally, demobilization.

Capital Equipment

The major cost elements of this CRTI solid phase chemical destruction system, including design, fabrication, and building, are listed below. The complete capital equipment cost is $1,350,000. This unit would be designed with a 4 ton per day capacity and an estimated on-line factor of 80% to treat the 3.2 tons of oily residue produced through separation.

- Ammonia Recovery System
- Dryer Package
- Scrubber System
- Waste Materials Handling, pH Adjustment System
- Liquid Ammonia Handling System
- Product Oil Handling System
- Continuous Reactor System
- Ammonia Recovery Evaporator System
- Design, Fabrication, Building

Of these total capital costs, 100%, or $1,350,000, would be included by CRTI as a direct cost to the project.

Mobilization to Site

Mobilization of the equipment to the site, including project documents, bonding, permitting, shipping, installation, peripheral equipment, site office and laboratory, shelter structure, and testing, is estimated to take approximately 6 weeks and cost $142,000.

Checkout/Startup

This activity is expected to take 4 weeks and have a cost of $77,000. The primary costs associated with this activity are for site and home office related labor.

Reagents and Additives

Materials required include sodium and anhydrous ammonia. Small amounts of sulfuric acid are required for the scrubber, as well as small quantities of solvent for cleanup. This gives a total cost of $368,000, or $20.42 per ton of sediment, for all CRTI reagents and additives. This equates to $870 per ton of oily extract treated by the CRTI process.

Labor and Support Management

Operational costs are based on a 5 month schedule, working 24 hours per day and 7 days per week. A two person crew per shift is required, with one hour overlaps in shifts. This gives a total crew of eight. Two of the total eight person crew will be trained to operate gas chromatography equipment. Cost elements include labor, travel and living, procedures preparation, regulatory interface, project management, safety reviews, consumables, laboratory analyses, and miscellaneous operational items. The total labor and support costs are estimated to be $343,000, or $19.02 per ton of sediment. This equates to $811 per ton of oily extract that is treated by the CRTI process.

Demobilization

The estimated cost to demobilize the CRTI treatment system, including decontamination and shipping to a storage area, is $142,000. Consistent with the general approach for estimated treatment costs, foundation demolition and site restoration are assumed to be performed by others.

CRTI Cost Summary

The summary of CRTI's estimated total cost are presented below in Table 4-24. Costs are presented as total for the remediation effort and as per ton treatment costs based on treating 423 tons of extracted "oil" from a sediment extraction process.

Table 4-24
CRTI's Cost Estimated Summary

Category	Cost	Per Ton of Oil Extract Cost [1]
Capital Equipment Costs	**$1,350,000**	**$3,191.49**
Operational Costs		
Mobilization	$142,000	$335.70
Checkout/Startup	$77,000	$182.03
Reagents, Additives, and Utilities	$368,000	$869.98
Labor and Support Management	$343,000	$810.87
Demobilization	$142,000	$335.70
CRTI OPERATIONAL COST	**$1,072,000**	**$2,534.28**
TOTAL CRTI COSTS	**$2,422,000**	**$5,725.77**

[1]The per ton costs only apply for treating exactly 423 tons of extracted material. The treatment of material in excess of 423 tons would be performed at an additional cost of $1,680.85 per ton. If less than 423 tons is treated, $1,680.85 per ton can be deducted from the total cost.

Total RCC and CRTI Cost Summary

To evaluate the estimated total cost for treatment using a combination of solvent extraction and solid phase chemical destruction, the results of the Ionics RCC and CRTI estimates are combined in Table 4-25. The estimates include the total Ionic RCC and CRTI fixed and operational cost, based on treatment of 18,000 tons of Hot Spot sediment.

Table 4-25
Total RCC and CRTI Cost Summary

Category	RCC	CRTI	Total RCC and CRTI Cost	RCC and CRTI Per Ton of Sediment Cost [1]
Capital	$7,650,000	$1,350,000	$9,000,000	$500.00
Operational	$2,899,000	$1,072,000	$3,971,000	$220.61
Total	**$10,549,000**	**$2,422,000**	**$12,971,000**	**$720.61**

[1] The per ton costs only apply for treating exactly 18,000 tons of Hot Spot sediment. The treatment of sediment in excess of 18,000 tons would be performed at an additional cost of $121.32 per ton. If less than 18,000 tons is treated, $121.32 per ton can be deducted from the total cost.

4.5 Geosafe Test Program

The Geosafe vitrification process was the second pilot study conducted on the Hot Spot sediment. This process involved the pilot scale testing of vitrification by electrically heating and subsequently melting the sediment, thus volatilizing or destroying the organic contaminants and immobilizing heavy metals within the melt. Data from the pilot study indicated that the process immobilized metals during the melting process. The resulting solid product was relatively inert and did not contain PCBs or other organics in measurable concentrations. Results from the pilot study also indicated that significant concentrations of PCBs, dioxins, and furans were essentially desorbed from the sediment during treatment. These organic compounds required additional off-gas treatment prior to release to the atmosphere.

The following subsections describe the vitrification process, the pilot study test program, the effectiveness of the process in treating the Hot Spot sediment, and potential full-scale application. Steps that would be necessary to implement this technology at full scale were developed based on the pilot study results. These are also discussed below. The Geosafe pilot study report summarizing the field work and Geosafe's conclusions are included in the Data Compendium. TRC's report on the off-gas sampling procedures results and laboratory data from the Geosafe study are also included in the Data Compendium.

4.5.1 Process Description

Vitrification technology has been under development and testing by the Pacific Northwest Laboratories Division of Battelle Memorial Institute (Battelle) since 1980. The process was originally developed for possible application on soils contaminated with radioactive transuranic materials (i.e., plutonium, americium, uranium), related refuse (i.e., wood, plastic, rubber, metal, cloth, cleaning chemicals, sealed containers), and other process chemicals (i.e., nitrate, sulfate, fluorine, carbon tetrachloride, tribromophenol).

The Geosafe vitrification process is a patented, thermal treatment/immobilization technology for treatment of hazardous materials, including PCBs, dioxin, pesticides/herbicides, other SVOCs and VOCs, metals, inorganic compounds, and radionuclides. The vitrification technology involves electrically melting contaminated media where the material has been placed for treatment. Figure 4-13 illustrates the overall vitrification application system. Electrodes are initially placed only a short distance into the media to be treated. A graphite starter path is used between the electrodes to carry the initial current and to cause the adjacent surface media to melt. Once the typically earthen media becomes molten, it becomes electrically conductive and becomes the primary current carrying element for further processing.

The high operating temperature destroys and removes hazardous organic materials through pyrolysis (i.e., thermal destruction of the organic compounds in the absence of oxygen). The temperature is also sufficiently high to cause inorganic compounds to break down or otherwise enter into chemical reactions with other materials present in the material. Those materials that are not sufficiently volatile to evaporate from the melt during processing are permanently incorporated (immobilized) into the residual product through chemical and physical incorporation into the glass-like solid structure. The residual product resulting from the vitrification process is a glass-like solid similar to volcanic rock, that exhibits structural and weathering properties capable of enduring long term environmental exposure. Off-gases from the treatment are treated to ensure air emissions comply with regulatory standards.

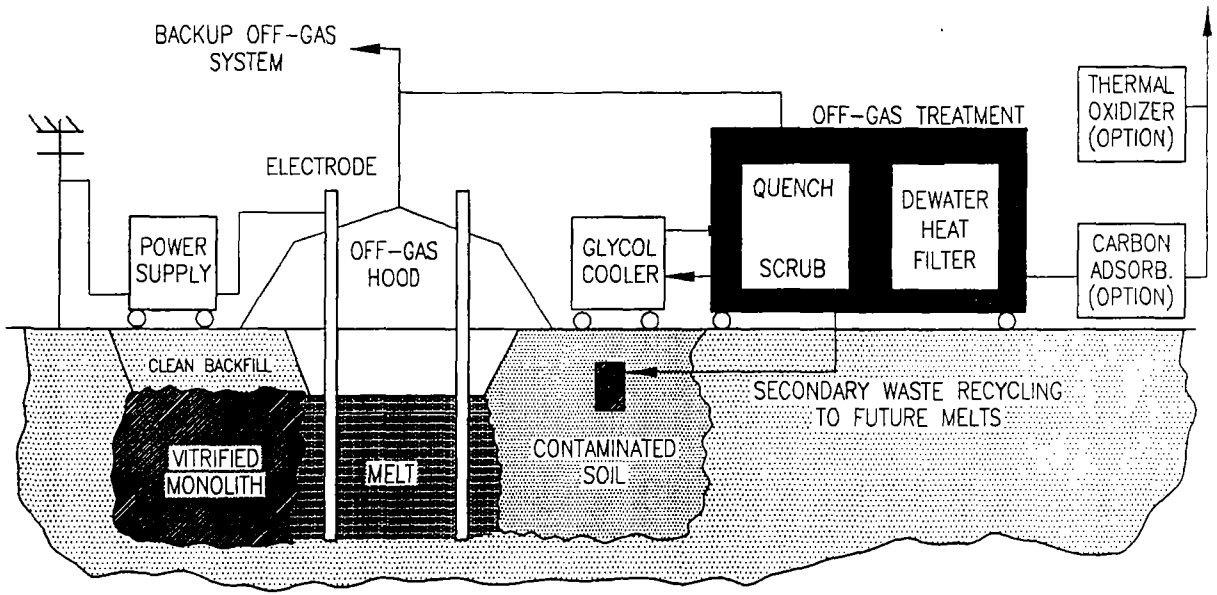


FIGURE 4-13

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

TYPICAL VITRIFICATION SYSTEM

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE NO. 8860A013.DWG
DATE 8/4/97

4.5.2 Geosafe Test Program Elements

The Geosafe pilot study test program is described in this section. The test program included two batches using a large scale pilot treatment system capable of holding approximately 2,000 pounds of sediment. The test program was originally envisioned to occur over a two week period but was later extended over a two month period due to difficulties encountered in the field. Some of the difficulties encountered during the first batch included the overloading of the gas sampling trains with particulate, stack gas concentrations approaching the lower explosive limit (LEL) and recurring difficulties with gas flow through the activated carbon filters used for off-gas treatment. Rapid turnaround laboratory results from key off-gas sampling locations confirmed that the process was releasing significantly elevated concentrations of PCBs, dioxins, and furans in the off-gas. These conditions were not anticipated at the onset of testing and the off-gas treatment system was not designed to adequately address such elevated concentrations.

The time between batches was used by Geosafe to design, procure, and implement an off-gas treatment system that could treat off-gas within the "worst case" concentration of contaminants identified during batch #1. Results from batch #2 had similar off-gas results suggesting that the problems encountered during the pilot test are intrinsically related to the Hot Spot sediment matrix and indicating that the process will require significant additional modification and testing before it can be considered for full-scale implementation. Additional detail on the pilot study testing results and the implications for future Hot Spot applications are discussed in the following subsections.

The major elements of this section include a discussion of the overall test program schedule, the Geosafe pilot study test equipment and operations, and the sampling and analytical chemistry program that was used to gather data to evaluate the effectiveness of the process. A discussion of the testing results is provided in Section 4.5.3.

4.5.2.1 Actual Test Program Schedule

The Geosafe test program consisted of two treatment batches using a test vessel that held approximately 2,000 pounds of wet Hot Spot sediment. The original plan was to use sediments that had been somewhat dewatered through gravity settling for Batch #1 and sediments (not dewatered) for Batch #2. This plan was ultimately modified in the field following Batch #1 as a result of problems experienced by Geosafe. Accordingly, the sediments for Batch #2 had some of the free standing water removed from the surface of the test container and as a result, the two batches were quite similar, with the exception of the off-gas treatment systems. Geosafe substantially modified the off-gas treatment system based on the difficulties experienced during Batch #1. These problems appear to have been moisture related and are described in detail below.

Following the period of installation of the test vessels and off-gas treatment equipment, and subsequent filling of the test vessels with sediment, Geosafe initiated Batch #1 at approximately 10:00 a.m. on July 20, 1996. The test program was run for approximately 34 hours out of the planned 48 hour melt period. Due to significant concerns with vitrification operations, the associated impact on the effectiveness of the off-gas treatment system and the potential atmospheric release of contaminants, the first batch was termianted early and the second batch was postponed for two months.

Over the two month postponement period EPA, the state, and other members of the forum group discussed the possibility of conducting the second batch provided that Geosafe modify their operating parameters and upgrade their off-gas treatment system. Geosafe agreed to implement changes to the amount of clean soil placed on top of the sediment to be vitrified and added several components to the off-gas treatment system including a venturi scrubber, larger carbon canisters and a thermal oxidizer. With the modifications in place, Geosafe started Batch #2 on August 26, 1996 with the intent to conduct melting activities for a 48 hour period. This batch was halted by Foster Wheeler after 22 hours because many of the same process difficulties experienced during Batch #1 were still occurring. In addition, the potential for explosion within the treatment vessel had reached a level where concern for worker safety and health mandated the test be stopped. The overall test program schedule is presented in Table 4-26.

Table 4-26
Geosafe Pilot Test Program Schedule

Date	Test Day	Test No.	Test Description
7/20/96	1	#1	Test started at 0955 hr
7/21/96	2	#1	Test completed 34 hrs later
7/22/96 through 8/25/96 - Off-gas treatment system was revised			
8/26/96	3	#2	Test started at 1658 hrs
8/27/96	4	#2	Test completed 22 hrs later

4.5.2.2 Pilot Scale Test Equipment

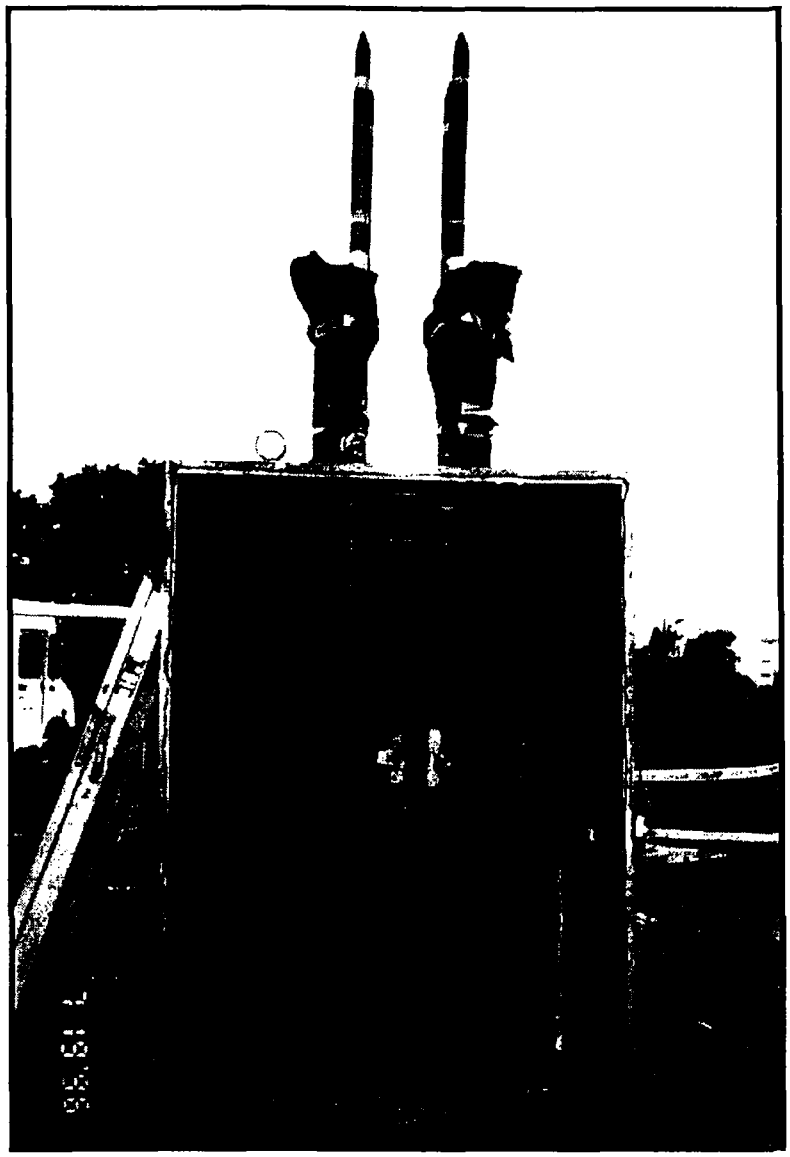
A photograph of the pilot scale unit is included in Exhibit 4-7. An illustration of the configuration of the pilot scale unit is included as Figure 4-14. The system consists of a power supply, a test waste container, a containment box, an off-gas treatment and water collection system, and a data monitoring and storage system. The power system utilizes a 30 kW Scott-Tee transformer for converting three phase primary input power to a balanced two phase secondary output. The transformer is equipped with 12 voltage taps and two silicon controlled rectifiers on the secondary side for controlling the power input to the melt. Transformer output is monitored via metering on the secondary output to the electrodes for power, amperage, and voltage. Power connections for this test were supplied by the local utility service.

The test container was used to hold the contaminated sediment during the study and was placed inside the containment box. The containment box is constructed of carbon steel and is fitted with ports for air inlet, off-gas removal, instrumentation, and electrode feeding. In addition, the containment box has a view port so the melt can be observed during testing.

The system is equipped with movable electrodes to allow gravity or controlled feeding during processing. The feeders are equipped with air grippers to provide the capability to drive, or hold, the electrodes depending upon the operating conditions that exist.

The off-gas treatment system for the pilot scale system was designed to facilitate acquisition of off-gas samples from the melt and to provide nominal off-gas treatment. It was not designed to emulate the performance of the off-gas treatment system used during full-scale operations. The treatability test off-gas sampling system for batch #1 consisted of a section of stainless steel pipe equipped with three

Exhibit 4-7
Geosafe Pilot Scale Treatment Unit



sampling ports. The off-gas treatment system included two parallel, single-pass shell and tube heat exchangers to cool the off-gas. Liquids that condensed from cooling of the off-gas were collected in a tank immediately downstream of the condensers. The off-gases continued through a filter system containing a desiccant to remove moisture, and a granular activated carbon filter to remove particulate and organic vapors that may have been released from the sediments. The off-gases were then routed through the blower to the exit sampling port and out the stack.

Batch #2 employed an enhanced off-gas treatment system. The enhancements included the addition of a scrubber equipped with caustic addition capability, a larger blower, a particulate roughing filter, a two-stage venturi vapor phase carbon filter, and a thermal oxidizer. Additional sampling ports were also incorporated

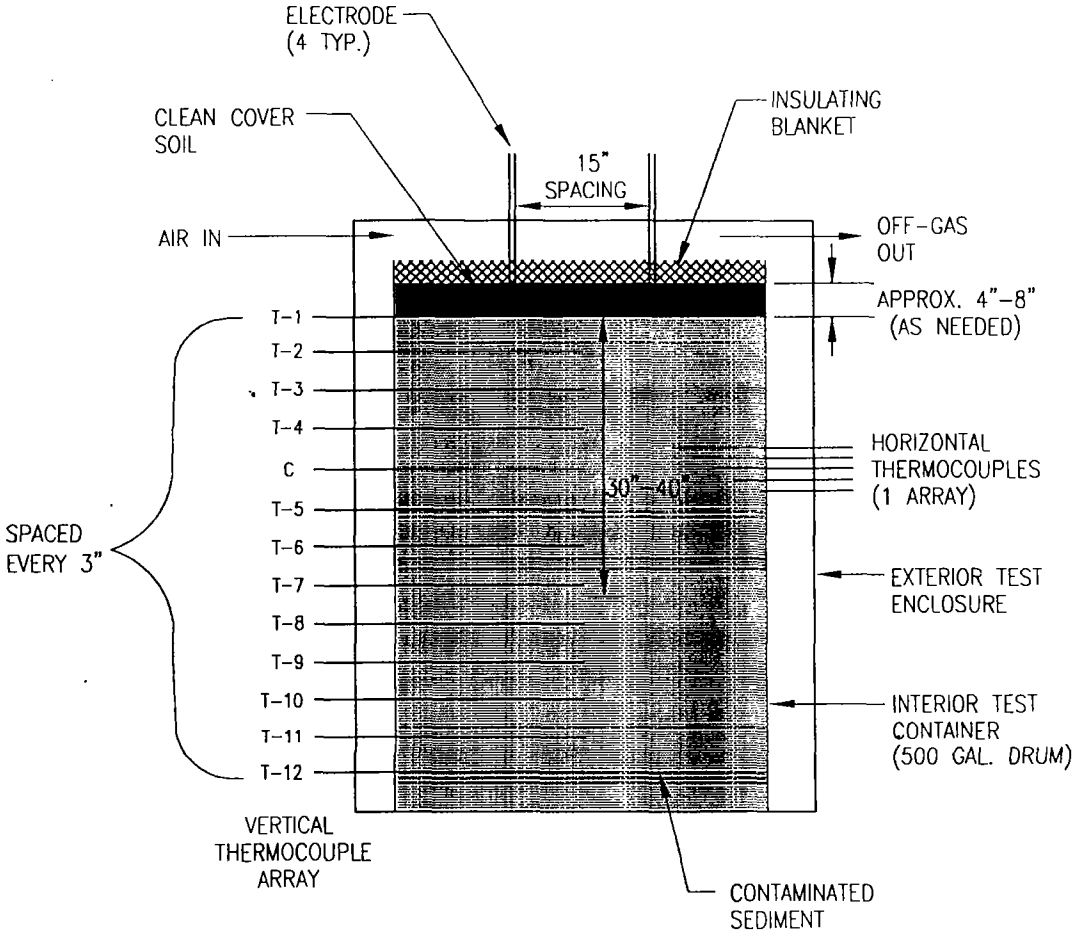


FIGURE 4-14

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

CONFIGURATION OF MATERIALS AND INSTRUMENTATION IN GEOSAFE TEST CONTAINER

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE NO. 8860A012.DWG
DATE:9/4/97

into the off-gas system design. Figure 4-15 shows the treatability test setup for Batch #2. The enhancements to the off-gas treatment system were incorporated into the second test to reduce the possibility of potential contaminant release during treatability testing. The decision to incorporate the modifications to the off-gas system was determined based on field observations and preliminary air sampling performed during the first treatability test. This is discussed further in Section 4.5.3, Effectiveness Evaluation.

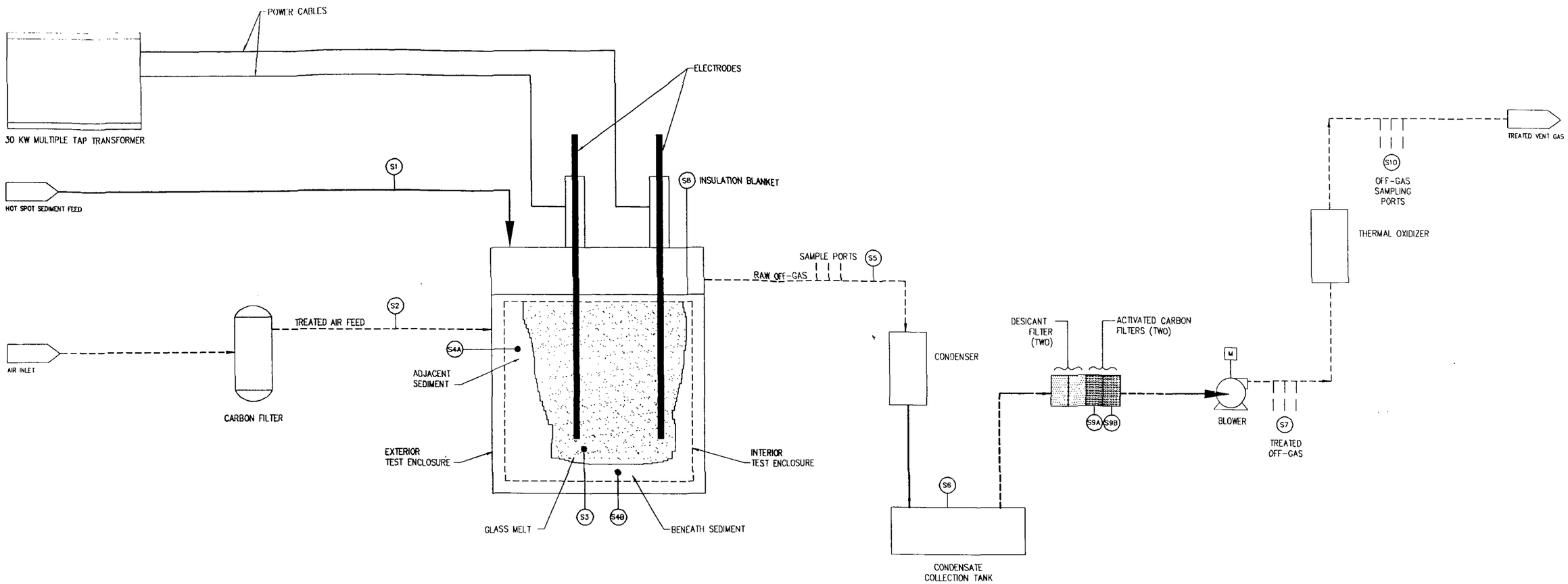
The temperature of the melt and the off-gas were monitored via a temperature recorder. A Leeds and Northrup 25000 data logger recorded temperatures of the soils surrounding the molten area, the molten mass, and the off-gas at various locations every 5 minutes.

4.5.2.3 Test Setup and Operation

The pilot scale treatability tests were conducted in Geosafe's pilot scale treatability test containers. One container was used for each of two batches. The containers are cylindrical carbon steel and measure 50 inches in diameter and 60 inches in height. Before the waste was placed into the test containers, 14 type K thermocouples (TCs) were placed vertically in the center of each test container. The TC arrays were incremented every 3 inches to achieve a total monitoring interval of 42 inches. The vertical array was used to monitor the depth of the melt. Another array of 7 type K thermocouples were placed laterally 20 inches below the top vertical thermocouple to monitor the width of the melt and also to provide post-test sampling isotherm locations in the surrounding soil. The lateral thermocouple array extended horizontally from the electrode plane out 21 inches toward the edge of the test container in 3 inch increments. After thermocouple placement, the sediment was staged by pouring the wet sediment materials into the test container.

Contaminated sediment was placed into the containers so that the surface of the sediment was at the same level as that of the uppermost thermocouple (TC#1). For the first batch, the sediment surface remained at that level until the test was initiated. However, the second batch was dewatered during the 5-week period between filling the container and performing the test. Accordingly, the level of sediment was lower for the second test. After removing the water from the second container, it was determined that the sediment had subsided 4 inches. Therefore, the uppermost two thermocouples (TCs #1 and #2) were positioned 5 inches and 1 inch above the sediment surface, respectively.

To monitor the melt temperature, type C thermocouples were placed at the 20 inch depth in each test container. A type C thermocouple is capable of reading temperatures up to 2,400°C. At melt temperatures of 1,600-2,000°C, the molybdenum sheath oxidizes quickly; therefore, to prolong the service life of the type C thermocouples, alumina sheaths were placed over the thermocouples.



PARAMETERS	S1 HOT SPOT SEDIMENT FEED	S2 TREATED AIR FEED	S3 GLASS MELT	S4A ADJACENT SEDIMENT POST TREATMENT	S4B BENEATH SEDIMENT POST TREATMENT	S5 RAW OFF GAS	S6 CONDENSATE	S7 TREATED VENT GAS BEFORE OXIDIZER	S8 INSULATION BLANKET (KAOWOOL)	S9A CARBON CANISTER #1	S9B CARBON CANISTER #2	S10 TREATED VENT GAS AFTER OXIDIZER
WHOLE ROCK ANALYSIS	✓											
PCBs	✓		✓	✓	✓		✓		✓			
SVOCs	✓			✓	✓		✓		✓			
DIOXINS/FURANS	✓			✓	✓	✓	✓	✓	✓			✓
PCB ISOMERS	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓
SELECTED PAHs						✓		✓				
SELECTED HEAVY METALS						✓		✓				
O&G	✓			✓	✓		✓					
METALS	✓		✓	✓	✓		✓		✓			
TCLP METALS & ORGANICS (METHOD 1311)	✓		✓	✓	✓							
TCLP METALS & ORGANIC (CAGE METHOD)			✓									
PARTICULATES/TEMP						✓		✓				
HCl AND Cl_2						✓	CHLORIDE ONLY					
MOISTURE (WT%)	✓			✓	✓							
TSS							✓					
DS							✓					
TS							✓					
BULK DENSITY	✓		✓	✓	✓							
SP. GRAVITY												
WATER CONTENT						✓						
pH	✓			✓	✓		✓					
MASS	✓		✓	✓	✓		✓		✓			
VOLUME	✓		✓	✓	✓	✓	✓	✓				

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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

GEOSAFE PILOT-SCALE PROCESS SCHEMATIC WITH SAMPLING LOCATIONS

SIZE D | FIGURE 4-15 | REV –

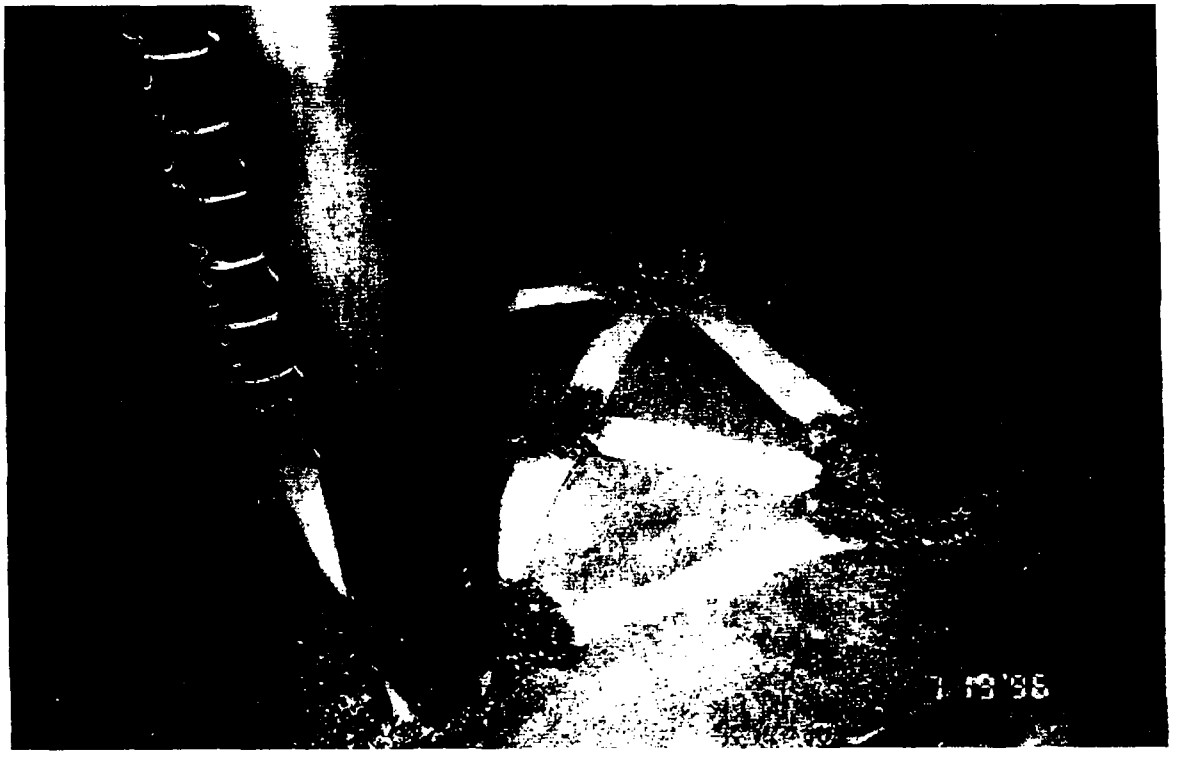
SCALE: NONE | PLOTDATE: 9/26/97 | SHEET 1 OF 1

Batch #1 Configuration

Following waste loading, the test container for batch #1 was prepared for testing. This involved placing a plastic sheet barrier on top of the sediment followed by a layer of clean soil for test startup. The clean soil layer was intended to prevent contaminated material from coming in contact with air during the melt. Clean dry soil was used for starting the vitrification process and the plastic sheet was required in this test to prevent water from saturating the dry cover soil before the melt could be initiated. Also, the sediment was so fluid, the plastic barrier provided some buoyancy to prevent the cover soil from sinking into the sediment. The cover soil for Batch #1 was spread over the sediment to a depth of 1 inch around the perimeter of the test container and was mounded in the vicinity of the electrodes to a depth of 4 inches. The mounding provided extra cover soil to enable a smooth startup procedure.

Once preparation of the test container was complete and after it was placed into the containment box, the electrodes were buried into the soil to a depth of 3 inches. The starter path (a mixture of graphite flake and glass frit) was then placed in a 1 inch thick "X and square" pattern to provide a conductive pathway between the electrodes. The photograph in Exhibit 4-8 shows the starter path configuration.

Exhibit 4-8
Starter Path Configuration



The zone to be vitrified was covered with a 2 inch thick layer Kaowool insulation blanket leaving small gaps around the electrodes for venting. The insulation was intended to promote subsidence of the molten zone and improve the efficiency of the process and is also used in large scale operations. With the starter

path laid and the insulation in place, a final check of the instrumentation was conducted and the containment hood sealed in preparation for testing.

Batch #1 Operation

Batch #1 was conducted on July 20-21, 1996. Power to the electrodes was initiated at 0955 hr on July 20. Power input was normal and stable up to the target operating level of 25 kW, which was achieved in approximately 3 hours. The vitrification process proceeded to the target depth of 31.5 inches as indicated by a >1,000°C centerline temperature reading just below that depth. The total test duration with power applied was 34 hours.

A total of 785 kWhr of energy was consumed during the batch #1 melt. The test was terminated at a depth of 31.5 inches after 34 hours of operation. Approximately 700 lbs. of melt was produced during batch #1. The power, voltage, and amperage data are detailed in the Geosafe report (Data Compendium). The average power during melt operations was approximately 24 kW. The complete record of power use during batch #1 is contained in the Geosafe report.

The power input, and thus the energy, is controlled based on transformer meter readings to provide an accurate scaledown of power density from the large scale system operating levels. Power density is defined as PD = P/A; where PD is power density (kW/ft^2), P is the power level (kW), and A is the surface area (ft^2) of the vitrification zone (area of the plane between the four electrodes). The normal power density of the large scale system is in the range of 11.5-28 kW/ft^2, which is based on a maximum power supply of 3,750 kW and an electrode separation of 11.5 feet to 18 feet (132 ft^2 to 324 ft^2). The average power level of this test was 24 kW, and the estimated surface area of the melt was approximately 225 in^2 or 1.56 ft^2. This yields a power density of 15.38 kW/ft^2 which is expected to be generally consistent with large scale operations.

The melt resistance for batch #1 was typical of vitrification operations. The resistance begins to increase as the material transitions from the starter path to the melting of surrounding material. As the melt becomes larger, incorporating more material, the resistance gradually decreases over the duration of the melt. The data show fluctuations in the containment vessel vacuum during the test. These may be attributable to system plugging, possibly due to particulate generation and influences from sampling periods. The peak melt temperature (measured by a type C thermocouple) was 1,665°C. Raw thermocouple data is provided in the Geosafe report included in the Data Compendium.

A molten surface was formed once the starter path was consumed. The surface of the melt was observed to be bubbling vigorously as the water in the sediment was vaporized into the plenum of head space region of the containment vessel. As melting continued, particulate (dust) coated the inside surface of the viewing window obscuring direct visual observation of the melt. It is expected that the vigorous bubbling continued for the duration of the test.

Off-gas sampling for batch #1 was conducted periodically during the test period in an attempt to obtain samples representative of the melt duration (i.e., beginning, middle, and end). Sampling was initiated 2 hours after the test was started and conducted until 4 hours after power was terminated.

A relatively linear melt rate was achieved after startup with the melt rate slowing down later in the test. This is due to the fact that, as the melt gets larger, a larger percentage of the total of energy is consumed in

generating lateral growth and an increasing amount of energy is lost to heating the surrounding soil. During a large scale melt, the power to the melt can be increased to partially compensate for the increased heat loss. However, this test was performed at maximum output for the transformer and thus a further increase in power could not be made. The 31.5 inch depth was reached in a time of 34 hours resulting in an average melt rate of 0.93 inch/hour. This melt rate was slower than expected and was attributed to the high concentration of water in the sediment. Power was terminated at 2000 hours on July 21.

Batch #2 Configuration

The data collected from batch #1 prompted Geosafe to change the configuration and to enhance the off-gas treatment system for batch #2 with a thermal oxidizing unit. The specific reasons for these changes are discussed below. The batch #2 configuration was similar to the batch #1 configuration but included extra cover soil (10 inch depth) and extra Kaowool insulation to cover the entire surface inside the test container. The extra cover soil and insulation were added in an attempt to reduce the amount of particulate generated by the process.

In addition to the extra soil and insulation, the batch #2 container was allowed to sit undisturbed for 5 weeks prior to the test being initiated. Following the 5-week period, water had accumulated at the surface of the contaminated sediment. Approximately 70 gallons of water were decanted prior to the test. The water was removed to reduce the amount of steam generated during the test which, in turn, would help reduce the quantity of particulate.

Batch #2 Operation

Batch #2 incorporated an enhanced off-gas treatment system, and was conducted on August 26-27, 1996. Power to the electrodes was initiated at 1658 hours on August 26, after a thorough operational check of the off-gas system. The melt objective for batch #2 was a target depth of 33 inches. Due to high particulate and organic vapor readings identified during the batch sampling, the melt was terminated at 1503 hours on August 27, 1996. The total test duration was approximately 22 hours, and 20 inches of melt depth was achieved during this time.

A total of 522 kWhr of energy was consumed during the batch #2 melt. The average power during melt operations was 24 kW. Power level was decreased in the latter stages of the melt in an attempt to address the particulate and organic vapor problems experienced during the test. The estimated surface area of the melt was approximately 225 in^2 or 1.56 ft^2; this yields a power density of 15.38 kW/ft^2, which is expected to be consistent with large scale operations.

The melt resistance for batch #2 was typical of vitrification operations. The resistance increased as the melt transitioned from starter path to the melting of surrounding material. As the melt became larger, incorporating more material, the resistance gradually decreased over the duration of the melt. The containment vessel vacuum data show fluctuations attributable to system plugging possibly due to particulate generation and flow influences from sampling periods. Fluctuations prior to melt termination were due to efforts to reduce the organic vapor and particulate generation problems experienced during this test. The peak melt temperature for batch #2, as measured by a type C thermocouple, was not obtained because the melt did not progress deeply enough to contact the type C thermocouple.

A molten surface was formed once the starter path was consumed. The surface of the melt was not observed to be bubbling as vigorously as during batch #1. A considerable amount of particulate generation was observed during the melt and during post-test evaluations, especially during processing of the wet sediment.

A relatively linear melt rate was achieved after startup of batch #2. The test was prematurely concluded after twenty-two hours due to high particulate and organic vapor levels in the off-gas. A melt depth of approximately 22 inches was achieved during this time, while maintaining an average melt rate of 0.9 inches/hour. Similar to batch #1, the slower than anticipated melt rate of batch #2 was attributed to the high concentration of water in the sediment. Power was terminated at 1500 hrs on August 27, 1996.

4.5.2.4 Sampling and Analysis Program

Sampling locations and the respective analyses are illustrated on the process flow diagram included as Figure 4-15. Additional information in the analytical program and the associated quality control procedures are discussed in Section 4.3. As shown in the flow diagram (Figure 4-15), samples were collected of feed material (S1) and the vitrified, glass-like solid (S3) to evaluate the overall effectiveness of the vitrification process. The vitrified product was very similar to a solid rock or glass and was analyzed for a limited number of analyses. The vitrified rock was pulverized to pass through a 40 mesh sieve prior to analysis in order to better evaluate the contaminants entrained in the glass-like matrix.

In addition to sampling the treated product, samples were collected of the dry fine sediment adjacent (S4A) to and beneath (S4B) the vitrified block. Samples were collected approximately one inch and 3.5 inches from the block. The purpose of this sampling was to evaluate the changes in chemical concentration and composition during the treatment process.

Samples of vent gas aqueous condensate (S6) were collected from several locations in the vent gas treatment process to measure the disposition of contaminants throughout. Samples were collected from the untreated process vent gas (S5), from the vent gas following condensate collection and treatment with activated charcoal (S7), and from the thermal oxidizer off-gas (S10). The thermal oxidizer vent gas (S10) was released to the atmosphere. Vent gas samples were collected by TRC Environmental using EPA approved methods. Additional detail on the sampling is provided in TRC's report included in the Data Compendium.

The thermal oxidizer unit added as part of the Batch #2 emissions control system was a commercially available unit with conventional sampling ports designed to accommodate typical stack gas sampling equipment. Such sampling equipment is used to measure flow rate, temperature, moisture and other parameters within the stack. Using this stack data and the sample collection data (i.e., collection flow rate and time), sample results can be used to calculate an accurate measure of stack and, therefore, emissions concentrations. In order for the calculation to accurately represent the flow or concentration inside of the stack, the stack width must be large enough to accommodate the sampling equipment within causing eddies and currents in the stack flow. The stack sampling methods include strict minimum requirements for the width and length of the stack relative to the sampling ports and other sources of disturbance. Meeting these minimum requirements and measuring the stack and sample flow rates to ensure that the collected sample is representative of the stack gas stream is referred to as isokinetic sampling.

Sampling ports on the thermal oxidizer off-gas were conventional stack gas sampling ports and could be sampled isokinetically. Data collected from this location is most likely to be representative of stack emissions. Due to equipment limitations, vent gas locations S5 and S7 could not be sampled isokinetically. The overall impact of the sampling limitations to the use of the vent gas data is discussed in the following section. Additional detail on the vent gas sampling limitations is provided in the TRC sampling report included in the Data Compendium.

Samples were also collected of the Kaowool cover material and the activated charcoal from the vent gas treatment system, in the event that this data were needed to determine the overall disposition of contaminants.

4.5.3 Geosafe Effectiveness Evaluation

The overall effectiveness of the Geosafe process including overall process performance and material balances is discussed in this section. Process performance is discussed in terms of analytical and field measurement results.

The Geosafe pilot scale testing identified some significant matrix related difficulties during batch #1. These difficulties and the corrective actions taken for batch #2 are discussed in the following subsections. In summary, the high moisture content and fine grained nature of the sediment resulted in a high level of particulate and organics being volatilized in the off-gas vent stream. As was done for the other pilot tests, batch #1 was considered an optimization batch, and was not used in the overall process evaluation. Where batch #1 information is pertinent and useful, it is discussed in the following subsections. For overall evaluation purposes, only data from batch #2 are discussed.

The pilot study resulted in a glassy rock-like monolith that experienced temperatures above organic destruction temperatures for sustained periods of time (hours). For this reason, organic contamination is typically not detected in the silicate vitrification product. The soil immediately adjacent to the vitrified mass also experienced sustained high temperatures.

During the first Geosafe batch, some significant difficulties with the process were identified that appeared to be related to the Hot Spot sediment matrix. During the pilot test, elevated concentrations of organic compounds including PCBs, dioxins and furans were released in the off-gas. Geosafe hypothesizes that the high organic concentrations were the direct result of the combination of the high moisture content and the fine grained nature of the sediment as discussed below.

1. The fine-grained nature of the contaminated sediment and its lack of cohesiveness in the dry state made it readily mobile. Consequently, even a small degree of agitation of dry sediment would result in airborne dispersal. As the melt progressed outward, the water in the sediment boiled and evaporated, leaving dry sediment that was subsequently melted. The boiling and evaporating of the water created turbulence resulting in a high amount of particulates becoming airborne above the sediment.

2. The high moisture content of the contaminated sediment resulted in significant rates of steam production during processing. The high rate of steam production coupled with the fine particulate nature of the dry sediment resulted in significant agitation and fluidization of the sediment within the test container. This energetic steam generation resulted in airborne dispersal of sediment within

the test container. The airborne sediment had increased in temperature but had not yet melted. The release of hot, untreated sediment in the form of fine particulate into the test container caused the presence of elevated levels of organic compounds including PCBs, dioxins and furans in the off-gas.

The elevated particulate levels in the off-gas were immediately identified by the stack gas sampling team, as the particulate collection filters became too clogged to draw sample in less than one hour. The field team quickly determined that the proposed vent gas sampling program was not feasible due to the high level of particulate. The sampling team also observed greenish fluid, apparently hydrochloric acid, at the sampling ports, and a sulfur odor attributed to hydrogen sulfide near the off-gas sampling ports. Rapid turnaround laboratory results confirmed that the off-gas contained elevated concentrations of PCBs, dioxins, and furans.

The high particulate concentration created a challenge for the small scale off-gas treatment system that was used for batch #1. This system included a heat exchanger, condensate knock-out box, desiccant filter, and two small activated carbon chambers. It is important to note that this system was not designed to deal with high particulate loading. The data collected during batch #1 confirmed that this system was not effective in addressing the high particulate loading.

Because of the difficulties encountered with batch #1, significant changes were implemented in the technical approach to the second test. These changes included the addition of a wet venturi scrubber with caustic solution to remove particulate and hydrogen sulfide, and to neutralize the hydrochloric acid. A particulate filter was added downstream of the condensate collection tank. Also, two vapor phase carbon canisters each containing 180 lbs. of activated carbon were connected in series. A blower was also added to accommodate the pressure drop of the enhanced off-gas system. To ensure that organic contaminants were not released to the atmosphere in unacceptable concentrations, a propane-fired, Sur-lite thermal oxidizer was connected to the off-gas treatment system.

The configuration within the test container was also modified to help minimize the production of particulate. These changes included:

1. Placement of 8 to 12 inches of clean cover soil over the entire surface of contaminated sediment. The additional cover soil was expected to help prevent fluidization of the sediment and act as a particulate filter to prevent contaminated sediment particles from being mobilized. This cover soil was separated from the sediment by a plastic sheet to prevent the cover soil from becoming partially saturated with water. This plastic sheet was also expected to help prevent movement of particulate away from the contaminated zone.

2. Placement of a layer of Kaowool over the entire surface of cover soil. The Kaowool acts as a particulate filter to help keep the particulate below the soil surface and out of the off-gas stream.

These corrective actions were only partially successful in mitigating the operational problems. Similar problems with elevated particulate levels and organic emissions were observed on a slightly lesser scale during batch #2. Accordingly, batch #2 was also terminated early. As mentioned above, the difficulties encountered during batch #1 and the subsequent modifications were substantive enough that batch #1 was not used to further evaluate the vitrification process. Batch #2 was used in the overall evaluation discussed

below. Analytical and field data that provide a quantitative measurement of the effectiveness of the vitrification process are presented and discussed in the following subsections.

4.5.3.1 Analytical Results

Results from key sampling locations are summarized and discussed in this section for the purpose of quantitatively assessing the vitrification pilot scale performance. A more complete data set, including batch #1 results is included in the Geosafe report included in the Data Compendium. The TRC sampling report and laboratory results are also included in the Data Compendium. A discussion of the laboratory methods and associated quality control is included in Section 4.3.

Feed Sediment (S1) and Vitrified Product (S3) Results

A physical and chemical characterization of the Hot Spot sediment is discussed in Section 2.0. As discussed in Section 2.0, the concentrations of PCBs in the Geosafe feed material were generally lower than the expected average Hot Spot concentrations. Concentrations detected in the test feed material were used to evaluate the pilot study performance. The higher concentration results from the third pilot study are expected to be more representative of the CDF sediment and are used for the full-scale applications analysis discussed in Section 4.5.4.

The vitrified material was allowed to cool for three days prior to removing it from the test container. Once the vitrified block was removed, it was steam cleaned and then broken open with a sledge hammer. Samples were selected at random from the broken pieces. Pieces were selected that were not in contact with the outside boundary (fusion zone) of the vitrified mass. The fusion zone was in contact with un-vitrified soil that might have contaminated the vitrified product sample.

PCB concentrations in the initial Hot Spot sediment averaged 2,085 ppm (measured as Aroclors). PCBs were not detected in the vitrified glass-like product.

A summary of feed sediment and treated materials TCLP data is given in Table 4-27. The mobility of cadmium, chromium, and lead was reduced by the vitrification. The results for the other TCLP metals do not appear to be significantly different for the untreated and treated material. This appears to be a function of the relatively low concentrations in the initial feed sediment. Note that no heavy metals exceeded TCLP regulatory criteria in the initial Hot Spot sediment (Section 2.2).

Table 4-27
Summary of Feed Sediment (S1) and Vitrified Product (S3) TCLP Metals Results

TCLP Analyte	TCLP Regulatory Limit	Average Feed Concentration	Average Vitrified Product
Arsenic	5,000	17	5.37
Barium	100,000	264	329
Cadmium	1,000	43.6	ND
Chromium	5,000	71.7	14.3
Lead	5,000	694	14.4
Mercury	200	ND	0.24
Selenium	1,000	4.1	8.9
Silver	5,000	ND	ND
Results are reported in units of ug/L ND - Not Detected			

Vitrified product results indicate that the glass-like matrix is essentially inert, and would not release significant concentrations of organics or metals to the environment should it be left in place on-site.

Sediment Adjacent (S4A) to and Beneath (S4B) the Vitrified Block

Sampling of the soil adjacent to (S4A) and beneath (S4B) the melt was performed by collecting samples from two regions adjacent to and beneath the vitrified product. Samples were collected from the zone that reached maximum temperatures of 100°C and from the zone that reached temperatures between 300 and 400°C. These regions were determined from thermocouple data to be 1.5 inches (300-400°C) and 3.5 inches (100°C) from the vitrified mass, respectively.

The samples were collected after removing the cover soil from the test container. An 18-inch long stainless steel tube (1 inch diameter) was pounded in vertically at various locations 1.5 inches and 3.5 inches from the melt. Enough core samples were collected to ensure that an adequate quantity of material was available for analysis. The tubes were driven in at each sample location and then they were capped with tape to ensure that no contaminated material from additional coring or digging operations would fall into the tubes. The soil surrounding the sample columns was then removed, which permitted the removal of the sample columns. The sample columns from each of the thermal regions were then transferred onto a clean plastic liner and composited. Three composite samples were collected: two adjacent to the vitrified mass and one beneath. The target thermal regions for the adjacent samples were the one inch (300-400°C) and 3.5 inches (100°C) from the block and the beneath sample represented the 100°C (3.5 inch) region.

Samples were collected to evaluate the treatment process prior to the actual melting. The data were used to assess whether PCBs were treated or volatilized during the heating process prior to actual vitrification. Data were also used to assess the behavior of metals during the process.

Table 4-28 summarizes the analytical results for the sediment collected from adjacent to and beneath the vitrified block. Results are the average of batches #1 and #2 which provided similar results. These samples were dry, fine grained and powdery. No evidence of melting was observed in the portions of adjacent materials collected for analysis. The results summarized in Table 4-28 indicate that the concentration of PCBs was reduced in the zones adjacent to the melt. The concentration of metals in the zone next to the

melt remained approximately the same, although the lead data indicate that this more volatile metal may have been desorbed and recondensed in the 3.5 inch zone. Mercury data suggests that the relatively small amounts of this metal were also volatilized during the vitrification process.

Table 4-28
Results for Sediment Collected Adjacent to and Beneath the Melt

Analyte (mg/kg)	Feed Sediment	Adjacent (1 inch)	Adjacent (3.5 inches)	Beneath (3.5 inches)
Total PCBs	2,085	64	750	410
Mercury	1.0	0.08	0.05	0.28
Lead	418	396	809	864
Cadmium	7.0	6.9	14	7.8
Arsenic	5.0	5.0	6.5	4.9

The New Bedford treatability tests resulted in adjacent soil contaminant concentrations that are consistent with Geosafe's past vitrification tests. Samples taken three inches away from the vitrified mass had relatively low levels of contamination. PCB levels in the samples collected one inch away from the melt were reduced by 80 to 90%. These data suggest that the PCBs are removed during the heating process, prior to melting. The off-gas sample results (see below) also suggest that a significant portion of the organic contaminants were desorbed rather than destroyed during the vitrification process.

Off-Gas Analysis

The vitrification treatability test system was designed to simulate waste melting conditions at full-scale. The off-gas sampling and treatment system was designed to facilitate characterization of the off-gas for the purposes of designing full-scale needs. The data gathered from off-gas system sampling during testing was used to assess system performance, control emissions, and facilitate full-scale off-gas treatment system design.

Gas samples were collected during two segments of batch #2. Due to the high organic vapor and particulate concentrations measured during batch #2, and the subsequent stoppage of the test, the second sampling duration was shortened considerably. Gas samples were taken at four locations in the off-gas system. Samples were collected at the following locations:

- The inlet port of the test container (S2)
- Untreated gas exiting the test container (S5)
- Gas exiting from the condensate collection tank and carbon bed (S7)
- Gas exiting the thermal oxidizer unit (S10)

Sampling locations are illustrated in Figure 4-15. Sampling methodologies and detailed results are provided in the TRC report included in the Data Compendium. Analytical methods are discussed in Section 4.3.

Back pressure difficulties appeared to interfere with the collection of samples at S2 and other sampling related difficulties prevented the collection of isokinetic sampling at locations S5 (system off-gas) and S7

(carbon treatment inlet). Sampling at location S10 (post thermal oxidizer) was conducted isokinetically in accordance with EPA approved methodology. For performance assessment purposes, only the vitrification off-gas (S5) and the thermal oxidizer off-gas (S10) are discussed in this section. Results from S7 and S10 were fairly similar. Due to the potential error associated with the S7 location, this data was not considered useful for comparison with the more accurate S10 data. Similar sampling difficulties were noted for the S5 location. However, these data indicate elevated concentrations of contaminants at this location and are useful in an overall effectiveness evaluation, provided that the user consider the inherent inaccuracies in the data. The Geosafe report, included in the Data Compendium, summarizes the various vent gas samples in more detail.

A summary of the masses of key organic constituent at various points is given in Table 4-29. Calculations for the sediment mass are based on the masses in the various treatment zones given in Section 4.5.3.2. The mass of contaminant removed from sediment was calculated as the contaminant concentration multiplied by the treated mass including the mass of the adjacent and beneath zones (see Section 4.5.3.2) corrected for the concentration remaining in the adjacent and beneath zones. Vent gas data were taken from the TRC report included in the Data Compendium. Sediment PCB data are provided for both Aroclors and isomers for comparison purposes, as the different analyses provide slightly different results (see Section 4.3 for additional discussion on the analytical methods). Air samples were analyzed for PCBs using the isomer method only. Similarly, data for dioxins and furans are given for total mass and for 2,3,7,8-TCDD equivalents.

Table 4-29 also includes a measure of overall process destruction/removal efficiency. Determination of the DRE is as follows (40 CFR 1991):

$$DRE = \frac{W_{in} - W_{out}}{W_{in}} \times 100$$

where: W_{in} = (mass in untreated sediment) - (mass remaining in treated sediment)
W_{out} = mass at the thermal oxidizer outlet (S10).

Table 4-29
Summary of Masses for Organic Contaminants

Analyte	Mass Removed from Sediment (W_{in})	Mass Detected at (S5)	Mass Detected at (S10) (W_{out})	DRE (%)
PCB - Aroclor (mg)	654,995	376,704	61.9	99.9905
PCB - Isomer (mg)	1,417,427	342,397	61.9	99.9956
PCDD/PCDF (ng)	8,902,801	89,400,000	493,000	94.4624
PCDD/PCDF - tox eq (ng)	266,822	1,600,000	8,690	96.7431

The DRE equation is a measure of the overall effectiveness of the melting process in conjunction with the off-gas treatment system. The sediment masses used for the DRE calculation are given in Section 4.5.3.2. Results from the one inch and 3.5 inch treatment zone were used in the calculation in an effort to consider

partial treatment of the sediment in these zones, with the reasonable assumption that the process was capable of treating all sediment to an inert (non-detect) glass-like solid.

The results and DREs summarized in Table 4-29 indicate that the off-gas treatment system is capable of treating the organic contaminants present in the vitrification off-gas. Therefore, by considering only the mass from the initial sediment (W_{in}) and the mass released to the atmosphere (W_{out}), it can be concluded that the vitrification process treats organic contaminants, including PCBs, dioxins and furans.

To fully understand the vitrification process with respect to the treatment of Hot Spot sediment, the results from the vitrification off-gas (S5) must also be considered. These results are also summarized in Table 4-29. Based on these data, approximately 25 to 50 percent of the PCBs from the sediment were desorbed into the vent gas (S5) rather than being destroyed or otherwise incorporated into the vitrified product. Furthermore, the process resulted in a ten fold increase in dioxin and furan mass and a six fold increase in 2,3,7,8-TCDD toxicity equivalent mass. Based on these results, it appears that the vitrification process does not destroy the organic contaminants, but rather, releases them in the vent gas. Subsequently, any vent gas treatment system proposed to be used in conjunction with vitrification must be designed to destroy the maximum potential concentration of organic contaminants that could be released during vitrification.

Results from the thermal oxidizer outlet (S10) indicate that the off-gas treatment system treated the contaminants prior to release to the atmosphere. Overall process DREs were lower than typically experienced by Geosafe. Geosafe believes that this is due to the high moisture content and fine grained nature of the sediment and can be improved by dewatering the sediment prior to vitrification. The data presented suggest that dewatering is a reasonable approach to improving performance. This approach and the subsequent testing that would be required prior to full-scale implementation are discussed in Section 4.5.4.2. The effectiveness of the vent gas treatment system used for the pilot test is estimated in Table 4-30. The data presented in Table 4-30 can be used as an approximate estimate only, given the sampling inaccuracies at the S5 location. Despite sampling inaccuracies, the data indicate that modifications and additional testing could improve the off-gas treatment system.

A complete characterization of the vent gas streams is provided in the TRC report included in the Data Compendium. The data in the TRC report were used to develop potential full-scale treatment needs (see Section 4.5.4.2). Removal efficiency was calculated according to the following calculation:

$$\frac{\text{S5 Flow Rate - S10 Flow Rate}}{\text{S5 FlowRate}} \times 100 = \%\text{Removal}$$

The data presented in Table 4-30 indicate that the off-gas treatment system is treating the organic contaminants in the vent gas stream. The removal efficiencies given in Table 4-30 appear to be less than optimal, although definitive conclusions cannot be drawn due to the inaccuracies in sampling at the S5 location. Given appropriate state of the art vent gas treatment equipment and appropriate optimization and testing, it is expected that a vent gas treatment system can be developed that adequately treats the vent gas to below applicable treatment standards (see Section 4.5.4).

Table 4-30
Summary of Organic Contaminants in Geosafe Vent Gas Streams (Batch #2)

Analyte (Flow Rate)	Vitrification Off-Gas Average (S5)	Thermal Oxidizer Outlet Average (S10)	Vent Gas Treatment System Removal Efficiency (%)
PCB Total (mg/hr)	17,100	2.81	99.9836
PCDD/PCDF (mg/hr)	4.07	0.0224	99.4489
PCDD/PCDF Tox Eq (mg/hr)	0.0729	0.000395	99.4585
Lead (lbs/hr)	0.0041	NA	
Particulate (lbs/hr)	0.21	NA	
NA = Not Analyzed			

4.5.3.2 Characterization of Monoliths and Volume Reduction

Table 4-31 summarizes the volumes of mass treated in the vitrified monolith, the 0-1 inch surrounding zone and the 1-3 inch surrounding zone for batch #1 and batch #2. These values were used to determine the destruction and removal efficiencies presented above and were calculated by subtracting the mass contributed from the clean cover layer. Geosafe calculated the volume of the vitrified mass using the mass and density of the material. The calculations for these values can be found in the Geosafe report included in the Data Compendium.

Table 4-31
Summary of Treated Mass Zones

Parameter	Batch #1	Batch #2
Mass of Glass (kg)	271.1	95.3
Mass in 0-1 inch Zone (kg)	73.1	63.6
Mass in 1-3 inch Zone (kg)	171.6	154.4
Average Bulk Density (g/cm^3)	1.09	1.47

Vitrified monoliths typically consist of a layer of bubbles in glass overlying a relatively homogeneous solid glass layer in the block. A photograph of the vitrified product is included as Exhibit 4-9. When power is terminated, the melt begins to cool and the bubbles that exist at that time freeze and are preserved. The surface of the vitrified mass typically resides below the surface of the surrounding soil as a result of volume reduction but the degree of subsidence will vary depending upon the thickness of the layer of frozen bubbles. While the thickness of the layer of bubbles can be significant at pilot scale, it generally collapses under its own weight at full-scale and is relatively insignificant.

Exhibit 4-9
Vitrified Product

Batch #1 resulted in a vitrified mass weighing 694 lbs. (315 kg) including the clean soil cover layer. The glass has a density of approximately 2.4 g/cm^3. Thus, the volume of the glass (not including void space) was 129.6 liters. The maximum dimensions of the volume of sediment treated was approximately 27 inches by 30 inches wide by 31.5 inches deep indicating an approximate volume of 418 liters. Using these figures, a total volume reduction of approximately 69% took place during the test. Batch #2 resulted in a vitrified mass weighing 405 lbs. (184 kg). The glass has a density (excluding void space) of approximately 2.4 g/cm^3. Thus, the volume of the glass (not including void space) was 76.5 liters. The maximum dimensions of the volume of sediment treated was approximately 28.5 inches by 28.5 inches wide by 24.5 inches deep indicating an approximate volume of 266 liters. Using these figures, a total volume reduction of approximately 71% took place during the test.

For both tests, the precise volume of vitrified sediment is difficult to determine. This is because the width of the vitrified zone is wider at the base than at the top and because the vitrified masses are irregularly shaped. Therefore, the above volume reduction estimates should be considered a maximum. The actual volume reduction that can be expected for the New Bedford Harbor sediments is likely between 60% and 65%. A summary of the vitrified dimensions is provided in Table 4-32.

Table 4-32
Vitrified Block Dimensions

Parameter	Batch #1	Batch #2
Maximum Depth (in.)	31.5	24.5
Maximum Diameter (in.)	30.0	29.5
Maximum Circumference (in.)	94.5	88.0
Weight (lb.)	694	405
Volume Reduction (%)	69	71

Removal of Additional Water

For batch #1, the removal of water from the sediments around the vitrified mass caused subsidence of the entire sediment surface in the test container from 4.5 to 9.5 inches below the level measured at the beginning of the test. This represents a minimum of 227 liters of water that was removed from the container during the heating/melting process.

For batch #2, the removal of water from the sediments around the vitrified mass caused subsidence of the entire sediment surface in the test container of 3.5 inches below the level measured at the beginning of the test. This represents a minimum of 111 liters of water that was removed from the container during heating/melting.

The New Bedford Harbor sediment is held in suspension by its high water content. As water is removed by heating, volume is lost until the sediment particles are no longer suspended. Water continues to be removed as heating progresses, but this water is removed from between sediment grains and does not contribute to further volume reduction of the dried surrounding sediment soils. It is assumed that the total quantity of water removed from the thermally treated zone during batches 1 and 2 was 227 liters and 111 liters, respectively.

4.5.3.3 Energy Consumption and Efficiency

The energy efficiency of the vitrification process is defined as the amount of energy consumed during melting divided by the mass of the block produced. Batches 1 and 2 had an estimated energy efficiency of 2.49 kWh/kg and 2.84 kWh/kg, respectively. Geosafe indicates that typical efficiencies for engineering scale testing range from 1.0 to 1.6 kWh/kg. Based on Geosafe's previous experience, large scale efficiencies range from 0.8 to 1.0 kWh/kg and are typically better than smaller scale efficiencies due to a decrease in heat loss caused by a greater surface area to volume ratio at large scale. The New Bedford Harbor testing energy efficiency values are much higher apparently due to the excessive water that must be removed prior to vitrifying the soil. If the estimated water quantities of 227 kg and 111 kg for batches 1 and 2, respectively, are incorporated into the energy efficiency evaluation, the respective kWh efficiency values for the tests become 1.45 kWh/kg and 1.77 kWh/kg. These values are more consistent with typical vitrification.

4.5.4 Geosafe Full-Scale Application

The application of the vitrification technology to full-scale treatment of the Hot Spot sediment is discussed in this section. The general approach to full-scale implementation and the associated requirements were developed based on the known characteristics of the sediment (Section 2.2), pilot scale testing results, Geosafe's testing experience and Foster Wheeler's experience and engineering judgment. This section includes a discussion of Geosafe's experience, the conceptual full-scale system, the technology implementation schedule, technology limitations, a HAZOP review, and estimated treatment costs.

In summary, based on pilot scale testing and Geosafe's experience, vitrification at full-scale may be a potential option for treatment of the Hot Spot sediment. Following completion of the pilot study, it was concluded that some significant matrix related difficulties require resolution and additional testing prior to full-scale implementation. Specifically, the process off-gas data from the pilot study indicate that the Destruction and Removal Efficiency (DRE) was lower than the Geosafe process typically achieves. The data also indicate that the process produced organic by-products, including dioxins and furans.

It appears that these difficulties were directly related to the sediment matrix. That is, the sediment contains a large proportion of water (approximately 50%) and is very finely grained. This caused the sediment to become "fluidized" during the melting process, releasing significant amounts of steam and particulate to the off-gas stream. Under these circumstances, organic compounds were released with steam from the perimeter of the melt rather than remaining entrained in the sediment matrix. The organic compounds in the steam/particulate phase were then no longer available for treatment in the melting process and were subsequently transferred and treated within the off-gas treatment system. Several data gaps and process operation difficulties were identified during pilot scale testing that need to be resolved prior to full-scale implementation. These are briefly summarized below. Further discussions on the process modifications and additional design testing are provided in the following subsections.

Pilot scale testing and Geosafe's experience indicate that vitrification can successfully "melt" Hot Spot sediment into an essentially inert block of glass. Analysis of the resulting glass product indicated that PCBs and other organics were no longer present in the glass matrix and that the inorganics that remained were not leachable in quantities above relevant regulatory criteria.

At a minimum, full-scale application would require the dewatering of the sediment prior to vitrification and an off-gas treatment system. These modifications to the process should improve destruction and removal efficiencies and minimize the generation of undesirable organic compounds in the vent gas stream. Additional testing of Hot Spot sediment with successful resolution of matrix related difficulties would be required prior to fully evaluating full-scale implementation. These additional tests could be completed during the design phase of the clean-up. However, it must be noted that implementing these steps may or may not appropriately address the concerns identified during the pilot study. Should additional testing determine that the vitrification process is not a viable treatment process for the Hot Spot sediment, it may be advisable to have a back-up or contingency plan in place.

The full-scale treatment approach presented in this section was developed based on Geosafe's project experience and the results from the pilot study. Geosafe has considerable project experience with vitrification and believes that the difficulties encountered during the pilot test can be overcome with system modifications. Foster Wheeler is of the opinion that the modifications must be tested at pilot scale to determine that they adequately address the matrix related issues identified during the pilot test. The

approach discussed below is conservative and relies heavily on the results from the pilot test to determine the requirements for additional testing and full-scale implementation.

4.5.4.1 Geosafe Experience

This section provides a summary level discussion of the development and commercialization of the technology and Geosafe's specific project experience.

Vitrification developers have defined seven (7) scales of vitrification equipment. Melt size is the primary determinant of scale. Equipment power level and melting rate are related factors, although the possible melt sizes for different scales of equipment overlap somewhat. The scales of the vitrification equipment and the anticipated equipment power levels are listed in Table 4-33. The New Bedford Harbor Hot Spot pilot scale testing was conducted using a 30 kW system (Scale 2).

Table 4-33
Scales of Vitrification Equipment

Scale	Typical Melt Size	Equipment Power Level (kW)
1	1 to 5 lbs.	5
2	50 to 200 lbs.	30
3	0.5 to 10 tons	30 or 75
4	20 to 50 tons	500
5	100 to 1,400 tons	1,500 or 3,750
6[1]	2,000 to 5,000 tons	20,000
7[1]	10,000 to 15,000 tons	50,000

[1] Equipment scales 6 and 7 have been studied only and have not been tested; vitrification melting has been performed at the other scales.

Geosafe typically performs treatability testing at Scale 2 (approximately 20 lb/hr processing rate), which is technically acceptable for scale-up use, while being reasonably economical and efficient to perform. Geosafe is able to use the results from this scale of testing for performing remedial design and cost estimates for operation at Scale 5 (large scale). Scale 5 is the largest scale that employs mobile (trailer mounted) equipment. Scale 5 equipment has existed since 1984, and Geosafe has been operating the vitrification technology at Scale 5 on a continuous commercial basis since 1993.

During the development work, the application of the technology to the hazardous chemicals of concern under the Toxic Substances Control Act (TSCA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) and the Resource Conservation and Recovery Act (RCRA) became obvious. The process system has been developed and demonstrated through large scale, and wastes treated at various scales include a variety of hazardous chemical, radioactive, and mixed wastes. Development and testing on various hazardous materials has enabled the use of vitrification for commercial application.

The primary sponsor for the development and test work has been the U.S. Department of Energy (DOE). Other sponsors include the EPA, the U.S. Department of Defense (DOD), the Electric Power Research

Institute (EPRI), Battelle, Geosafe, and numerous other private companies. Battelle has obtained exclusive rights to application of the technology in the field of hazardous waste remediation. Battelle, in turn, has exclusively sublicensed Geosafe for the commercial implementation of the technology.

The vitrification technology is typically applicable to TSCA, CERCLA, and RCRA waste, contaminated soils, sludges, tailings, sediments, and similar earthen materials. Accordingly, Geosafe has tested and evaluated the applicability of vitrification to many PCB contaminated sites. Geosafe has completed a full-scale TSCA demonstration at a private industrial site in Washington State as part of the requirements for obtaining a National TSCA Operating Permit for treatment of PCBs throughout the United States.

The Geosafe mobile vitrification treatment system meets the EPA definition of an alternate disposal method, intended for use in more than one EPA region, and defined by the regulations promulgated under TSCA. The Code of Federal Regulations, Title 40, Part 761 (40 CFR 761) establishes rules on the disposal of PCBs and PCB items. Under these rules, organizations or persons wishing to dispose of PCBs are required to use approved methods and must obtain a permit. Geosafe has a National TSCA permit that allows for treatment of PCB contamination to maximum levels of 17,860 ppm.

A summary of full-scale remediations at two Superfund sites (GE/Spokane and Wasatch Chemical) performed by Geosafe is included below.

GE/Spokane Superfund Site

Date of Project	7/94 to 10/94
Duration of Project	4 months
Client Name	Bechtel Environmental San Francisco, CA
Client Address, Phone	Russ Stenzel (415) 768-3385
Contaminant Concentrations:	PCBs: Concentrations Up to approximately 17,000 ppm
Waste Media	Sandy Soil
Type of Project:	Full-scale
Waste Quantity	3,300 tons
Cleanup Goals	2 ppm PCBs
Treatment Efficiency (DRE)	>99.9999% DRE

Wasatch Chemical Superfund Site

Date of Project	11/94-12/95
Duration of Project	14 months
Client Name	Entrada Ind. Salt Lake City, UT
Client Address, Phone	Roland Gow (801) 534-5528
Contaminant Concentrations:	VOCs: <3,533 ppm Pesticides <300 ppm 2-4 D: 70 ppm PCP: 4,000 ppm TCDD: 3,000 ppb
Waste Media	Dense Clay
Type of Project:	Full-Scale
Waste Quantity	6,000 tons
Cleanup Goals	1 ppb dioxin
Treatment Efficiency (DRE)	>99.9999% DRE

An aerial photograph of the Wasatch Chemical Superfund Site in Salt Lake City, Utah is included as Exhibit 4-10. The Wasatch site used a 6 x 6 array of melts and staging of contaminated material for treatment, as would be recommended by Geosafe for the New Bedford Harbor Hot Spot sediment. The photo shows the use of two off-gas hoods, which would also be applicable to the New Bedford Harbor site.

Exhibit 4-10
Aerial Photograph of Full-Scale Implementation
at the Wasatch Chemical Superfund Site in Salt Lake City, Utah

4.5.4.2 Conceptual Full-Scale Treatment System

The overall treatment approach is presented in Figure 4-16 and is an adaptation of the original concepts provided by Geosafe. Foster Wheeler has adapted the approach in order to provide a conservative, yet potentially viable approach to implement vitrification in a safe and environmentally compliant manner.

The section presents a discussion of the proposed activities including additional pilot scale testing, drying, vitrification and off-gas treatment. The overall treatment approach includes the following steps:

Step 1. Transport the wet sediment from the CDF to the thermal dryer unit.
Step 2. Dry the sediment to less than 15 percent moisture using a thermal dryer and transport it under dust control to an area (potentially the existing empty CDF) where it can be redeposited, compacted, and prepared for vitrification. The off-gas from the dryer would be treated in the off-gas treatment system. Treatment would be performed over a 6 month period prior to vitrification operations in order to eliminate process interferences between the drying and vitrification steps.
Step 3. Redeposit dry sediment in another area of the CDF and implement vitrification in sequential batches over a one and a half year period.

These steps are discussed in more detail below following a discussion of requisite pilot study testing activities. Details of the other related site support activities including materials handling between the various steps are presented in the remedial alternatives discussion with Section 6.

Pilot Scale Testing of Treatment System

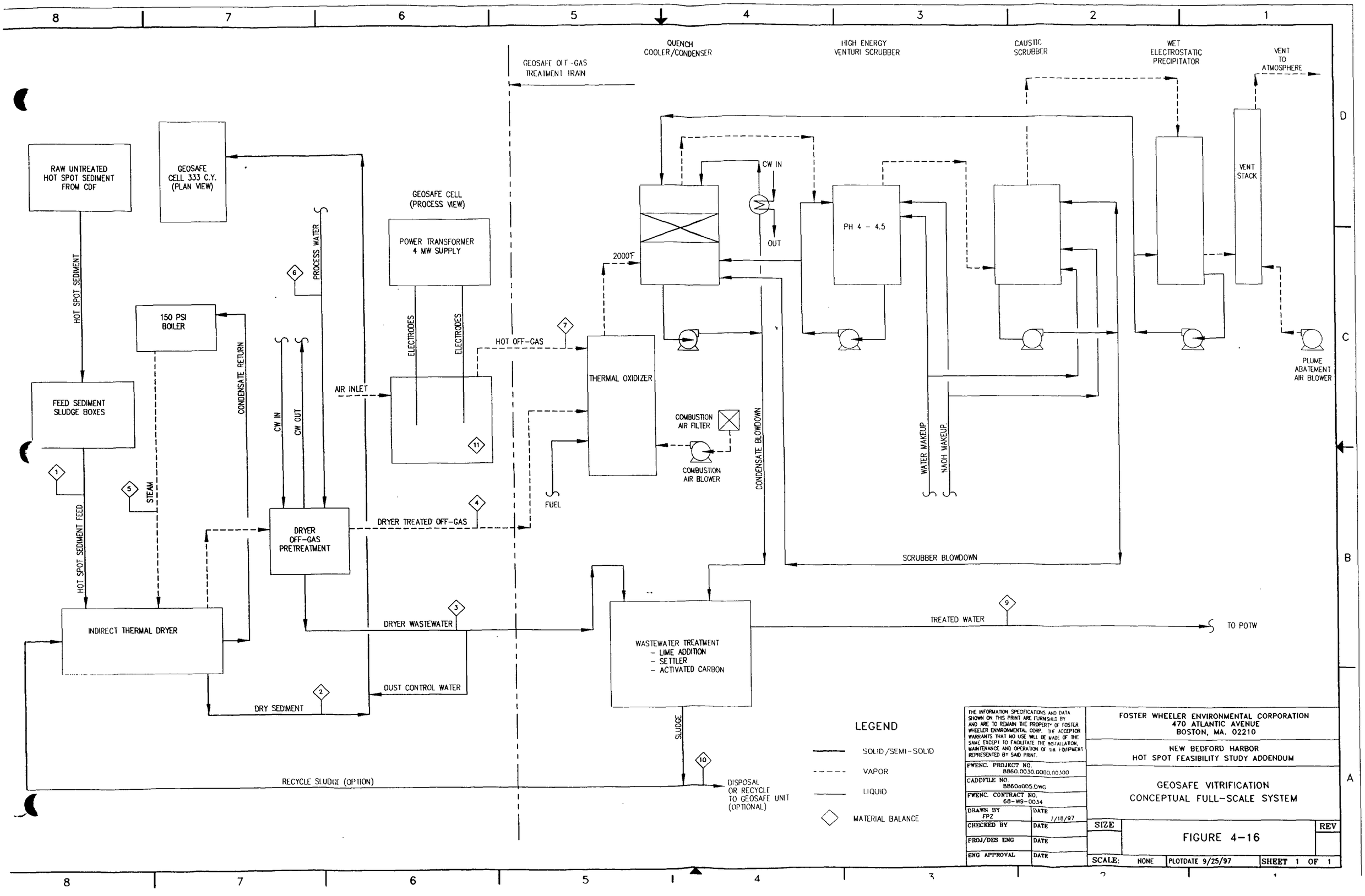
The steps discussed above, specifically, the dewatering of the sediment and the implementation of an off-gas treatment system, should improve the destruction/removal efficiency of the process and should reduce the concentration of dioxins and furans released in the off-gas. The effectiveness of these steps cannot be quantitatively assessed without further testing. To measure the full-scale process as a viable treatment option, it is recommended that the process, as proposed in this section, be tested on Hot Spot sediment at the pilot scale. The result of such testing should be fully evaluated prior to implementation of full-scale treatment.

This pilot study testing would be similar to that discussed in Section 4.5.2, but would be modified to specifically address the following issues identified during the initial Hot Spot sediment test:

- The thermal dryer proposed for dewatering sediments must be tested for effectiveness. This testing would be similar to that conducted for the thermal desorption pilot study (see Section 4.6.2) and would include off-gas monitoring for PCBs, dioxins, and furans.

- The vitrification off-gas must be sampled isokinetically to accurately evaluate the effectiveness of the process on dewatered sediments.

- Similarly, the accurate sampling of the off-gas would provide data that could be used to assess the destruction of contaminants via vitrification versus thermal desorption and subsequent vapor phase treatment.



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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

GEOSAFE VITRIFICATION
CONCEPTUAL FULL-SCALE SYSTEM

SIZE | FIGURE 4-16 | REV

SCALE: NONE | PLOTDATE 9/25/97 | SHEET 1 OF 1

- The off-gas treatment system, including scrubber solutions and the thermal oxidizer off-gas must be analyzed to determine the distribution of materials and to ensure that emissions meet regulatory criteria.

The implementation and testing of these process elements would provide data that can be used to evaluate full-scale viability. Although these modifications would be expected to significantly improve the process performance, there are no guarantees that this process will be effective for the Hot Spot sediment. Should further testing of the vitrification alternative be conducted in anticipation of full-scale implementation, it is recommended that a contingency treatment process be considered simultaneously, should vitrification be determined unsuitable for this particular matrix.

Sediment Drying

The first step in full scale treatment would be transferring the Hot Spot sediment to the dryer feed hopper and subsequent feeding into the indirect, steam-heated dryer. The dry sediment product would be transferred to the excavated area adjacent to the CDF where it would be deposited and compacted for future melting. Dust control would be implemented to ensure no adverse environmental effects. The off-gas from the dryer would be pretreated to remove moisture and particulates from the sediment and then sent to the off-gas treatment system to destroy PCBs, SVOCs, dioxins, and other organics.

Sediment Vitrification

The contaminated solid media to be melted at the New Bedford Harbor site is a sediment consisting primarily of fine-grained silt with small quantities of sand and shellfish debris. The results of the geochemical evaluation and the pilot tests indicate that the concentration of glass-forming ions (e.g., silicon, aluminum) and monovalent alkali earth metals (e.g., sodium, potassium, lithium) are within the acceptable range for efficient processing. No chemical modification or additives would be required to enable processing of the sediment.

The geochemical evaluation predicted a melt temperature near 2,000°C. However, the maximum melt temperature recorded during the treatability test was 1,665°C. This temperature discrepancy is believed to be due to the presence of shell fragments in the sediment that was melted, whereas such fragments were not present in the sediment samples collected prior to the test and employed in the petrologic evaluation. The shell fragments contributed calcium to the melt. Calcium acts as a flux and suppresses melt temperatures. A cooler melt results in extended electrode life and lower temperatures in the off-gas hood. Hence, the presence of shells in the sediment is beneficial to the process.

The minor quantities of debris (rocks, wire, plastic, and wood) that were processed during the pilot test had no observable effect on the vitrification process. Significantly higher concentrations of such debris can be tolerated by the vitrification process. The New Bedford Hot Spot sediments are not expected to contain a significant amount of debris and this is not likely to be a concern.

Following drying, the sediments would be staged in the eastern end of the CDF where the dredged material from the pilot study was placed. The dry sediment (still contaminated) would be covered with a geotextile and two feet of clean soil to prevent transport of fine grained particles away from the site. Once all of the contaminated sediment was placed and compacted (approximately six months) the vitrification operations would commence. The vitrification operations would take approximately two weeks at each of the 36 melt

sites. Geosafe anticipates using two off-gas collection hoods during the application to provide adequate coverage during melting and cooling operations.

During the melting process, Foster Wheeler anticipates that additional off-gas controls above what Geosafe has planned, could be required. The next section discusses this off-gas treatment system.

Geosafe Off-Gas Treatment System

As a result of the pilot study tests, it is apparent that the pilot vitrification system generated significantly higher concentration emissions than originally estimated. Therefore, a full-scale vitrification system would likely need a more comprehensive gas cleaning system than originally proposed by Geosafe. This subsection presents a conceptual design for an off-gas cleaning system that would be able to meet the stringent emission limitations expected to be imposed on the project.

Off-Gas Treatment System Design Criteria

The design of an off-gas treatment system must consider potential emissions of particulate, hydrogen sulfide, heavy metals and organics. These are discussed in more detail below.

Particulate Emissions

The most significant issue with the particulate emissions is the quantity of particulates below one micron. The particles in this size range are the most difficult to remove and present a significant problem to most types of pollution control equipment. One of the few types of equipment that can control these sub-micron particulates is a wet electrostatic precipitator or wet ESP (WESP). However, a WESP cannot handle heavy dust loads very well. Usually, a WESP is preceded by another particulate control device (such as a low to medium energy venturi scrubber) to remove the large particulate and heavy dust loading prior to the WESP,. Venturis are very efficient at removing particulates larger than three microns in size and can handle heavy dust loads effectively, as long as the total suspended solids in the scrubbing liquid is kept low, usually less than 5% to 10% by weight.

Hydrogen Sulfide Emissions

Hydrogen sulfide (H_2S) presents not only an odor problem, but also a health problem. The best way to control hydrogen sulfide is to oxidize it to water (H_2O) and sulfur dioxide (SO_2). The sulfur dioxide emissions can be removed using a wet scrubber.

Heavy Metal Emissions

Based on the pilot test data, the primary metal that presents a problem is lead. It is the only metal present in a relatively high concentration and it also volatilizes at relatively low temperatures. Since it is expected that the high temperatures of the melt will volatilize the lead, this presents a potential problem with off-gas emissions. The best way to control the emission of lead is to condense it back to the solid phase in the gas cleaning system and remove it. However, when lead condenses from a vapor to a solid particle, it usually forms a sub-micron particle. Difficulties and treatment associated with sub-micron particles are discussed above.

Organic Emissions

This a broad category that includes all organic emissions from the process, such as PCBs, products of incomplete combustion (PICs) and, potentially, dioxins and furans. The best way to control these emissions is to oxidize them in a thermal oxidizer.

Conceptual System Design

Based on these potential emissions from the sediment drying and vitrification processes, a conceptual design for an off-gas treatment system was developed and is briefly summarized below.

Thermal Oxidizer

The off-gas from the process should first pass through a thermal oxidizer to control the volatilized organic emissions. This unit would be designed to oxidize all of the various compounds that might be present in the gas stream, including PCBs, PICs, dioxins and furans. As a result, it is expected that the unit will operate at in the temperature range of 980° to 1200°C with a residence time of approximately 2 seconds. Either natural gas (if available) or propane would be used as the auxiliary fuel.

Venturi/Packed Tower Scrubber

Following the thermal oxidizer would be a venturi scrubber designed to remove the heavy dust loading expected to be emitted from the system. The scrubber would be effective in controlling the large particulate and reducing the concentration of particulates to a range acceptable to the WESP. Following the venturi would be packed tower scrubber designed to remove the acid gases generated when the H_2S and chlorinated compounds in the waste (such as PCBs) are burned. The combination of the venturi and packed bed scrubber is expected to be effective at controlling the bulk of the particulate emissions and the acid gas emissions.

Wet Electrostatic Precipitator (WESP)

After the venturi/packed tower scrubber, the only remaining issue is expected to be the sub-micron particulates. These would be controlled by a WESP, designed to remove the sub-micron particulate generated by the high temperatures in the vitrification process.

4.5.4.3 Technology Implementation Schedule

Geosafe would employ a total on-site crew of about 11 people to operate the large scale vitrification equipment system 24 hours a day. The total time to dry and vitrify the sediments would be approximately two to three years. However, the pilot scale testing and additional process development steps could take as long as three years. This results in a combined schedule of approximately five to six years.

The primary technology limitation for the vitrification of the Hot Spot sediments appears to be excessive moisture. While other factors, such as grain size distribution, also play a role, excess moisture appears to present the primary challenge. As a result, a complex and expensive off-gas treatment system has been included by Foster Wheeler in the conceptual full-scale design. A comprehensive design scale testing program has been included in the conceptual full-scale application to determine if the sediments can be

dewatered to the 10 to 15 percent moisture range and if this would be effective in eliminating the problem of excess particulates and the creation of dioxins and furans. It is possible that the results of the pilot testing conducted during the design phase would demonstrate that these limitations had been overcome. However, it is important to note that it could take up to three years to go through this design scale testing phase.

4.5.4.4 Geosafe Vitrification Hazards Review

This review is conceptual in scope because there are no detailed Process Flow Diagrams (PFDs), no detailed Piping and Instrumentation Diagrams (P&IDs), operating instructions, etc., that exist to form the basis for an in-depth HAZOP review. Should implementation proceed at sometime in the future, such an in-depth HAZOP Review would be performed. In summary, this Hazards Review highlights the main areas of concern to ensure these issues are factored into the overall evaluation of this technology.

Vitrification Overview

The Geosafe process employs hazardous operating conditions both in the vitrification where the molten glass temperature is about 1,600 to 1,700°C, and in the thermal oxidizer where the temperature is about 900°C after the hot vitrification off-gas is burned. All of these process units operate close to atmospheric pressure. Another potential hazard is the high electrical energy load required to vitrify the sediment.

Hazards Analysis

Hazards associated with the vitrification process are discussed below. Hazards are discussed in terms of physical and chemical hazards as well as hazardous operating conditions and equipment or utility failure.

Physical Hazards

The physical hazards that may be encountered are burns from hot equipment, noise, exposure to the cold, heat stress, sharp surfaces, falling objects, lifting, electrical shock, and those associated with work near heavy and industrial equipment. Should implementation proceed, the Site Safety Officer or alternate, would address activity-specific safety procedures to minimize the potential for injury associated with these hazards during full-scale operations.

Weather Events

Major equipment would be exposed to the weather. High ambient temperature does not appear to present any process hazard. Low (sub freezing) temperature could cause problems maintaining flow of aqueous streams required for off-gas treatment and wastewater treatment presenting the possibility of release of inadequately treated material. Tracing (electrical or steam) of exposed piping should be considered where appropriate.

In the event of rain, power cables to the vitrification unit and connections to the electrodes would be exposed. Elevating and insulated cables appear preferable to laying them on the soil surface. This would reduce likelihood of mechanical damage and personnel exposure. Infiltration of moisture into stock piled or unprocessed dried silt could result in processing conditions leading to poor destructions of contaminants as experienced in the pilot work.

Accumulation of an unusually heavy amount of snow on the vitrification unit containment hood could present the possibility of collapse of the covering with release of untreated off-gas. Short-circuiting of the electrodes to the containment hood appears to be another possibility. Proper maintenance and weather proofing should eliminate these concerns.

Off-Site Event

Fire or other incidents occurring on adjacent property do not appear to present additional hazard from the Geosafe equipment.

Chemical Hazards

The following materials associated with the process are hazardous because of toxicity:

PCBs
Dioxins (produced during vitrification)
Other toxic organics in the sediment
Heavy metals

Equipment Failure

Leakage or catastrophic failure of piping or pumps would release contaminated silt during the transfer of hot spot sediment to and from intermediate storage causing possible personnel exposure. Berms will be provided to minimize the spread of such releases.

Failure of the thermal dryer could release contaminated vapor and silt. Leak detection equipment will be used to prevent such a failure. The method of transfer of dry sediment to the melt area has not been determined. However, moving the dried sediment poses the potential for release of contaminated dried material which could be carried by wind and could cause personnel exposure and/or on and off-site contamination.

Misoperation of the off-gas treatment system could cause release of contaminated vapor and particulates. This system will have a backup carbon absorption unit. Misoperation of the scrubbing system and thermal oxidizer could create a release of hot contaminated gas. A carbon adsorption system would back-up these units.

Failure of the induced draft fan could lead to development of positive gauge pressures in the system with the possibility of contaminated gas leakage from melt hood or scrubbing equipment. A backup power generator will prevent this event.

Utility Failure

Lack of electrical power would force the total shut down of the system. This may not present a hazard provided it is not of sufficient duration to permit solidification of a partially vitrified cell. Recovery operations (i.e., reheating) may entail potential exposure of personnel. Lack of water would force a total shut down. Unanticipated failure could result in release of contaminated gas to the atmosphere. The source of thermal oxidizer fuel is not indicated (i.e., utility service gas or on site LPG). Loss of the fuel

source would cause a forced shut down and possible release of contaminated gas or water due to an overloaded scrubber system.

Hazards Summary

In summary, major HAZOP issues of concern are the following:

- Release of hot contaminated gases from the vitrification unit and thermal oxidizer.
- Release of hot, molten glass.
- Electrical shock from the high electrical energy load.

These issues of concern are addressed in the following ways:

- Release of contaminated gases is prevented with a backup carbon adsorption system.
- Release of molten glass will be prevented by proper staging of the melt cells and suitable clean soil cover based on past Geosafe practice.
- Elimination of electrical shock by elevating and insulating electrical cables, and employing NEMA OSHA standards.

4.5.4.5 Estimated Treatment Cost

This section presents the treatment only costs for vitrification of the 18,000 tons of Hot Spot sediments. Although Geosafe anticipates that following dewatering the sediment volume will be reduced to 12,000 cubic yards from the initial volume of 15,000 cubic yards, the per ton cost of treatment is based on the initial 18,000 tons currently contained in the CDF. This is consistent with the development of the costs which also include dewatering.

Foster Wheeler modified the estimated Geosafe costs in several areas. The first modification increased estimated costs for electrical power, as the regional cost for electrical power used by Geosafe was low by a factor of two. Other modifications included the addition of a comprehensive design scale test program, thermal dryer and enhanced off-gas treatment system. The estimated vitrification costs are presented in Table 4-34 and include design scale testing, mobilization, dewatering, melt processing, off-gas treatment and demobilization. The costs for the enhanced off-gas treatment system are divided between the costs for dewatering and melting operations. The division of cost is based on the duration of these two activities, six months and eighteen months, respectively.

Table 4-34
Estimated Vitrification Preparation Costs

Activity	Estimated Cost
Design Scale Testing	$1,616,000
Mobilization	$300,000
Dewatering	$6,324,000
Melt Processing	$8,196,000
Off-Gas Treatment for Melt Operations	$4,001,000
Demobilization	$250,000
Total:	$20,687,000
Cost per ton of wet sediment (18,000 tons)	$1,149/ton

The estimated costs for the design scale testing include a month long test program for both thermal dewatering and vitrification operations. A minimum of four separate melts would be conducted on the dried sediment. The sediment drying activities would be done at a rate to provide enough sediment for vitrification operation and to assess the efficacy of the drying operations. This would include the energy required to dry the sediment and measurement of the quantity and quality of the resulting off-gas. Both tests would include extensive off-gas sampling, detailed analytical chemistry evaluations and a comprehensive site-wide air monitoring program.

4.6 SAIC/Eco Logic Test Program

The third pilot study was conducted by Science Applications International Corporation (SAIC) and Eco Logic in a teaming partnership. The treatment technology evaluated was a two stage process involving thermal desorption of contaminants from the Hot Spot sediment and subsequent chemical reduction of chlorinated organics in the gas phase vent stream. The technology and equipment are Eco Logic's. Accordingly, discussions regarding the pilot test refer to SAIC/Eco Logic, full scale technology and implementation discussions refer to Eco Logic's process experience and equipment.

In order to fully assess full scale applicability of these processes, the two stages (thermal desorption and chemical destruction) are discussed in conjunction with one another, as the pilot test was conducted. These two unit processes are also discussed as separate processes, capable of being used independently and in conjunction with other treatment technologies. For instance, the gas phase chemical reduction process could potentially be used to treat residual oil generated by solvent extraction (see Section 4.4).

The data collected to evaluate the processes are summarized and discussed in the following subsections. SAIC/Eco Logic's report of the pilot scale testing program is included in the Data Compendium. TRC conducted the vent gas sampling during the SAIC Eco Logic test program and their report including the associated stack sample results is included in the Data Compendium. Laboratory results for the samples collected during the program (all media including solids, liquids and air) are also included in the Data Compendium.

4.6.1 Process Description

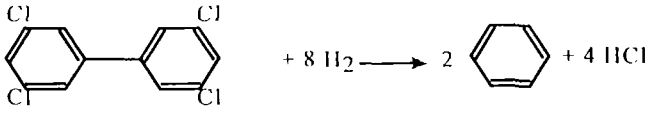
Since 1986, Eco Logic has conducted research, development, and product engineering with the aim of developing a new technology for destroying organic wastes in a wide range of matrices including harbor sediments, soils, leachates, lagoon sludges, and highly concentrated organic wastes. Much of this work was supported by the Government of Canada (National Research Council - Environment of Canada and the Department of National Defense) and the EPA. The goal was to develop a commercially viable chemical process that could deal with aqueous wastes, contaminated soils, sediments, and also destroy concentrated organic wastes (i.e., solvents, PCB oils, industrial wastes, pesticides, and chemical warfare agents). Additional detail on the history of the process is included in the Eco Logic report included in the Data Compendium.

The process consists of a thermal reduction mill (TRM) that pulverizes and grinds the sediment at elevated temperatures. The operation of the TRM is conceptually similar to other indirect thermal desorption systems. However, the TRM uses a molten tin bath as a means of heat transfer and the operating atmosphere is hydrogen based to minimize the potential for the creation of dioxins and furans. Organic compounds and steam are volatized from the sediment and removed from the TRM by the hydrogen sweep gas. The TRM off-gas is vented to the gas phase reactor, where the gas is subjected to high temperatures in a hydrogen atmosphere.

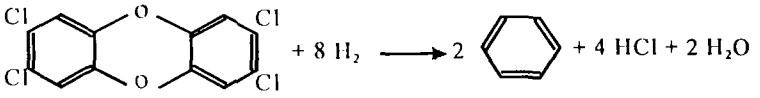
The Eco Logic reactor destroys the organic compounds through chemical reaction with hydrogen at high temperature, reducing contaminants to methane and hydrochloric acid. Off-gas exiting the reactor is processed through scrubbers to remove water, hydrochloric acid and hydrogen sulfide. The gas is subsequently processed through an excess gas burner that destroys methane and other residual organics

prior to release to the atmosphere. The thermal energy from the excess gas burner can also be used within the process to operate a steam boiler. The chemical process reactions are illustrated in Figure 4-17.

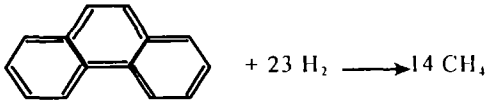
Figure 4-17
Eco Logic Process Reactions



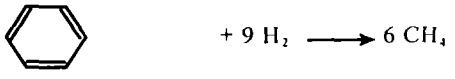
PCB molecule & hydrogen react to produce benzene & hydrogen chloride



Dioxin molecule and hydrogen react to produce benzene, hydrogen chloride & water



PAH molecule and hydrogen react to produce methane



Benzene and hydrogen react to produce methane

$C_n H_{(2n+2)} + (n-1) H_2 \longrightarrow n CH_4$

Hydrocarbons & hydrogen react to produce methane

WATER SHIFT REACTIONS

$CH_4 + H_4O \longrightarrow CO + 3 H_2$

Methane and water react to produce carbon monoxide and hydrogen

$CO + H_2O \longrightarrow CO_2 + H_2$

Carbon monoxide and water react to produce carbon dioxide and hydrogen

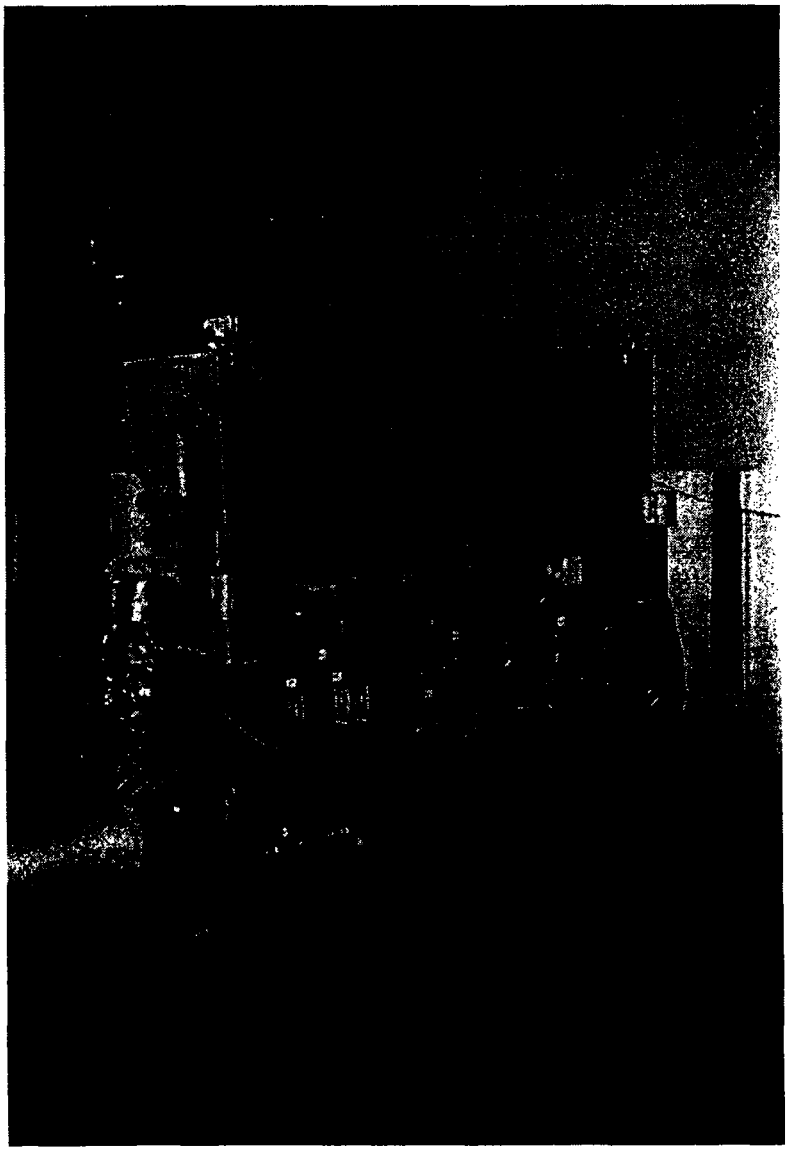
The chemical process reactions are reductive in nature with the exception of the reaction between water and methane to generate hydrogen, carbon monoxide, and carbon dioxide. These "steam reforming" or "water shift" reactions also shown in Figure 4-14 are utilized to regenerate hydrogen for the reduction reactions, reducing the requirements for purchased hydrogen (under full scale applications).

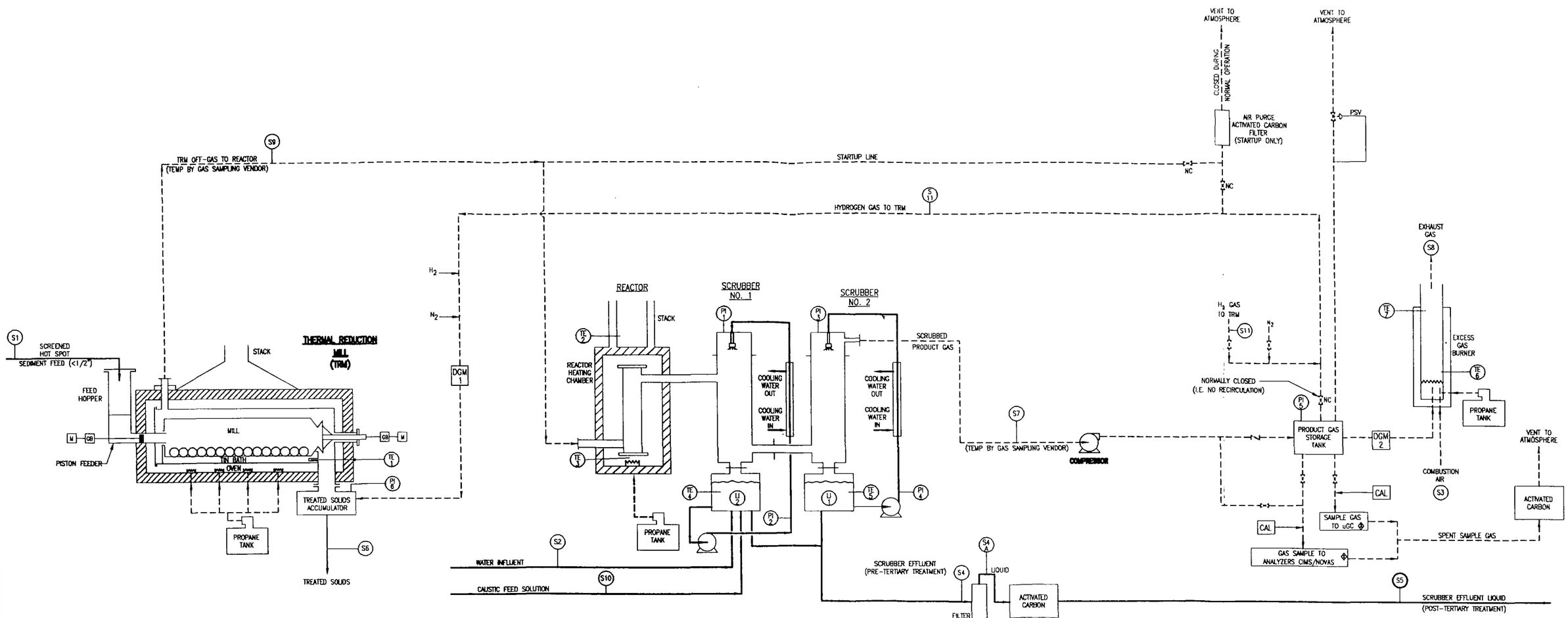
Unlike typical incineration systems which utilize oxidation reactions, the efficiency of the reduction reactions is enhanced by the presence of water, which acts as a reducing agent and a source of hydrogen. Consequently, aqueous waste such as harbor sediments, sludges, and leachates can be treated efficiently and without prior dewatering.

A benefit of using an active reducing hydrogen atmosphere for the destruction of chlorinated organic compounds, such as PCBs, is that oxygen is not present in significant concentrations such that the potential for formation of dioxins or furans is greatly minimized.

Pilot scale systems have been used by Eco Logic over the past few years to perform waste specific studies for several commercial clients. Several of these projects have resulted in full scale treatment units. A process flow diagram summarizing the pilot scale test program is included as Figure 4-18. This figure also includes the sampling locations that were used and the analyses that were conducted for each sample. The pilot system includes a piston feed system for delivery of soil to the TRM, a gas phase chemical reduction reactor and a two stage gas scrubbing system with continuous emission monitoring equipment. Photographs of the pilot unit components are included as Exhibits 4-11 and 4-12. Exhibit 4-11 shows the pilot scale TRM and Exhibit 4-12 shows the Reactor Chamber, the Scrubbers and Excess Gas Burner.

Exhibit 4-11
Pilot Scale TRM





PARAMETERS	S1 SCREENED HOT SPOT SEDIMENT FEED (<1/2")	S2 WATER INFLUENT	S3 COMBUSTION AIR	S4 SCRUBBER EFFLUENT (PRE-TERTIARY TREATMENT) S4A LIQUID	S4 SCRUBBER EFFLUENT (PRE-TERTIARY TREATMENT) S4B PARTICULATES	S5 SCRUBBER EFFLUENT LIQUID (POST-TERTIARY TREATMENT)	S6 TREATED SOLIDS	S7 SCRUBBED PRODUCT GAS	S8 EXHAUST GAS	S9 TRM OFF-GAS TO REACTOR	S10 CAUSTIC SOLUTION	S11 HYDROGEN GAS TO TRM
PCBs	✓			✓	✓	✓	✓					
SVOCs	✓			✓	✓	✓	✓					
DIOXINS/FURANS	✓			✓	✓	✓	✓	✓	✓	✓		
PCB ISOMERS							✓	✓	✓	✓		
SELECTED PAHs								✓	✓	✓		
SELECTED HEAVY METALS								✓	✓	✓		
O&G	✓			✓	✓	✓	✓					
METALS	✓			✓	✓	✓	✓					
TCLP METALS & ORGANICS (METHOD 1311)	✓						✓					
BENZENE									✓			
TEMPERATURE								✓	✓	✓		
PARTICULATES, HCl AND Cl_2								✓	✓	✓		
MOISTURE (WT%)	✓				✓		✓	✓	✓	✓		
TSS				✓		✓						
DS				✓		✓						
TS				✓		✓						
pH	✓			✓	✓	✓	✓					
CHLORIDE	✓			✓		✓	✓					
SULFUR (AS SULFATE)	✓			✓		✓	✓					
BULK DENSITY (FIELD MEASURE)	✓						✓					
MASS	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
VOLUME	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

LEGEND

———	SOLID/SEMI-SOLID
- - - -	VAPOR
———	LIQUID
CAL	CALIBRATION GAS INJECTION POINT
NC	NORMALLY CLOSED
U	LEVEL INDICATOR
TE	TEMPERATURE RECORDER
DGM	DRY GAS METER
PI	PRESSURE INDICATOR

NOTES

1. TO ENSURE ADEQUATE SAMPLE VOLUME AND REPRESENTATIVENESS, ONE COMPOSITE SAMPLE OF SCRUBBER PARTICULATE WILL BE PREPARED FROM THE 5 PERFORMANCE BATCHES.
2. IN LINE CONTINUOUS SAMPLING WILL BE CONDUCTED USING THE CIMS & NOVA ANALYZERS FOR BENZENE, MONOCHLOROBENZENE, TOLUENE, DICHLOROBENZENE, TRICHLOROBENZENE, HYDROGEN, METHANE, CARBON MONOXIDE AND CARBON DIOXIDE. REFER TO TEXT FOR MORE DETAIL.
3. GAS FROM PRODUCT STORAGE TANK IS ANALYZED USING A MICRO GC AT REGULAR INTERVALS (APPROXIMATELY ONCE PER MINUTE) FOR BENZENE, MONOCHLOROBENZENE AND HYDROGEN SULFIDE. REFER TO TEXT FOR MORE DETAIL.

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470 ATLANTIC AVENUE
BOSTON, MA. 02210

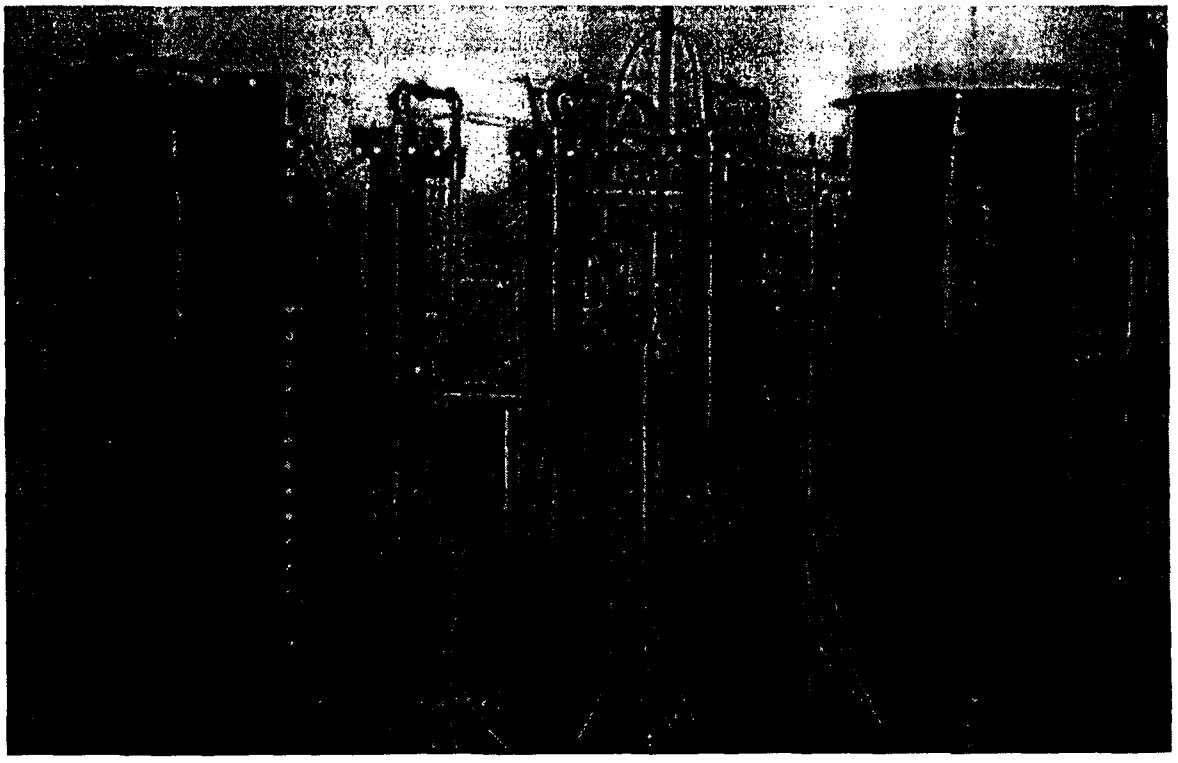
NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

ECO LOGIC PILOT-SCALE PROCESS SCHEMATIC WITH SAMPLING LOCATIONS

SIZE D | FIGURE 4-18 | REV –

SCALE: NONE | PLOTDATE:9/25/97 | SHEET 1 OF 1

Exhibit 4-12
Pilot Scale Gas Phase Reactor and Off-gas Treatment System



The hydrogen sweep gas, water, and desorbed contaminants exited the TRM and entered the gas phase chemical reduction reactor at the bottom. The reactor was operated in an atmosphere of hydrogen and was heated by propane to maintain a temperature of at least 900°C. Reduction of the organic contaminants occurs along the length of the reactor and the resulting gases exited the reactor from the top after a typical residence time of 4 to 10 seconds. The process reactions take place in less than one second, but a residence time of several seconds was used to ensure complete destruction.

The reacted product gas leaving the reactor was routed through a two stage gas caustic scrubbing system to remove heat, water, hydrocloric acid and particulates. The scrubbed product gas was then compressed and sent to temporary storage before being burned in the Excess Gas Burner. At the end of each test run, the scrubber effluent solution/slurry was collected and then pumped through a filter followed by a bed of activated carbon.

4.6.2 SAIC/Eco Logic Test Program Elements

The pilot test program for the SAIC/Eco Logic process is described in this section. The following three subsections discuss the pilot scale test schedule, optimization and operating conditions, and the sampling and analytical program. Additional detail in the pilot scale test program is provided in the SAIC/Eco Logic report included in the Data Compendium. The results of the pilot program are discussed in Section 4.6.3.

4.6.2.1 Pilot Test Schedule

The SAIC/Eco Logic test program consisted of three "acclimation" runs and three "performance" verification runs, for a total of six test runs. The acclimation runs (A1, A2, and A3) were conducted on November 18, 19, and 20, 1996. Each acclimation run consisted of a shortened batch, approximately two to three hours in duration, under steady-state conditions. The acclimation runs were used to provide preliminary data for optimizing processing conditions prior to commencing the performance tests. Optimization focused on the TRM operation and included variations in the waste feed rate, mill speed, and sweep gas flow rate. System conditions downstream of the TRM, including the reactor, scrubbers, and flare, were constant throughout all acclimation and performance verification runs.

The tests conducted on November 18 and 19 (A1 and A2) were intended for optimization purposes only, and did not include sampling and analysis of all potential sample locations within the system. Run A3, conducted on November 20, provided a more complete set of data (including gas sampling locations), and was later included as part of the process evaluation (see Section 4.6.3). The overall actual test schedule is shown in Table 4-35.

Table 4-35
SAIC/Eco Logic Test Program Schedule

Date	Test Day	Run No.	Test Description
11/18/96	1	A1	Acclimation/Optimization runs
11/19/96	2	A2	Acclimation/Optimization runs
11/20/96	3	A3	See Note
11/23/96	4	P1	Verification/Performance runs
11/24/96	5	P2	Verification/Performance runs
11/25/96	6	P3	Verification/Performance runs

Note: Run A3 was intended as an acclimation/optimization run but was later used in conjunction with performance data to provide a larger data set for evaluating overall process performance.

The test program was originally envisioned to occur over a seven-day period. This was anticipated to include two days of acclimation testing and five days of performance testsing. However, initial difficulties experienced by SAIC/Eco Logic during the acclimation testing extended the acclimation testing with three days remaining for performance testing. Continuing difficulties with the unit ultimately shortened the test program to 3 days of acclimation testing and 3 days of performance testing. SAIC/Eco Logic was also afforded a brief "rest" period between the acclimation and performance test phase to disassemble the TRM and examine the inner workings to ensure continuous operations during the performance tests.

Performance runs (P1, P2, and P3) were conducted on November 23, 24, and 25, 1996 to determine the ability of the pilot scale system to meet the study objectives. During each test, detailed sampling and analyses were performed on input sediment, treated solids, and scrubber water. Gas samples were collected

for all performance tests. Specific details on the gas sampling program are presented in the TRC report which is included in the Data Compendium.

It was originally anticipated that data would be formally evaluated for the performance runs only. However, the TRM experienced mechanical difficulties during run P3. Because of the operational difficulties, P3 data was not expected to represent optimal operating conditions It was therefore determined that, based on the relative thoroughness of the data from run A3, this data could be used in addition to the performance runs to evaluate process performance. Data from run P3 was also included in the overall evaluation. The mechanical difficulties associated with this run are further discussed below.

4.6.2.2 Pilot Scale Test Conditions

After the first two acclimation runs (A1 and A2), operating conditions were held constant throughout the remaining acclimation and performance runs (A3 and P1 through P3). Each run day commenced with a brief health and safety meeting followed by a two hour set-up period. This procedure included a system pressure and leak check, instrument calibration, preparation of scrubber solutions and bringing hydrogen concentration and heating zones to optimum operating conditions. Waste processing operations commenced once optimum conditions were reached and ranged from five to eight hours in duration. After waste processing was halted, the system was shut-down and samples were collected. This procedure required approximately two hours. The SAIC/Eco Logic report included in the Data Compendium includes the manual operator logs for system start-up, operation and shut-down for all acclimation and performance runs. The manual logs were collected for system conditions every ten minutes of operation. In addition, an automated datalogger was programmed for on-line continuous monitoring of various parameters, including system temperatures, bulk gas concentrations and trace gas concentrations. System conditions for run A3 and the performance runs are summarized in Table 4-36.

TRM Operation

Sediment was loaded into the TRM in pre-weighed batches. The piston feed system was manually turned to deliver two kilograms of waste per hour to the TRM ball mill. The total amount of waste processed for each batch ranged from 9.7 to 17.3 kilograms, depending on the total run duration which ranged from five to eight hours. The TRM was operated in a hydrogen atmosphere with tin bath temperatures for the test runs ranging from 627°C to 639°C. Once sediment processing was complete, the unprocessed sediment was recovered from the feed system and weighed to determine the total amount of sediment processed. Treated sediment, recovered from the TRM catch pot, was weighed and sampled.

Reactor System

The reactor was operated at temperatures for the test runs ranging from 910°C to 939°C. The reactor was designed to ensure a residence time of at least 1.5 seconds for the destruction of the organic contaminants. The system operating pressure was slightly positive and the hydrogen content was maintained in excess of 97 percent throughout all test runs.

Through their experience gained in treating a variety of wastes, Eco Logic has determined that 55 percent is the minimum concentration of hydrogen required for the reactor to ensure complete destruction of the waste. The concentration of hydrogen in the pilot-scale reactor during treatment of New Bedford Harbor sediment was well above (approximately 97 percent) that required. However, this was necessary to ensure

adequate gas flows through the entire system and to allow collection of gas samples after the scrubber system. The excess hydrogen does not adversely affect, nor does it enhance, the reduction reactions, i.e., there is a hydrogen threshold beyond which the destruction efficiency of the process is not affected.

Table 4-36
SAIC/Eco Logic Test Program Operating Conditions

Parameter	Run No.			
	A3	P1	P2	P3
Date:	11/20/96	11/23/96	11/24/96	11/25/96
Start Time:	11:10	9:25	9:10	9:05
Stop Time:	16:00	14:30	15:10	17:10
Total Test Duration (min):	290	305	360	485
Waste Solids (kg):				
Input Waste (wet solids)	9.7	10.3	11.3	17.3
Recovered Solids (dry solids)	4.4	2.1	3.0	4.1
Scrubber Water Volume (L):				
Pre-Run	70	70	70	70
Post-Run	76	76	77	80
System Temperatures (°C):				
TRM - Tin	627	636	629	639
Reactor Flame	786	829	783	823
Reactor Exit	912	916	939	910
Scrubber 1	28	26	27	29
Scrubber 2	15	14	13	15
Product Gas	10	10	6.6	13
Flare Inlet	574	613	738	741
Flare Outlet	669	714	835	848
Product Gas Concentration (%):				
Carbon Monoxide	1.39	1.98	1.66	1.66
Methane	2.12	0.47	0.39	0.34
Hydrogen	97.9	98.1	97.4	98.4
Oxygen	0.0	0.0	0.0	0.0

Scrubber System

The scrubbers were designed with both top and middle spray inputs to ensure thorough wetting and reaction with the product gas. The flow of the product gas was concurrent for the first scrubber and counter-current for the second scrubber. The solutions within each scrubber were continuously circulated from the solution

tank through the gas chamber. The scrubbers were equipped with cooling water jackets to ensure sufficient heat removal from the scrubbing solutions and to facilitate condensation of the water component of the product gas. The scrubbers contained a caustic (sodium hydroxide) solution for the removal of hydrogen sulfide and hydrochloric acid.

During system set-up prior to each test run, the scrubbers were charged with 35 liters of fresh caustic solution. The solutions were periodically checked and maintained at pH 10 by adding concentrated caustic when necessary. The temperature of the first scrubber solution ranged from 26°C to 29°C and the temperature of the second scrubber solution ranged from 13°C to 15°C. The product gas exiting the second scrubber was approximately 10°C. At the completion of each test run, the scrubber solutions were sampled and discharged to a 40-gallon drum. The combined scrubber solutions were allowed to settle overnight and were then filtered through GAC and sampled after this tertiary treatment.

Excess Gas Burner

The gas exiting the second scrubber was tested using the on-line instruments, compressed, and then temporarily stored in a tank prior to being released to a vertical gas flare. The excess gas burner chamber was propane fired and operated at temperatures ranging from 669°C to 848°C.

4.6.2.3 Sampling and Analysis

Sampling and analysis was conducted to ensure that appropriate data were available at the completion of the study to allow an evaluation of the process with regard to the objectives of the program. This Section provides an overview of the analytical program and summarizes the samples collected and associated analytical parameters.

Field Measurements

Throughout sediment processing, specific operating parameters were monitored and recorded both manually and using the automated datalogger. The data collected included the following:

- temperature of the TRM tin bath
- temperature of the reactor
- temperature and pH of the scrubber solutions
- temperature of process gas
- temperature of excess gas flare
- manual recording of sediment, hydrogen, nitrogen and propane flows
- mass of sediment input
- mass of treated sediment recovered
- test duration
- process gas monitoring for oxygen content and destruction products
- chemical analysis of input sediment, treated sediment, pre- and post-test scrubber solutions, and process gas

On-Line Instrument Analysis

The scrubbed product gas was continuously monitored using an on-line chemical ionization mass spectrometer (CIMS). The CIMS monitored ten organic compounds every few seconds at concentrations ranging from percent levels down to ppb levels. The CIMS was used as part of the Eco Logic process to monitor the concentrations of certain compounds indicative of the process destruction efficiency. SAIC/Eco Logic also used a micro-GC to analyze for benzene and monochlorobenzene (discussed below) and NOVA analyzers to measure for oxygen, hydrogen, methane, carbon monoxide, and carbon dioxide.

Chemical Ionization Mass Spectrometer (CIMS)

The CIMS was used to continuously monitor the product gas as it exited the second scrubber and before it was compressed. The CIMS is the first indicator of destruction efficiency and allowed the operator to immediately identify conditions causing reduced destruction efficiency, before the gas is sent to the product gas storage tank.

The CIMS is a single quadrupole ionization mass spectrometer capable of monitoring, continuously displaying, and recording organic compounds at concentrations down to the low parts per billion range. As many as ten compounds can be selected for analysis as indicators of organic destruction efficiency. Therefore the system can be tuned to be waste-specific. Decreases in destruction efficiency, as indicated by continuous product gas monitoring, automatically trigger system alarms.

The indicator compounds selected for monitoring by the CIMS depend on the character of the wastes being processed. For this Hot Spot sediment pilot study, where PCBs were the primary contaminant, monochlorobenzene was the primary compound monitored as an indicator of destruction efficiency. (The chemical reduction of a PCB molecule generates monochlorobenzene as a final step before complete dechlorination to benzene). The low concentration of monochlorobenzene in the product gas was used by SAIC/Eco Logic as an indication that PCB destruction was proceeding to completion. The CIMS continuously monitors and records the concentration of monochlorobenzene in the gas. In this manner, the CIMS provides a permanent record of reactor performance.

During the testing, an increase in monochlorobenzene concentration in the product gas would have automatically triggered a process control alarm. This alarm was not triggered at any time during the pilot-testing. Benzene concentrations were also monitored to provide an indication of process efficiency. Toluene and hydrogen sulfide concentrations were also monitored.

Micro Gas Chromatograph (Micro-GC)

In addition to the CIMS, an on-line micro-GC was used to evaluate indicator compounds in the process, which provide an estimate of process performance. As with the CIMS, monochlorobenzene and benzene concentrations were measured. This on-line instrument was used to monitor the compressed product gas from the product gas storage tank to ensure that the gas sent to the excess gas flare did not contain levels of organic compounds above operating specifications. Target compounds were not detected above acceptable levels during the test runs.

The micro-GC is a self-contained miniaturized gas chromatograph equipped with a micro-machined injector system, microbore analytical and reference columns and a micro-machined solid state detector. This system

is capable of providing relatively accurate, high resolution gas analysis in seconds. The GC was calibrated using gas mixtures of known concentration. At each minute during destructor operations, a gas sample was collected in the sample loop and separated on the OV-1 microbore analytical column. Observed peaks were compared to the calibrated compounds and the concentration determined.

Nova Multi-Gas Analyzer

The gas composition in the system was carefully monitored to ensure that all the components necessary for the operation of the process were present. The levels of specific products of reduction are used to monitor the process and to demonstrate that the appropriate reactions are taking place in the reactor. A Nova Multi-Gas Analyzer was employed to monitor the concentrations of hydrogen, methane, carbon monoxide, and carbon dioxide in the gas exiting the scrubber and prior to the compressor. All of the gases except hydrogen are detected by a high precision infrared detector. Hydrogen was monitored by a temperature controlled thermal conductivity cell contained within the analyzer, compensated for carbon monoxide, carbon dioxide, and methane. The levels of bulk gases were consistent between the test runs, at levels which indicated that the treatment process was proceeding optimally.

Nova Oxygen Analyzer

As part of a comprehensive plan for the safe handling of hydrogen in a closed, heated vessel, the concentration of oxygen was monitored on a continuous basis. A Nova Oxygen Analyzer, equipped with an electrochemical cell, was used to sample the product gas exiting the scrubber prior to the compressor to ensure that there was no oxygen in the system. If oxygen had been detected above a specified limit, an alarm would have automatically alerted the operator to take the appropriate action. This alarm was never triggered. A backup analyzer was also kept on-site.

Off-Site Laboratory Analysis

Table 4-37 outlines the sampling and analytical program for the treatability study, designed to characterize the system inputs and outputs. Sampling locations are illustrated on the process flow diagram included as Figure 4-18. These analyses provided data for the determination of TRM desorption efficiency, system DRE, mass balance, as well as the fate of the inorganic contaminants.

Laboratory results and vent gas sample results are included in the Data Compendium. A discussion of the analytical methods and associated QC is included in Section 4.3.

4.6.3 Effectiveness Evaluation

The effectiveness of the Eco Logic pilot scale treatment unit on the Hot Spot sediment is discussed in the following subsections. The first subsection discusses process performance in terms of the analytical results for the various outputs from the process. The second subsection discusses the materials balances for the pilot test. The results discussed in this section were used to develop the concepts for full-scale application discussed in Section 4.6.4. Where appropriate, the process is discussed as two processes, thermal desorption separately from chemical destruction. The process is also discussed as a single operation, based on the way the pilot test was performed.

Table 4-37
Sampling Locations and Analysis for the SAIC/Eco Logic Pilot Scale Test

Sample Location/Matrix	Sampling Technique	Parameters Analyzed	Test Run and Frequency
S1 screened hot spot sediment feed	composite grab collected from pre-designated buckets prior to waste processing	PCBs, SVOCs, metals, oil & grease, EOX, chloride and sulfate, pH, and % solids PCDD/PCDFs TCLP	All test runs in duplicate A3, P1, P2, and P3 P2 and P3
S6 treated solids	grab sample collected from TRM catch pot after waste processing complete	PCBs, SVOCs, metals, oil & grease, chloride and sulfate, pH, and % solids PCDD/PCDFs TCLP	P2, in duplicate P1 and P3; P2 in duplicate P1 in duplicate; P2 and P3
S4 scrubber effluent, pre-tertiary treatment	grab sample collected directly from scrubber after waste processing	PCBs, SVOCs, metal, PCDD/PCDFs, oil & grease, chloride and sulfate, pH, TSS, and TDS	P1, P2, and P3 in duplicate
S5 Scrubber effluent, post-tertiary treatment	grab sample collected after scrubber solution filtered through GAC	PCBs, SVOCs, metals, PCDD/PCDFs, oil & grease chloride and sulfate, pH, TSS, and TDS	P1, P2, and P3
S9 TRM off-gas to reactor	non-isokinetic sample collected of gas exiting TRM (M23 and M29)	PCB Isomers, PAHs, PCDD/PCDFs Metals Chloride Particulate	A3, P2, and P3 P1 and P3 P1 and P2 P2
S7 scrubbed product gas	non-isokinetic sample collected of gas exiting second scrubber (M23, M29, M26A)	PCB Isomers, PAHs, PCDD/PCDFs Metals Chloride and Particulate	A3 and P2 P1 and P3 P1, P2, and P3
S8 exhaust gas	Isokinetic sample of final hot vent gas effluent (M23, M29, M26A)	PCB Isomers, PAHs, PCDD/PCDFs Metal, chloride, benzene, and particulate	P1, P2, and P3 A3, P1, P2, and P3

4.6.3.1 Process Performance

Overall process performance is discussed in two segments the first being equipment performance and the second in terms of analytical results for the process outputs. Process mass balances and the effect on the evaluation process are discussed in Section 4.6.3.2.

Equipment Performance

During the pilot study, the pilot scale equipment and on-line instrumentation generally worked as anticipated. The effectiveness of the reactor and the vent gas treatment systems were measured quantitatively and are discussed in the following subsection. Several operational difficulties associated with the TRM were encountered during the test. These difficulties may have had a negative effect on the desorption efficiency of the TRM. The mechanical difficulties are summarized below. Desorption efficiencies are discussed in the following subsection.

- During TRM commissioning on-site, difficulties were experienced in heating the TRM to the appropriate temperature for waste processing. This was due to inadequate propane supply to the TRM burners, caused by the use of inappropriate regulators on the tanks, and compounded by low ambient temperatures. This problem was alleviated by replacing the propane tank regulators with those suitable for liquid propane tanks and capable of delivering adequate propane despite the low ambient temperatures.

- It was originally anticipated that SAIC/Eco Logic would process soil at a rate of approximately ten pounds per hour. However, data generated during the acclimation tests indicated lower than expected desorption efficiencies, which were thought to be due in part to inadequate residence time of the soil in the TRM. The throughput rate was decreased by half in order to increase the residence time and achieve improved desorption of organic contaminants. Factors other than throughput were also found to contribute to the lower desorption efficiencies.

- After the first acclimation run, the flow rate of hydrogen through the TRM was increased in an attempt to improve the desorption efficiencies. This caused an increase in particulate carryover into the TRM mill casing, but did not adversely affect the performance of the TRM. This problem may be mitigated in the full-scale TRM through the use of dust shrouds and purging of the dust shroud area during soil processing operations.

- Following the final performance run (P3), the TRM was dismantled and inspected. It was then discovered that the treated sediment auger had separated from the drive mechanism during the run. This was a result of slippage of the drive coupler on the shaft of the output solids auger. This resulted in treated sediment accumulating in the auger, possibly restricting gas flow through the system and limiting the rate of desorption in the TRM. The auger system was demonstrated in the earlier runs to successfully remove processed solids from the system. The problem encountered in the final run was mechanical and not attributed to an inherent design flaw.

- The carry-over of particulate into the mill casing caused displacement of the tin from the tin bath into the output solids collection pot. This was compounded by overfilling the tin bath in an effort to ensure sufficient tin for adequate heat transfer to the contaminated sediment. The larger

dimensions of the full-scale TRM and significantly larger amounts of tin would likely result in negligible impact from particulate carryover.

Eco Logic's commercial scale TRM is equipped with pairs of 8 inch feed augers that are intermeshed and reverse threaded to turn in opposite directions to prevent blockages. These augers feed into a 2-foot diameter opening that allows for a sufficient flow of gas to prevent concurrent flow of sediment and gas. This feed system was developed specifically for the commercial-scale TRM and was tested after fabrication and prior to transport to a site in St. Catharines, Ontario.

Analytical Results

Analytical results from the SAIC/Eco Logic pilot test are discussed in the following subsections. The results are discussed in two subsections, the first being the TRM and the second being the Eco Logic reactor. Additional detail for each batch is included in the SAIC/Eco Logic report included in the Data Compendium. The details of the vent gas sampling are included in TRC's report also included in the Data Compendium.

To evaluate the effectiveness of the SAIC/Eco Logic process, data from batches A3, P1, P2, and P3 were used. These data agreed well and appeared to be generally representative of the process. Acclimation batch A3 was not initially intended to be used for evaluation purposes. However, operating difficulties during batch P3 made it desirable to use a larger data set for overall evaluation. Because A3 was operated under essentially the same conditions as batches P1 and P2, it provided additional data useful for the overall evaluation. Each of the four batches was given equal weight in the evaluation process.

TRM Results

Sampling locations (S1 through S9) are illustrated on Figure 4-18 and described in more detail in Table 4-37. Table 4-38 summarizes average concentrations for feed and treated material data for the SAIC/Eco Logic pilot study. The tables include the averages from batches A3, P1, P2, and P3, where available. Data from each batch are included in the Data Compendium. In some cases, results were not available from each batch. For instance, vent gas samples could not be collected for each analysis during each batch due to sampling limitations time constraints. Available data are included in the calculated average.

Throughout this evaluation discussion, PCB Aroclor data for solid and aqueous samples are reported as the sum of the detected Aroclors (typically Aroclors 1242 and 1254). Total PCBs in the gas samples are reported as the sum of the detected isomers. Dioxin TEQs are calculated using International Toxic Equivalency Factors (I-TEF), assuming non-detect congeners were not present. This is consistent with Method 23 of 40 CFR Part 60, Appendix A. The total PAHs represent the sum of only those PAHs detected above the method reporting limit (values below the quantitation limit were not included). Only those semivolatile compounds detected above the method quantitation limit are included in the summary tables.

Table 4-38
SAIC/Eco Logic Analytical Results for Feed (S1) and Treated (S6) Sediment

Analyte	Feed Sediment Average (S1)	Treated Sediment Average (S6)
Total PCBs (mg/kg)	5,700	52
Dioxin and Furan (TEQ) (pg/g)	1,775	34
Dioxin and Furan (Total) (pg/g)	29,750	2,100
Semi Volatiles (mg/kg)		
1,4-Dichlorobenzene	19	0.4
Total PAHs (mg/kg)	16	1.2
Chloride (mg/kg)	17,500	7,525
Metal (mg/kg)		
Arsenic	12	7.3
Barium	160	168
Cadmium	15	6.3
Chromium	325	313
Copper	753	595
Lead	603	328
Mercury	0.95	0.17
Selenium	2.6	1.4
Silver	3.35	2.7
Zinc	1,925	1,400

Desorption Efficiency in TRM

Desorption efficiency is a measure of the effectiveness of the TRM to desorb PCBs, dioxins and furans from the sediment. This value was calculated as follows:

$$\text{Desorption Efficiency (\%)} = 100 \times \frac{[\text{concentration in untreated solids - concentration in treated solids}]}{\text{concentration in untreated solids}}$$

PCBs

Table 4-39 presents the desorption efficiencies calculated for PCB desorption from the Hot Spot sediment for A3 and each performance batch. In each test, greater than 98% of PCBs present in the sediments were desorbed using the TRM. This indicates that high levels of organic contaminants were removed from the sediment using this pilot-scale desorption technique. These desorption efficiencies were achieved with a single pass of the sediment through the TRM. Over the four runs, the concentration of PCBs in the treated solids ranged from 28 ppm to 77 ppm, with an average concentration of 52 ppm.

Table 4-39
PCB Desorption (Removal) Efficiency in TRM

Parameter	A3	P1	P2	P3
PCBs in Untreated Solids (ug/g)	6,400	4,700	5,000	6,700
PCBs in Treated Solids (ug/g)	31	77	28	72
Desorption Efficiency of PCBs (%)	99.52	98.36	99.44	98.93

TRM desorption efficiencies ranged from 98.36 to 99.52% and averaged 99.06%. In all test runs, the PCB levels in treated sediment were higher than SAIC/Eco Logic anticipated. The likely reasons for the higher than expected PCB concentrations in the treated sediments were the problems encountered with TRM. These difficulties included the sediment feed system for the TRM. SAIC/Eco Logic believe that intermittent plugging of the feed tube caused "squirting" of untreated sediment up the mill and reduced the effective TRM residence time. In addition, when waste plugged the end of the waste feed tube, the flow of gas out of the mill became restricted, causing hydrogen to flow around the mill instead of through the mill and decreased desorption efficiency. Water vapor produced at the feed end of the mill may also have caused condensation of PCBs on the treated sediments exiting the mill.

Dioxins and Furans (PCDDs and PCDFs)

Average dioxin and furan data are also presented in Table 4-38. TEQ values are provided in addition to total concentrations. The average concentration of dioxins and furans in treated solids was 2,100 pg/gm (parts per trillion). The TRM reduced the concentration of dioxins and furans in the sediment by approximately 93%. Desorption efficiency on a TEQ basis was approximately 98%, similar to the efficiency calculated for PCBs.

Results from the TRM were reviewed to evaluate the potential for PCB destruction within the TRM. Because the TRM operates at elevated temperatures in a hydrogen (reducing) atmosphere, the potential for PCB destruction exists. Similarly, as for any thermal treatment process, the possibility for the formation of dioxins and furans also exists and was evaluated. The evaluation of the TRM as a single operating unit was limited because sampling limitations precluded the collection of an isokinetic (flow representative) sample of the TRM off-gas (S9) location. Because of this sampling limitation, definitive conclusions regarding the characterization of the TRM off-gas cannot be drawn. However, the data were used to provide a summary level evaluation of the TRM performance with respect to PCB destruction and/or the potential for the formation of other organic compounds. The results of this evaluation are discussed below.

Available data for PCBs, dioxins and furans from sediment and the TRM off-gas are summarized in Table 4-40. Ratios of the off-gas to the input sediment are also included for comparison. Based on the data summarized in the table, it appears that the total mass of PCBs was reduced by the thermal desorption process. The total mass of dioxin and furan appears to have increased in two out of three of the batches, although the dioxin TEQ was increased in only one of the batches. In general, the mass of dioxin and furan increased with the decrease in PCB concentration, although the relationship does not appear to be linear.

Table 4-40
Comparison of Mass in Input From Sediment (S1-S6) and TRM Off-Gas (S9)

Parameter	A3 Input	A3 TRM Off-Gas	A3 Ratio Off-Gas to Input	P2 Input	P2 TRM Off-Gas	P2 Ratio Off-Gas to Input	P3 Input	P3 TRM Off-Gas	P3 Ratio Off-Gas to Input
PCB (mg)	25,000	1,100	0.044	23,000	7,300	0.317	46,000	19,000	0.413
Dioxin/furan (ng)	120,000	13,000	0.108	120,000	240,000	2.0	190,000	800,000	4.2
Dioxin TEQ (ng)	6,500	270	0.042	7,600	5,100	0.67	12,000	15,000	1.2

Results from each of the three batches were highly variable, as were the ratios of the mass output versus the mass input. This variability between batches is an indication that the sampling procedures were not truly representative of the process operation. However, the fact that during batches P2 and P3, PCBs at this location (S9) decreased in total mass, while the mass of dioxins and furans increased, is strong suggestive evidence that the results are not merely an artifact of sampling variability and that the thermal process has the potential to form dioxins and furans.

Given the sampling results and the known limitations of the TRM off-gas sampling location, these summary level results should be used for consideration only. Definitive conclusions regarding the extent of reduction of PCBs and the formation of dioxins and furans cannot be drawn. However, based on the available data, it does appear that the thermal process has the potential to produce dioxins and furans despite the hydrogen atmosphere inside of the TRM. To fully evaluate the process in terms of dioxin and furan production, additional testing must be conducted. Such testing would require a TRM off-gas sampling port that could be sampled isokinetically.

The dioxin TEQ values for the treated solids from batches A3, P1, P2, and P3 ranged from 19 to 48 pg/g (ppt). PCDD and PCDF levels in treated sediment were lower than the Universal Treatment Standards cited in 40 CFR 268.48, which list criteria of 1,000 pg/g for each of the tetrachlorinated through hexachlorinated PCDDs and PCDFs.

Other Contaminants of Concern

Results for other contaminants of concern are also summarized in Table 4-38. As expected for a process that treats PCB's dioxins and furans, other organic contaminants were also significantly removed in the thermal desorption process.

Results for inorganic parameters indicate that the inorganic composition of the sediment remains essentially unchanged with the notable exceptions of chloride, copper, and lead. These more volatile components were desorbed to some degree into the vent gas stream and treated in the scrubber system. Scrubber water results (see below) support this premise.

TCLP Results

Toxicity Characteristic Leaching Procedure (TCLP) results for untreated and treated sediment are provided in Table 4-41. TCLP analysis was utilized to evaluate the degree to which the thermal desorption process

may have altered the mobility and transport of contaminants, especially metals, as a result of treatment. Table 4-41 provides the average concentration of key contaminants in the leachate of the Hot Spot sediment and the treated solids compared to regulatory levels prescribed in 40 CFR 261.24.

Table 4-41
SAIC/Eco Logic TCLP Results for Feed (S1) and Treated (S6) Material

TCLP Analyte	Feed Sediment Average (S1)	Treated Sediment Average (S6)	TCLP Regulatory Limit
Total PCBs	27	0.6	NC
1,4-Dichlorobenzene	84.5	ND	7,500
Arsenic	22.5	ND	5,000
Barium	350	637	100,000
Cadmium	18	31	1,000
Chromium	21.5	11	5,000
Copper	50.5	2,450	NC
Lead	470	840	5,000
Mercury	ND	ND	200
Selenium	13	13	1,000
Silver	ND	ND	5,000
Zinc	8,250	4,100	NC

Results are reported in units of ug/L
ND = Not Detected
NC = No Criteria

Based on the available data, it appears that the thermal desorption process does increase the leachability (mobility) of certain heavy metals, particularly barium, cadmium and lead. The data in Table 4-41 suggests that copper leachability may also be increased as a result of the thermal desorption process. These TCLP copper results are inconsistent with those for the non-TCLP metal analysis (Table 4-38), suggesting a potential problem with the analytical methodology. Because copper is not a typical TCLP analyte (no regulatory criteria), it is likely that the laboratory methodology for TCLP copper is somewhat inaccurate. Should TCLP copper data be required for further quantitative assessment, additional investigations could be conducted on the appropriateness of the analytical methods. TCLP values for both the input waste and treated solids are below the regulatory criteria, indicating that the thermal desorption treatment does not cause the material to exhibit toxicity characteristics. Treated materials are not likely to require further treatment for metals.

The decreased levels of TCLP organic contaminants is attributed to their having been successful desorbed from the soil. The concentration of several metals in the leachate, such as arsenic, chromium, and zinc, decreased after treatment. This may indicate that these metals have either volatilized from the sediment during TRM processing or they have become more fixed to the treated solids and therefore less leachable.

Reactor Destruction Efficiency Results

To fully evaluate the potential for full scale implementation of this technology, it is useful to consider the destruction efficiency of the second stage of this process (chemical destruction) independently from the

thermal desorption unit. Unfortunately, sampling limitations associated with the pilot scale unit precluded the collection of truly representative vent gas samples before and after the Eco Logic process reactor and conclusive destruction efficiency cannot be reported. Despite these sampling limitations, a significant amount of data was generated that can be used to provide an overall assessment of the chemical destruction stage of this process. Average vent gas concentrations at the various sampling locations are summarized in Table 4-42. The sampling locations are illustrated on Figure 4-18.

Table 4-42
SAIC/Eco Logic Test Program
Chemical Characterization of Vent Gas Streams

Parameter	Untreated Vent Gas (S9) (Input to Reactor)	Treated Product Gas (S7) Exiting the Reactor/ Scrubber System	Treated Off-Gas (S8) Exiting the Thermal Oxidizer
Total PCBs (ug/dsm3)	546,667	1.2	0.11
Dioxin (TEQ) (pg/dsm3)	408,333	1.9	0.10
Dioxin (Total) (pg/dsm3)	21,400,000	189	26
Benzene (ug/dsm3)	NA	NA	9.6
Total PAHs (ug/dsm3)	105,667	53,000	5.3
Particulate (mg/dsm3)	5,700	37	6.68
Chloride (ug/dsm3)	4,900	51	ND
HC1 (ug/dsm3)	570,000	71	19
Metals (ug/dsm3)			
Arsenic	145	2.2	1.4
Cadmium	620	4.5	0.10
Chromium	6,650	431	21
Copper	7,150	9.3	3.2
Lead	6,700	51	2.2
Mercury	330	ND	ND
Zinc	52,000	185	25

NA = Not Analyzed
ND = Not Detected

Destruction Efficiency is the measure of the quantity of a contaminant input to the reactor which does not exit the system in the vent gas stream. It is calculated as follows:

$$\text{Destruction Efficiency (\%)} = 100 \times \frac{[\text{Mass of Contaminant into the system - Mass of Contaminant exiting the system}]}{\text{Mass of Contaminant into the system}}$$

Total contaminant mass input to the reactor can be calculated in two ways. The first being the total mass contributed to the reactor based on the input vent gas stream (S9). The second way to calculate the mass into the reactor is to calculate the mass desorbed from the input sediment (i.e., input sediment mass - treated sediment mass = mass desorbed).

Based on results from location S7, the combination of the reactor and the post-reactor scrubbers effectively reduces the concentration of PCBs, dioxins, furans, and metals in the off-gas. The results for each contaminant are discussed in more detail below. Scrubber water data (Table 4-43) support the conclusion that the reactor system destroys PCBs, dioxins, and furans.

Table 4-43
SAIC/Eco Logic Test Program
Chemical Characterization of Untreated (S4) and Treated (S5) Scrubber Water

Analyte	Untreated Scrubber Water Average (S4)	Treated Scrubber Water Average (S5)
Total PCBs (mg/L)	ND	ND
Dioxin (TEQ) (pg/L)	2.1	0.44
Dioxin (Total (pg/L)	970	63
Chlorinated benezenes (m/L)	ND	ND
Total PAHs (mg/L)	14	ND
Total Suspended Solids (mg/L)	587	28
Chloride (mg/L)	2,300	923
Metals (mg/L)		
Arsenic	ND	15
Barium	54	3
Cadmium	85	30
Chromium	57	11
Copper	907	78
Lead	1,540	318
Mercury	9.6	2.2
Selenium	ND	ND
Silver	3.4	1.6
Zinc	5,167	2,373

ND = Not Detected

PCBs

The reactor destruction efficiency, calculated using the TRM off-gas (S9) data for the input to the reactor and the scrubber off-gas (S7) as the output was 99.999%. As discussed above, samples were not collected isokinetically from either of these locations. Therefore, these results should be used as general estimates only.

Reactor efficiency calculated on the basis of the mass of PCB removed from sediment are summarized in Table 4-44. The data included in this table were calculated using the results obtained downstream of the off-gas thermal oxidizer unit (S8). These samples were collected isokinetically and, therefore, the data are likely to be more accurate than from the S7 sampling location. In addition, the results from S8 give a more accurate description of the reactor and off-gas treatment system as an operating unit as opposed to the S7 location which was located before the thermal oxidizer. As shown in Table 4-42, the difference between the S7 and S8 locations indicates that the thermal oxidizer unit provides some treatment of PCBs and other organics. The average destruction efficiency calculated using sediment data (Table 4-44) was 99.99989, slightly less than the 99.9999 (6 nines) typically required for incinerator operations.

Table 4-44
PCB DRE Based on Input Solids (S1-S6) and Exhaust Gas (S8)

Parameter	A3	P1	P2	P3
Total Mass of PCB Input Sediment (mg)	25,000	19,000	23,000	46,000
Total Mass of PCB Out (Exhaust Gas) (mg)	0	0.026	0.0023	0.13
Destruction Efficiency (%)	100.0000	99.99986	99.99999	99.99972

The difference in Destruction Efficiency (99.999 vs. 99.99989) is dependent upon the calculation method used (i.e., TRM off-gas (S9) versus sediment data (S1 minus S6)). Again, the difference in the mass balance of organic contaminants between the Hot Spot feed sediment data and the TRM off-gas (S9) data is responsible for the difference in these two Destruction Efficiencies. It is somewhat possible that the elevated temperatures of the TRM, in conjunction with the hydrogen atmosphere, destroyed some of the PCBs during the desorption process. In theory, this could account for the lower total mass calculated from the TRM off-gas results. In either event, it is clear that the reactor was very efficient in destroying the PCBs that were separated during the thermal desorption step.

Dioxins and Furans

Reactor destruction efficiencies for dioxins and furans were calculated using the same process as described for PCBs. Calculations were performed on a total mass basis and on a TEQ basis. The average of available results are summarized in Tables 4-45 and 4-46. Note that each sampling location could not be sampled during each batch due to sampling limitations.

Table 4-45
PCDD/PCDF Destruction Efficiency
Based on Input Solids (S1-S6) and Exhaust Gas (S8)

Parameter	Average
Efficiency Calculated on a Total PCDD/F Mass Basis	
Total Mass Input from Sediment (ng)	137,500
Total Mass Out (Exhaust Gas) (ng)	9.6
Destruction Efficiency (%)	99.9923
Efficiency Calculated on Dioxin TEQ Basis	
Total Mass of Input from Sediment (ng)	8,400
Total Mass Out (Exhaust Gas) (ng)	0.034
Destruction Efficiency (%)	99.99959

Dioxin and furan emissions from the thermal oxidizer outlet were approximately 15 pg/hr at a TEQ concentration of approximately 0.10 pg/dsm^3. With dispersion from the stack, ambient concentrations at the perimeter of the site are expected to meet the DEP ambient air guideline of 0.045 pg/m^3 TEQ.

Table 4-46
PCDD/PCDF Destruction Efficiency
Based on TRM Off-Gas (S9) versus Product Gas (S7)

Parameter	Average
Efficiency Calculated on a Total PCDD/F Mass Basis	
Total Mass from TRM Off-Gas (ng)	126,500
Total Mass Out (Product Gas) (ng)	2.5
Destruction Efficiency (%)	99.9948
Efficiency Calculated on Dioxin TEQ Basis	
Total Mass from Input TRM Off-Gas (ng)	2,685
Total Mass Out (Product Gas) (ng)	0.0245
Destruction Efficiency (%)	99.9993

Benzene

Sufficient data are available both historically and from this pilot program to conclude that benzene is a by-product of the reactor process. The concentration of benzene in the reactor off-gas was measured using the on-line instrumentation and is reported in the SAIC/Eco Logic report included as in the Data Compendium. Benzene data for the thermal oxidizer off-gas is given in Table 4-42. In addition to benzene, relatively low concentrations of other organic contaminants, primarily naphthalene, remain in the post-reactor vent gas (S7). The benzene and other organic contaminants are further treated using thermal oxidation. Samples collected following the thermal oxidization unit (S8) were collected isokinetically and are expected to be representative of the effluent vent gas from the SAIC/Eco Logic system. The data from S8 are included in Table 4-42. Comparison of S8 benzene concentrations with real time monitoring data (see Eco Logic report included in the Data Compendium) indicate that benzene concentrations are significantly reduced by the thermal oxidation process.

The average detected concentration of benzene was 9.6 ug/per dry standard cubic meter (dsm^3). The ambient air criteria for benzene in the State of Massachusetts are as follows:

Threshold Effects Exposure Limit (TEL) (24-hour average)	1.74 ug/m^3
Allowable Ambient Limit (AAL) (annual average)	0.12 ug/m^3

The levels detected during the test runs are stack gas levels, and can only be compared to ambient air criteria through consideration of the dispersion which takes place between the stack and the receptor (ambient air) location. The two most important factors in dispersion modeling are stack height and rate of gas flow out of the stack. Dispersion factors calculated for two of Eco Logic's commercial-scale operations show that concentrations are dispersed approximately 1,000 to 10,000 times, depending on the dispersion model used. To reduce the stack gas levels of benzene in the New Bedford Harbor test runs to reach AAL criteria, only about 5 to 100 times dispersion is required. Therefore, the levels detected during pilot-scale test runs are likely to be within acceptable limits.

The benzene data collected from pilot-scale testing will allow for the design of a suitably sized boiler/catalytic steam reformer stack which will ensure adequate dispersion of benzene at commercial-scale. This design will also account for the fact that in commercial-scale operations, benzene is removed in the

scrubber wash oil leg (SWOL), and that product gas is mixed with natural gas or propane prior to being used as boiler fuel, both of which will ultimately minimize the amount of benzene in the exhaust gas.

Semivolatiles

Table 4-42 presents total PAH vent gas concentrations, which were calculated by summing only those Toxic Compound List PAHs detected above the reporting limit.

The PAHs detected in post-reactor (S7) samples were primarily naphthalene, with minor amounts of acenaphthylene, phenanthrene and 2-methylnaphthalene. The presence of these compounds can be directly attributed to post-reactor condensation reactions. These are known by-products of the Eco Logic Process, which at commercial-scale are recovered primarily with solids from the scrubber filtration system and in the scrubber wash oil leg (SWOL) which removes PAHs from the gas stream.

Data from pilot-scale testing at the New Bedford Harbor site confirms that GAC treatment removes naphthalene and other PAHs from the scrubber water. (See Table 4-43). Naphthalene remaining in the product gas after scrubbing was combusted in the excess gas flare to near analytical detection limits during the pilot-scale testing program.

4.6.3.2 Material Balances

Mass Balance Closure (MBC) for a particular substance is defined as the deviation from perfect closure, as follows:

$$\text{MBC (\%)} = 100 \times \frac{\text{(total mass in input streams - total mass in out put streams)}}{\text{(total mass in-put streams)}}$$

The MBC is zero percent for perfect closure (i.e. inputs are equal to outputs). If the MBC is positive, then the measured inputs are greater than the measured outputs; if it is negative, the measured outputs are greater than the measured inputs. The MBC thus expresses the deviation from perfect closure.

Solids Mass Balance

Solids mass balance results are provided in Table 4-47. The solids mass balance closure calculations were based on calculation of the dry solids in the feed and the solids recovered from the treated solids catch pot and scrubbers. The measured wet feed weight was multiplied by the percent solids value to arrive at a weight of dry feed solids. The treated solids were calculated by adding the recovered weight of solids in the catch pot and an allowance for unrecovered solids remaining in the TRM, which was estimated at 500 grams for each run. This estimate was based on visual inspection of material recovered when cleaning the TRM, but could not be quantified due to the method of recovery.

Table 4-47
SAIC/Eco Logic Solids Mass Balance Closure

Solids Balance (Dry Basis)	A3	B2	B3
Mass In (g/min)	13	13	12	14
Mass Out (g/min)	17	8.7	9.8	9.6
Mass Balance Closure (%)	-32	33	20	30

The weight of solids exiting the process in the stack gas was relatively low, as indicated by particulate levels in Table 4-42. The sampling location most representative of particulate release to the atmosphere is S8. This sampling location was just prior to release of the off-gas to the atmosphere and the samples were collected isokinetically. As noted earlier, the sampling at S9 and S7 was not conducted isokinetically and some error is associated with these measurements. There may have been other areas, however, where solids hang-up occurred but where it was difficult or impossible to recover without completely dismantling the equipment after each run. These areas include the TRM, the piping between the TRM and reactor, the reactor, and the treated solids auger.

The mass balance closure results were -32, 33, 20, and 30% for tests A3, P1, P2 and P3, respectively. It appears that the solids mass balance closure for run A3 is an outlier and that, in general, less solids were recovered from the TRM than were input. As discussed above, this indicates that some solids remain in the TRM from one run to the next. The poor mass balance results are attributed to the operational difficulties experienced by the pilot scale TRM.

Fate of Metals

Table 4-48 provides the total mass of metals input to the system and recovered in treated solids, scrubber water and exhaust gas, for each test run. For the treated solids data, the total mass of the sample was calculated to be 95% of the dry weight untreated sediment input, which accounts for the loss of approximately 5% of the mass due to volatilization of cellulosic material. This approach assumes the solids which were not recovered were treated in the same manner as the recovered solids, and eliminates any error associated with the missing material.

Table 4-48
Mass of Metals Input to System and Recovered

	Input		Recovered		
Metal	Feed Sediment Average (S1)	Treated Sediment Average (S6)	Treatment Scrubber Water Average S4	Off-Gas Average (S8)	Percent Recovered
Arsenic	58	36	ND	0.0028	61%
Barium	788	763	4.2	NA	97%
Cadmium	73	30	6.8	0.00019	51%
Chromium	1,575	1,483	4.4	0.042	94%
Copper	3,650	2,800	71	0.0062	79%
Lead	2,950	1,525	120	0.0043	56%
Mercury	4.6	0.8	0.74	ND	34%
Selenium	11	9.2	ND	NA	84%
Silver	16	12	0.27	NA	78%
Zinc	9,200	6.575	403	0.049	76%

Results are reported in units of milligrams (mg)

NA = Not Analyzed
ND = Not Detected

The greatest portion of input metals were recovered from the treated solids. Data from the less volatile metals (barium, chromium, copper and zinc) gave recoveries of greater than 75% indicating that correcting for the lost solids is appropriate. Data for the more volatile metals (arsenic, cadmium, and lead) indicate that these metals are volatilized into the vent gas. Scrubber water data do not fully support this premises. However, it is likely that, due to the high level of particulate in the scrubber water, the sample collected and/or analyzed was not fully representative of the concentration of particulate and/or metals.

4.6.4 SAIC/Eco Logic Full-Scale Application

The following subsections discuss potential full scale application of thermal desorption and gas phase chemical reduction as a means for treating the Hot Spot sediment. The section begins with an overview of related full scale work that has been conducted by Eco Logic as they have developed their technology process and equipment over the past ten or so years. Much of this information has been taken directly from their report and so the claims of success are, by in large, theirs. These claims were not independently verified by Foster Wheeler.

The discussion of potential full scale treatment of the Hot Spot sediments includes an overview of the treatment system components and their operation, the estimated time to fabricate and deliver a treatment unit to the New Bedford site, the estimated cost to treat the 18,000 tons of Hot Spot sediment, a discussion of the unit's potential operational hazards and potential site specific and/or technological limitations for the process.

In much of this section, the Eco Logic process is discussed as a combination of thermal desorption and gas phase chemical destruction as the treatability study was conducted. It is important to consider that the processes could be operated separately as well. If considered separately, the thermal desorption process could be used to produce a semi-solid oil product, similar to that produced by the solvent extraction process. Similarly, the oil from the solvent extraction process could be vaporized and subsequently treated using the gas phase reactor. In addition, it should be noted that the technical approach and cost estimate have been modified by Foster Wheeler to reflect our evaluation of the treatment equipment during the pilot scale test and our engineering judgment based on direct experience with implementing innovative technologies in general, and at Superfund sites.

4.6.4.1 Eco Logic Full Scale Experience

Since 1986, Eco Logic has conducted extensive research, development, test evaluation, and product engineering with the aim of developing an efficient, non-incineration technology for destroying organic wastes in a wide range of matrices including sediment, soil, leachate, sludge, bulk solids, and high and low strength liquids. Much of this work was supported by the governments of Canada (Environment Canada and the Department of National Defense) and the United States (EPA).

The technology has been demonstrated and proven to be an efficient and publicly acceptable means of destroying high strength organic waste streams on-site. Development of the Eco Logic process has progressed to the point where commercial scale units are currently treating hazardous wastes at a site in Kwinana, Western Australia and at General Motors of Canada Limited in St. Catharines, Ontario. Details of these current commercial scale operations are briefly summarized below.

Kwinana, Western Australia

The first SE25 ELI Destructor is currently operational in Kwinana, Western Australia, where contracts for the destruction and recycling of pesticide residuals and PCB-contaminated electrical equipment have been awarded. Results of both DDT and PCB testing are included in Table 4-49.

Table 4-49
Stack Test Data for Commercial-Scale treatment of DDT and PCBs

Parameter	DDT *Quantity*	PCBs *Quantity*
Input:		
Duration of Run	81 minutes	110 minutes
Feed	127.5 L	122 L
Concentration	30.3 %	90 %
Mass Input	39.7915 kg	142.74 kg
Output:		
Gas Flowrate	0.76 m^3/sec	0.601 m^3/sec
Concentration	1.7 g/Nm^3	<0.72 μg/m^3
Mass Output	0.00000628 kg	0.00000187 kg
DRE	99.999984 %	99.999998%
DRE = 100 x (mass input - mass output) / mass input		

A compliance testing program overseen by the representatives of the Western Australian Department of Environmental Protection was conducted while processing PCB oils. An independent stack sampling company performed stack gas sampling at the catalytic steam reformer/boiler stack for PCB and semi-volatile analyses, and all analyses were conducted by an independent laboratory. No PCBs were detected in the stack gas, and detected semi-volatile compounds were at concentrations well below air emission guidelines. Based on a detection limit of 0.72 μg/m^3 for PCBs, the destruction removal efficiency (DRE) was calculated to be 99.999998 percent (seven nines). This same unit is now being utilized to treat PCB-contaminated electrical equipment from various regions in Australia. An aerial overview of this site is presented in Exhibit 4-13.

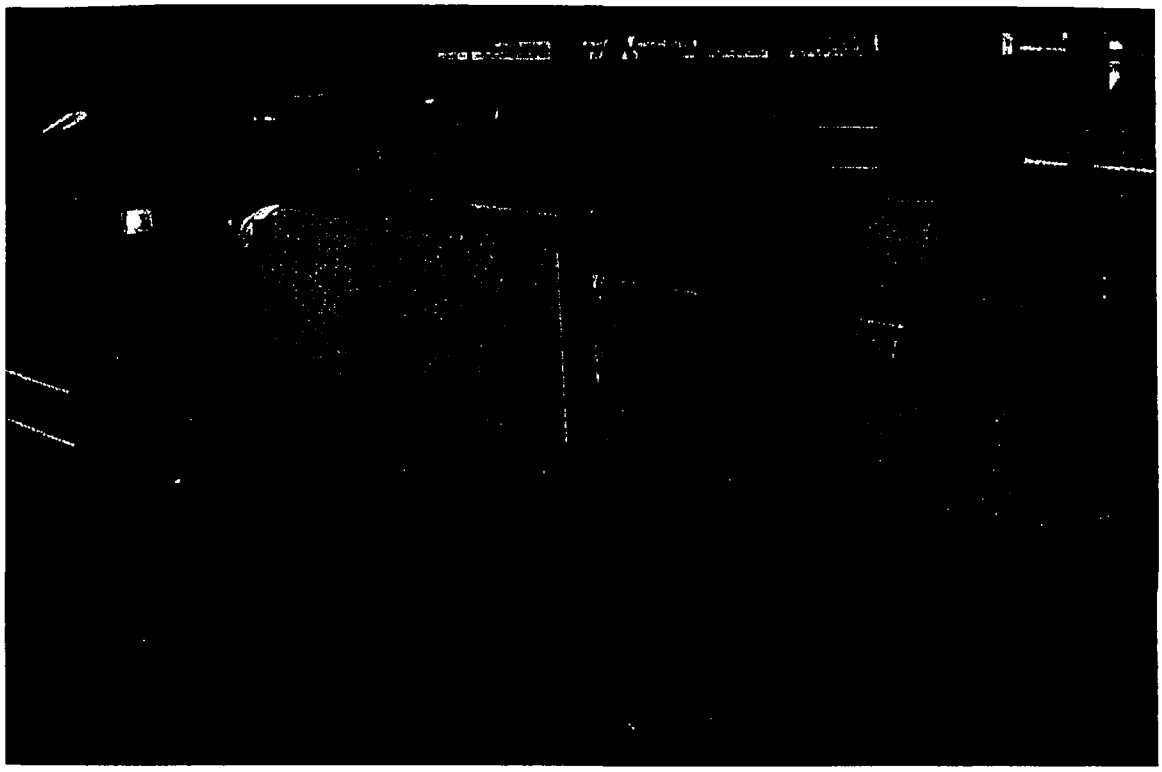
Exhibit 4-13
Ecologic Full-Scale Implementation at Kwinana, Western Australia

St. Catharines, Ontario

The second SE25 ELI Destructor is currently processing PCB-contaminated materials at the General Motors of Canada Limited (GMCL) facility in St. Catharines, Ontario. The contaminated matrices include soil, electrical equipment, askarel, concrete, and various other solid wastes including personal protective equipment and tools. GMCL has indicated that their remaining stored PCB inventory currently located at various facilities in Southern Ontario will be transported to St. Catharines for treatment. Photographs of the TRM and gas phase reactor at the St. Catharines site are presented as Exhibits 4-14 and 4-15, respectively.

Table 4-50 presents a summary of the DREs and destruction efficiencies (DEs) for PCBs and chlorobenzenes (CBs) from the performance testing program conducted at GMCL. Initial results for the treated material as well as ambient air indicate that the system is conforming to the guidelines set out by the Ontario MOE. Results of independent regulatory testing show that the Eco Logic treatment system consistently achieved a DRE of at least seven nines (99.99999 percent) for PCBs and at least six nines for CBs. This testing was conducted with the Eco Logic Sequential Batch Vaporizor (SBV) and the gas phase reactor.

Exhibit 4-14
Ecologic Full-Scale TRM

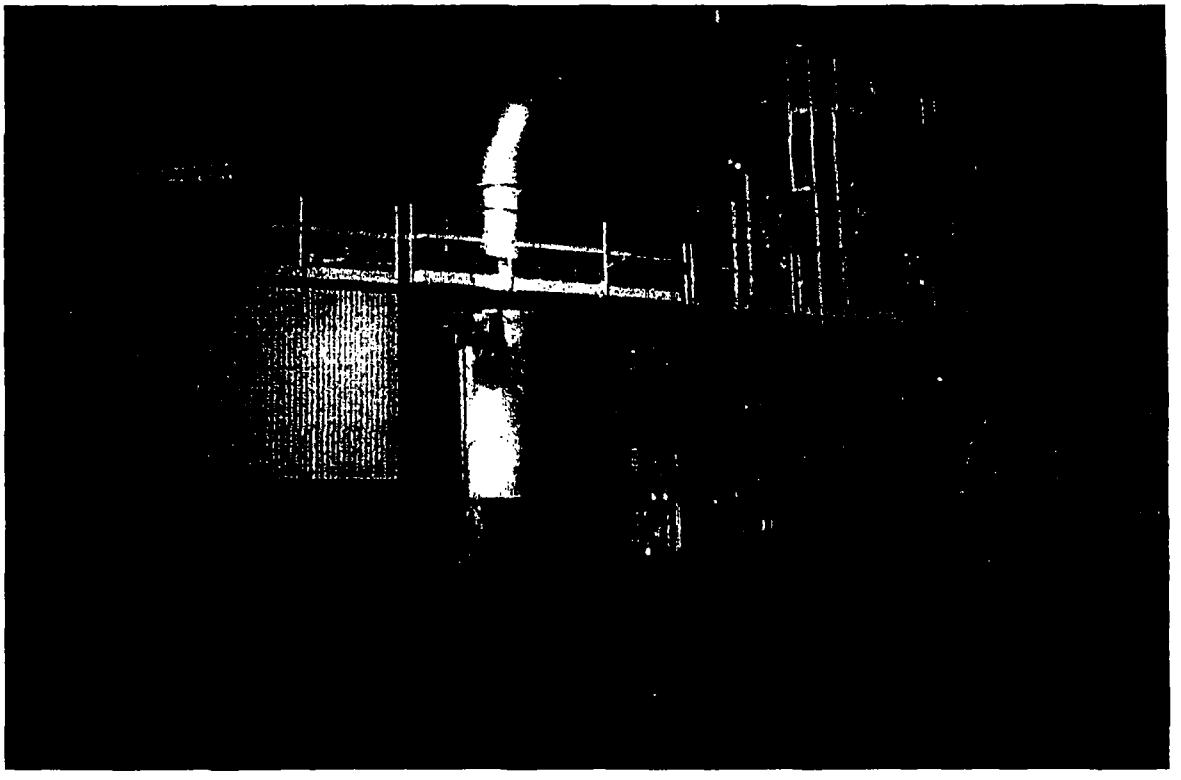


Eco Logic has also recently completed treating 1,500 tons of sediment type wastes that were contaminated with PCBs (referred to as settled solids) with the TRM and gas phase reactor. To date, Eco Logic reports that they have successfully treated these solids and have operated the TRM at throughput rates of up to 100 tons per day for several hours at a time. They also report that the process was effective in treating the settled solids from 170 ppm PCB to below single digit ppm range.

Table 4-50
Summary of DRE and DE Values for PCBs and CBs at GMCL

Parameter	*Units*	*Test 1*	*Test 2*	*Test 3*
DRE for PCBs	%	99.9999996	99.9999985	99.9999997
DRE for CBs	%	99.9999842	99.9999985	99.9999977
DE for PCBs	%	99.9999996	99.9999985	99.9999808
DE for CBs	%	99.9999836	99.9999972	99.9999971

Exhibit 4-15
Ecologic Full-Scale Reactor

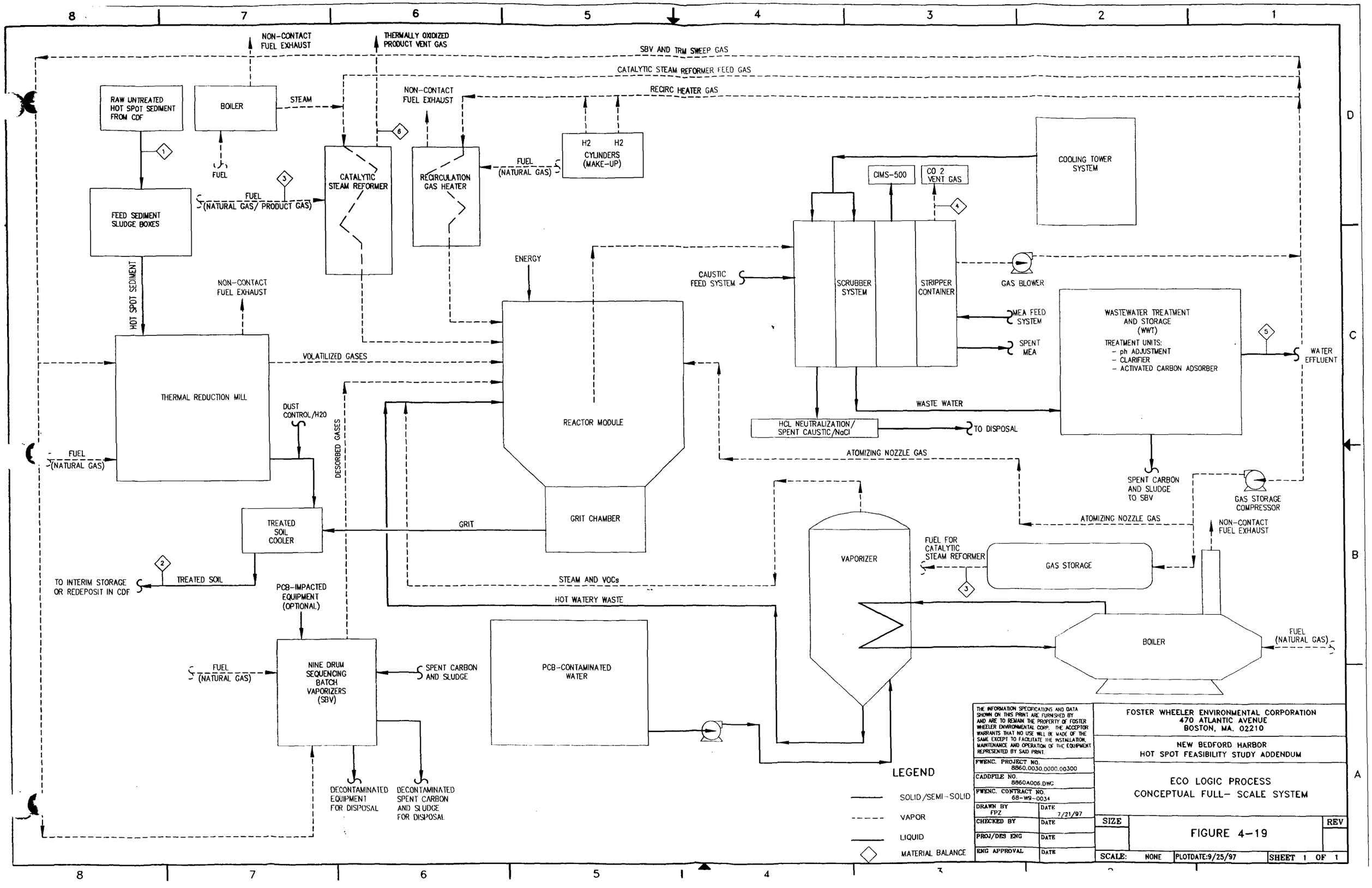


4.6.4.2 Conceptual Full-Scale Treatment System

The conceptual full-scale Eco Logic treatment system was developed based on over ten years of research, engineering, testing and full-scale application. The conceptual design also takes into account the results of the New Bedford Harbor Hot Spot treatability studies and the chemical/physical characteristics of the sediment. The system includes the TRM to separate the organic contaminants through thermal desorption and the gas phase reactor to complete the chemical destruction of the organic contaminants.

The methodology Eco Logic has used to scale-up the results of the pilot scale test to full-scale appear to be based largely on their overall experience in fabricating and operating full-scale treatment units. This would appear sufficient for the reactor system which has a much larger base of full-scale operating experience than does the TRM. As a result, full scale requirements for the TRM are not definitive and require further evaluation. Further details of the scale-up process proposed by Eco Logic are included in their report in the Data Compendium.

The conceptual full-scale Eco Logic treatment unit presented in Figure 4-19 is designed to operate 24 hours per day, seven days per week. The design capacity is 70 tons per day. The on-line factors used by Foster Wheeler in evaluating full-scale application was 60%, resulting in an estimated throughput of 42 tons per day of wet sediment. This on-line factor is based on an average of Eco Logic's projected factor of 80% and their performance during the pilot scale study which was at a throughput rate of 40%. Eco


NON-CONTACT FUEL EXHAUST
THERMALLY OXIDIZED PRODUCT VENT GAS
SBV AND TRM SWEEP GAS
CATALYTIC STEAM REFORMER FEED GAS
RECIRC HEATER GAS
RAW UNTREATED HOT SPOT SEDIMENT FROM CDF
BOILER
STEAM
NON-CONTACT FUEL EXHAUST
FUEL
FUEL (NATURAL GAS/ PRODUCT GAS)
CATALYTIC STEAM REFORMER
RECIRCULATION GAS HEATER
FUEL (NATURAL GAS)
H2 H2
CYLINDERS (MAKE-UP)
COOLING TOWER SYSTEM
CIMS-500
CO 2 VENT GAS
FEED SEDIMENT SLUDGE BOXES
HOT SPOT SEDIMENT
NON-CONTACT FUEL EXHAUST
ENERGY
CAUSTIC FEED SYSTEM
SCRUBBER SYSTEM
STRIPPER CONTAINER
GAS BLOWER
MEA FEED SYSTEM
SPENT MEA
WASTEWATER TREATMENT AND STORAGE (WWT)
TREATMENT UNITS:
- ph ADJUSTMENT
- CLARIFIER
- ACTIVATED CARBON ADSORBER
WATER EFFLUENT
VOLATILIZED GASES
THERMAL REDUCTION MILL
DUST CONTROL/H20
DESORBED GASES
REACTOR MODULE
WASTE WATER
HCL NEUTRALIZATION/ SPENT CAUSTIC/NaCl
TO DISPOSAL
FUEL (NATURAL GAS)
ATOMIZING NOZZLE GAS
SPENT CARBON AND SLUDGE TO SBV
GAS STORAGE COMPRESSOR
TREATED SOIL COOLER
GRIT
GRIT CHAMBER
ATOMIZING NOZZLE GAS
NON-CONTACT FUEL EXHAUST
VAPORIZER
FUEL FOR CATALYTIC STEAM REFORMER
GAS STORAGE
TO INTERIM STORAGE OR REDEPOSIT IN CDF
TREATED SOIL
STEAM AND VOCs
PCB-IMPACTED EQUIPMENT (OPTIONAL)
HOT WATERY WASTE
BOILER
FUEL (NATURAL GAS)
FUEL (NATURAL GAS)
NINE DRUM SEQUENCING BATCH VAPORIZERS (SBV)
SPENT CARBON AND SLUDGE
PCB-CONTAMINATED WATER
DECONTAMINATED EQUIPMENT FOR DISPOSAL
DECONTAMINATED SPENT CARBON AND SLUDGE FOR DISPOSAL
LEGEND
SOLID/SEMI-SOLID
VAPOR
LIQUID
MATERIAL BALANCE
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CHECKED BY
DATE
PROJ/DES ENG
DATE
ENG APPROVAL
DATE
FOSTER WHEELER ENVIRONMENTAL CORPORATION
470 ATLANTIC AVENUE
BOSTON, MA. 02210
NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM
ECO LOGIC PROCESS
CONCEPTUAL FULL- SCALE SYSTEM
SIZE
REV
FIGURE 4-19
SCALE: NONE
PLOTDATE:9/25/97
SHEET 1 OF 1

Logic is continuing with the testing and development of a large scale TRM that was constructed and tested during 1996 and 1997. Hopefully this continued development will result in higher throughput rates as their overall process continues to mature.

Full-scale application of the process is discussed in terms of waste inputs, waste processing and process outputs. Again, additional detail is contained in the SAIC/Eco Logic report (Data Compendium).

Waste Inputs

Waste inputs for the Eco Logic process are described below. These are discussed as sediment feed which can be desorbed in the TRM and those waste inputs not suitable for processing in the TRM.

Input Sediment Waste Feed

Hot spot sediments would be treated in the Thermal Reduction Mill (TRM), with the desorbed contaminants being sent to the reactor through a separate port. The TRM would be designed to vaporize water and organic contaminants in the feed sediment while mechanically working the solids into a fine granular mixture for optimum desorption. The water vapor and organic contaminants volatilized from the sediment would be continuously swept into the reactor by a side stream of hydrogen-rich, hot recirculation gas.

Bulk Solid Wastes

Bulk solid wastes not appropriate for the TRM would be treated using a Sequencing Batch Vaporizer (SBV). The SBV is a large heated autoclave-type chamber. Organic contaminants contained in the material treated are volatilized and the resultant organic vapors swept directly into the reactor by the hydrogen-rich hot recirculation gas. Examples of material suitable for SBV treatment include personal protective equipment (PPE), and oversized material screened from the sediment. The SBV can also be used to regenerate spent activated carbon.

Liquid Organic Wastes

Liquid wastes can be directly injected into the reactor through a series of nozzles to atomize the liquid waste. Potential wastes that could be treated through this method include PCB contaminated transformer oils and other highly concentrated liquid wastes.

Waste Processing

The various input streams to the reactor including vaporized liquid wastes as well as gas streams from the TRM and SBV, would be injected through several ports mounted tangentially near the top of the reactor. Special nozzles would be used to atomize liquid wastes to accelerate liquid vaporization. The gas mixture swirls around a central stainless steel tube, and is heated by 18 vertical radiant tube heaters with internal electric heating elements. By the time the gas drops to the bottom of the reactor, the gas mixture reaches a temperature of at least 850°C. The process reactions take place from the bottom of the central tube onwards, and take less than one second to complete.

Product gas leaving the reactor would be scrubbed to remove water, heat, fine particulate, HCl, aromatic compounds and carbon dioxide. The first stage of the scrubber (Scrubber Acid Leg - SAL) can be operated

to recover hydrochloric acid, which avoids acid neutralization with caustic. If the waste stream is heavily chlorinated, the acid can usually be recycled, and generation of large volumes of salty waste water requiring treatment and discharge can be avoided. For low strength waste, such as New Bedford Harbor sediment, hydrochloric acid recovery is not economically feasible. In this case, the SAL would be modified by the addition of extra spray nozzles to enhance particulate scrubbing. Further particulate and acid polishing are accomplished in the second scrubber stage. It was demonstrated at pilot-scale that atomizing spray nozzles are effective in controlling particulate levels in the gas stream. During the demonstration, it was observed that the first scrubber solution was dark in color after processing, and the second scrubber solution was clear. This suggests that the majority of particulate was successfully collected in the first scrubber.

The second stage of scrubbing drops the temperature of the gas to remove water and completes the removal of HCl by caustic packed tower scrubbing (Scrubber Weak Acid Caustic Leg -SWACL). Particulate matter (which may have entered the reactor as dissolved or suspended solids in the original waste) is removed in both the first and second stages of the scrubber by continuous filtering. Heat is removed using plate heat exchangers and is transferred to the cooling water system.

The third stage of scrubbing removes low levels of benzene and naphthalene from the gas stream by neutral oil washing (Scrubber Wash Oil Leg - SWOL). The rich oil is pumped to a stripper where benzene and naphthalene are removed and sent to the inlet of the catalytic steam reformer for conversion to hydrogen and carbon dioxide. The fourth scrubbing stage removes carbon dioxide using monoethanolamine (MEA) absorption (Scrubber Monoethanolamine Leg - SMEAL). The rich MEA is pumped to a stripper where the carbon dioxide is removed and is sent to the common boiler/catalytic steam reformer stack.

The scrubber water from the stage-two scrubber leg returns to the covered section of the scrubber tank through a drop-tube that extends well below the water surface. This acts as a seal against air infiltration and as an emergency pressure relief mechanism. There will be no gas release if a short-term pressure surge forces gas out of the bottom of this tube since a check valve allows the gas to re-enter the system once the pressure returns to normal. The entire treatment loop operates within 1 psi of atmospheric pressure.

As waste is processed through the system, acid and water are generated as outputs. Filtered acid is pumped to a storage tank for further activated carbon treatment prior to recycling. Scrubber decant water is also filtered and carbon-treated to remove organic contamination, and is then stored for analysis prior to discharge. Spent activated carbon can be regenerated on-site in the SBV, and the minor amount of scrubber particulate can also be processed through the TRM or SBV.

The cooled and scrubbed reaction gas is a clean dry mixture of hydrogen, methane, carbon monoxide, and other light hydrocarbons. Some of the reaction gas is reheated and recirculated back into the reactor. Reaction gas is also recirculated through the TRM and/or the SBV as sweep gas, and through the catalytic steam reformer for hydrogen generation. Excess reaction gas is removed from the system, compressed, and stored. This stored "product gas" is chemically tested and subsequently used as fuel to heat ancillary system components.

Figure 4-19 presents a process schematic of the entire system, including the TRM, the SE25 reactor and ancillary technologies. Most of the system components are mounted on standard-bed highway trailers for ease of mobility. The reactor trailer houses the reactor, the electric heating control system, the scrubber system, the recirculation gas blower, the recirculation gas heater and the watery waste preheater vessel. A second trailer contains the main power distribution room, the boiler and the catalytic steam reformer. Gas

cooling capacity for the scrubbing system is recirculated through evaporative coolers, and scrubber stripping operations are carried out in a container situated near the boiler. The product gas compression and storage system is also skid-mounted to allow flexibility in site layout. For processing soils and other solids, the TRM is housed on a separate trailer and the SBVs are skid-mounted units. The process control system, gas analyzer systems, and the command center are housed in a standard office trailer.

Process Outputs

The primary outputs from the treatment of PCBs in sediment are the treated solids, scrubber water, hydrochloric acid and product gas.

Treated solids

Sediment treated in the TRM would be recovered and wetted so as to cool the material for handling and reduce the potential for dust emissions. The treated material would be generated at a rate as low as 50% of the input mass due to losses of water, organic contaminants, and carbon. Treated sediment would be chemically tested for waste-specific contaminants to verify the adequate removal of organic contaminants. After analysis verified that the material was treated to cleanup levels, it would be transported to the on-site storage or disposal area. The treated sediment is expected to be a fine, inert, silica-rich material. Because of the design of the Eco Logic process, no caustic would be added to the sediment during treatment. Therefore, the treated sediment will be of average pH and salinity which does not prohibit development of plant life. The treated sediment would likely be disposed of in a CDF on-site.

Water

During normal operations, water is generated as scrubber decant water, which may contain trace levels of low molecular weight hydrocarbons (benzene and naphthalene) and metals. The water will be treated with granular activated carbon (GAC) and solids filtration, stored on-site, and tested to ensure compliance with local POTW discharge limitations prior to discharge to the municipal sewer system. Alternately, the treated process water can be re-used on-site in the evaporative coolers. Water collected from the spill pad sump can be managed in the same manner at the New Bedford Harbor site. SAIC/Eco Logic estimate that approximately 10,000 gallons per day of treated scrubber water will require discharge on-site or to the municipal sewer system.

Hydrochloric Acid

Moderate strength hydrochloric acid (approximately 25% acid by weight) is generated during normal operations. The acid is subjected to GAC filtration to remove trace levels of benzene and naphthalene. The acid is stored on-site until testing demonstrates compliance with relevant criteria. Because of the relatively low chlorine content of the New Bedford Harbor Hot Spot sediments, relatively low amounts of hydrochloric acid are expected to be generated and the scrubbed acid can be neutralized with caustic and discharged as salty wastewater to the municipal sewer system.

Product Gas

Excess product gas is generated during the destruction of PCBs and other organic contaminants, and would be recycled to the catalytic steam reformer to generate hydrogen to feed the reactor and TRM or would be

compressed and subsequently used on-site as fuel to heat the system steam boiler and catalytic steam reformer. Hydrocarbon levels obtained from stack sampling of product gas combusted in an excess gas flare during the pilot-scale testing program at New Bedford Harbor site indicate that local air standards can be achieved with the more sophisticated gas cleaning system of the commercial-scale system.

The approximate product gas composition for commercial-scale operations is as follows: hydrogen (65%), methane (25%), and carbon monoxide (approximately 10%), with trace amounts of lighter organic compounds (e.g., ethylene and benzene). Because PCBs, PCDDs/PCDFs and other semi-volatile compounds of interest cannot be measured accurately in real-time, the product gas is continuously tested (once per minute) for compounds indicative of incomplete destruction such as monochlorobenzene, using an on-line gas chromatograph (GC) following temporary storage. As part of standard operating procedure, the use of product gas as fuel is halted if the on-line GC detects monochlorobenzene concentrations in excess of 100 parts per million by volume (ppmv). Product gas is then diverted to a second storage tank, where it is reprocessed. Reprocessing of product gas has only been required on two or three occasions over the past two years of operating commercial-scale systems. In these cases, the processing of contaminated materials is halted and the product gas is recirculated until it meets established quality criteria as measured by the CIMS and micro-GC.

4.6.4.3 Technology Implementation Schedule

The technology implementation schedule included a number of components in addition to just treating the sediment. The schedule must incorporate the time to design and construct a full-scale treatment system capable of treating the Hot Spot sediments. Simply having a full-scale unit in existence may not be sufficient to meet the site-specific challenges that the Hot Spot sediment present. This was clearly demonstrated during the pilot scale testing program. In addition, the time to mobilize to the site, set-up the treatment unit skids and perform complete checkout/start-up activities must also be included. Finally, time must be included for decontamination and disassembly of the treatment equipment for demobilization.

For the Eco Logic process, Foster Wheeler has estimated the total time, including treatment, to be on the order of three years. This includes 12 to 15 months for design and construction of the treatment equipment; three months for mobilization and set-up/checkout activities; 15 months for treatment; and one month for decontamination and disassembly of the treatment equipment.

4.6.4.4 Technology Limitations

The process limitations are primarily associated with the TRM. Eco Logic has been operating full-scale reactor systems at several sites and has a base of successful operating data. However, the viability of the full-scale TRM to treat Hot Spot sediment has yet to be completely demonstrated. A commercial-scale TRM has been designed, fabricated and tested with clean sand for an extended period of time prior to transportation of the unit to General Motors of Canada Limited (GMCL) in St. Catharines, Ontario and subsequently processed 1,500 tons of PCB contaminated sediment over the past several months. Eco Logic also claims the TRM is scheduled to be used at a decommissioned General Electric Canada Inc. plant to process approximately 7,000 tons of PCB-contaminated soil currently stored above-ground. However, the schedule of this planned activity was unclear to Foster Wheeler at the time this document was prepared.

While the pilot-scale TRM did successfully desorb PCB's and other organics from the sediment, PCB concentrations in the treated sediments were substantially higher than expected, based on previous

treatability studies performed by Eco Logic on PCB-contaminated sediments. Potentially more concerning though was the constant string of mechanical difficulties which plagued the TRM throughout most of the pilot scale study.

The relatively low desorption efficiency of the pilot scale TRM may be directly related to mechanical and materials handling difficulties encountered during the treatability study test program. These difficulties include:

- Initial difficulties reaching the design operating temperature
- Sediment throughput at 40% of the design capacity
- Particulate buildup within desorption unit
- Loss of molten tin during treatment operations
- Mechanical breakdown of the exit system for solids

Elimination of these mechanical difficulties and the associated reduced throughputs should be able to overcome the lower than expected desorption with the appropriate design modifications. Prior to re-inventing the TRM, it may be possible for Eco Logic to investigate full-scale thermal desorption units that are available from other vendors. These units may provide better throughput rates and potentially better removal efficiencies. An important consideration in trying to co-mingle technologies is that the Eco Logic operates in a hydrogen atmosphere.

The other concept that must be kept in mind while evaluating the potential limitations of thermal desorption system is the formation of dioxins and furans. While it would appear that the hydrogen environment was effective in minimizing the formation of these compounds and the reactor system was effective in treating them, the data still suggest that these compounds are formed to some degree while treating the Hot Spot sediment. Again, it is important to note that only small quantities may have been formed and that the reactor treated most of this material.

4.6.4.5 Eco Logic Hazards Review (HAZOP)

This review is conceptual in scope because there are no detailed Process Flow Diagrams (PFDs), no detailed Piping and Instrumentation Diagrams (PIDs), operating instructions, etc. that exist to form the basis for an in depth HAZOP Review. Should implementation proceed at sometime in the future, such an indepth HAZOP Review would be performed. In summary, this Hazards Review highlights the main areas of concern to ensure these issues are factored into the overall evaluation of this technology.

Eco Logic Process Overview

The Eco Logic process employs hazardous operating conditions in the Thermal Reduction Mill (TRM) with an 590°C hydrogen and carbon monoxide atmosphere. The Reactor operates in a hydrogen and carbon monoxide atmosphere at 870°C. In addition, hydrogen is stored under high pressure. In the TRM the PCBs and dioxins are desorbed (volatilized) and sent to the Reactor where they are destroyed. Additional concerns include the escape of TRM gas containing PCBs and dioxins and the escape of reactor gas containing hydrochloric acid. Major issues of concern are the following:

- Release of gases with high hydrogen and carbon monoxide contents and high temperature from both the TRM and Reactor

- Release of hydrogen from the high pressure hydrogen storage vessels.
- Escape of TRM gas containing PCBs and dioxins and/or reactor gas containing HCl.

Hazards Analysis

Hazards associated with the Eco Logic process are discussed below. Hazards are discussed in terms of physical and chemical hazards as well as operating conditions and equipment failure.

Physical Hazards

The physical hazards that may be encountered are noise, exposure to the cold, heat stress, sharp surfaces, falling objects, lifting, electrical shock, and those associated with work near heavy and industrial equipment. Should implementation proceed, the Site Safety Officer, or alternate (SSO/alternate), would address activity-specific safety procedures to minimize the potential for injury associated with these hazards during full-scale operations.

Fire Exposure - Off-Site Fire

The Confined Disposal Facility site is well isolated from the surrounded development except for textile manufacturing activity opposite the site's frontage on Sawyer Street. The road is narrow and is a dead end; traffic appears rather low, limited to workers and deliveries to the manufacturing operations and the CDF. The potential for radiation from a significant building or vehicle fire activating relief valves on the hydrogen tube trailers or propane tank should be considered in siting this equipment. Installation of a sprinkler system should be considered to control equipment temperature.

Fire Exposure - On-Site Fire

Any leakage of hydrogen, gas/propane fuel, or in process gas, creates the potential for a fire. Possible ignition sources are propane burners for heating the TRM, steam generator, steam reformer, and electrical fault. Hydrogen leaking from a high pressure source may ignite if subjected to a spark or heat. Control of a gas fire should be by cutting off the supply of gas and allowing the fire to burn out. Block valves (possibly self closing on fire exposure) should be installed to permit isolation of equipment from all gas supply.

Chemical Hazards

The following materials associated with the process are hazardous because of toxicity and/or flammability:

Hydrogen
Propane
Carbon monoxide
Hydrochloric acid
Monoethanolamine
PCB's
Other toxic organics in the sediment
Heavy metals

Materials Handling

- Access to the Confined Disposal Facility by vehicles is along Sawyer Street, a narrow dead end road which may pose some difficulty for a hydrogen tube trailer. Frequency of delivery is not specified. Control of delivery time of day may be desirable. Praxair tube trailers range from 23-34 feet in length.

- The proposed use of an enclosed conveying system for sediment transfer appears desirable if adequate arrangements are made for safely venting any process gas leakage from the thermal reduction mill.

In-Process Material

The in process gas flows are hazardous. The total quantities of materials in the system are not given. The TRM appears to be the largest individual piece of equipment with an indicated volume of 245.7 cubic feet. Circulation of gas through the system is by a blower drawing recirculation gas from the scrubbing system and fresh material to supply pressure. Blower and compressor controls should protect against creation of a vacuum in the system which could lead to air infiltration.

Hazardous Operating Conditions

Operating temperatures in the TRM are 590°C and in the reactor, 870°C. Hydrogen is stored under high pressure. These conditions must be maintained and monitored to ensure safe operating conditions.

Performance Failure

Failure of the TRM to completely desorb the organics would lead to the discharge of contaminated solids which could be readily recycled without additional hazard. Failure of the Reactor to completely decompose the organics could lead to contamination of scrubber liquids; analytical checks should prevent additional hazard in handling/disposing of these liquids. Inadequate scrubber system performance could lead to emission of hazardous materials to the air. The provision of continuous analytical monitoring of the vent gas should adequately address this concern.

Utility Failure

Water is required to scrub and cool the gases exiting the reactor, cooling the treated soil discharged from the mill, and steam generation. It appears shutdown of the system following a supply failure would not create additional hazard. Interruption of electricity supply would prevent operation of the system with cooldown presenting the possibility of air infiltration, start-up purging procedures should be adequate without additional hazard.

Catastrophic Equipment Failure

Failure of any of the major pieces of equipment would likely lead to a complete release of the system's gaseous contents and fire. The TRM appears to be the piece of equipment most susceptible to failure since it rotates and is subject to a wide temperature range; maintaining a gas tight seal might be a problem and means of detecting leakage a desirable requirement. Provision of automatic excess flow valves in the

hydrogen supply and fuel supply systems (if not incorporated in supplier's equipment) should be considered.

Hazards Summary

The hydrogen and carbon monoxide gas concentrations, temperatures and hydrogen pressures experienced in the Eco Logic Process, are common operating conditions in the chemical and petro-chemical industries that produce commercial-grade hydrogen, methanol, ammonia and urea. Adapting these standard industrial practices to environmental remediation application is not a radical departure from proven technology.

4.6.4.6 Estimated Treatment Costs

The estimated costs to treat the 18,000 tons of Hot Spot sediment using the Eco Logic process are discussed in this section. The costs were projected on a throughput of 42 tons of wet sediment per day. This throughput rate is 60% of the treatment unit's 70 ton per day design. It is important to note that the estimate is for treatment of the sediments only, and does not include other support related efforts such as design, procurement, site facilities, sediment removal and treated material handling, and air monitoring. The cost estimates are based on input provided by SAIC/Eco Logic in their treatability study report (Data Compendium). Foster Wheeler has adjusted these estimates slightly in some areas to reflect our experience in implementing innovative treatment technologies at Superfund sites, and our overall engineering judgment.

The estimated treatment costs include several major categories including allocated capital costs such as design, fabrication and testing; permitting for the process; mobilization and demobilization, initial site testing of the technology (commissioning); and, treatment operations including labor, utilities and supplies. Two costing scenarios have been included for the Eco Logic process. The first scenario includes both treatment steps, thermal desorption to separate the contaminants and gas phase chemical destruction of the separated contaminants. The second scenario addresses potential application of the Eco Logic process to the oily waste extract produced by another separation process such as solvent extraction. Under this scenario, the 423 tons of extract are volatilized into the gas phase using the SBV and are subsequently treated in the gas phase reactor system. Each of these approaches are more fully discussed below.

Estimated Eco Logic Treatment Costs (Separation and Chemical Destruction)

The estimated costs for the Eco Logic process were developed based on 18,000 tons of Hot Spot sediment with a wet unit weight of 1.2 tons per cubic yard. This sediment would be provided to the Eco Logic process unit at anticipated rate of 42 tons per day. This treatment rate was lowered by Foster Wheeler from Eco Logic's estimate of 56 tons per day to reflect an overall on-line capacity of 60%. This on-line factor is on the low side for most commercial processes and is primarily attributed to the anticipated performance of the TRM, which if not operating properly, becomes a bottleneck for all treatment operations. The decision to use the 60% on-line factor was a balance between the positive aspects of Eco Logic's ongoing testing and development of their existing full scale TRM, and the operational difficulties they experienced during the Hot Spot treatability studies. During these studies, the Eco Logic pilot scale treatment unit only performed at 40% of the design capacity and experienced significant down-time.

The major cost components of the estimate include allocated capital costs; process permitting; mobilization; initial site testing or commissioning; treatment operations; and demobilization. The summary level costs for these items are presented in Table 4-51 and are discussed in more detail below.

Table 4-51
Estimated Treatment Costs for Eco Logic Process
Thermal Separation and Gas Phase Chemical Destruction

Activity	Estimated Cost
Capital (Allocated)	3,000,000
Permitting	100,000
Mobilization	1,810,000
Commissioning	290,000
Treatment Operations	5,239,000
Demobilization	675,000
Total Cost	**$11,114,000**
Cost Per Ton of Sediment (18,000 tons)	$617/ton

Allocated Capital Costs

Eco Logic typically amortizes the $10,400,000 cost of their treatment units over a five year period. To calculate the percentage of capital costs applicable to a potential cleanup of the Hot Spot sediments, the ratio of the time to complete a Hot Spot cleanup using the Eco Logic process, to the five year amortization period was multiplied by $10,400,000. The total project duration of 75 weeks results in an allocated capital cost of $3,000,000. The schedule estimate includes 61 weeks for treatment activities and 14 weeks for mobilization, commissioning and demobilization.

Permitting

Efforts under permitting include all efforts to obtain any federal, state or local permits that may be directly applicable to the treatment process and the associated reagents and process gases.

Mobilization

Mobilization costs include transportation and setup of the treatment equipment. Also included are costs to support hiring and training of local technicians and laborers to support treatment operations and the salary and living costs for company personnel.

Commissioning

The costs under this category are primarily associated with the efforts to completely test the treatment system. This will include a test of the individual system components and the operation of the overall system including the relevant safety systems.

Treatment Operations

The operations costs include all of the labor, utilities, reagents and process gases to treat the 18,000 tons of Hot Spot sediment over a 61 week period. Details of the operational costs are provided in Table 4-52.

Table 4-52
Estimated Operational Treatment Costs
Eco Logic Thermal Desorption and Gas Phase Destruction

Activity	Estimated Cost ($)
Personnel salaries, travel, accommodations	2,583,000
Electricity	1,291,000
Natural gas	144,000
Caustic	36,000
Wash oil	24,000
Monoethanolamine	24,000
Hydrogen	72,000
Nitrogen	72,000
Carbon Dioxide	12,000
Boiler chemicals, etc.	24,000
Calibration gases	12,000
Diesel fuel	12,000
Compressor and other oils	12,000
Personal protective equipment	287,000
Bag filters	48,000
Cartridge filters	48,000
Granule activated carbon	36,000
Miscellaneous parts and supplies	90,000
Equipment rental	215,000
Maintenance	179,000
Sewer and water	18,000
Total Operational Costs	$5,239,000
Operational Costs per Ton of Wet Sediment (18,000 tons)	$291/ton

Demobilization

The estimated costs for demobilization include the efforts to decontaminate the treatment system, disassemble the various pieces of treatment equipment for shipment off-site.

Estimated Eco Logic Treatment Costs (Gas Phase Chemical Destruction Only)

The estimated costs for this application of the Eco Logic process was developed to support 423 tons of oily extract generated through a separation process such as solvent extraction. The extract would be provided to the Eco Logic process unit at an anticipated rate of 3.2 tons per day. The conceptual

treatment approach would include heating the extract within the SBV and treating the resulting off-gas in the reactor system.

The major cost components of the estimate include allocated capital costs; process permitting; mobilization; initial site testing or commissioning; treatment operations; and demobilization. These are summarized in Table 4-53 discussed in more detail below.

Table 4-53
Estimated Operational Treatment Costs Eco Logic Gas Phase Chemical Destruction Only

Activity	Estimated Cost
Capital (Allocated)	1,085,000
Permitting	100,000
Mobilization	1,360,000
Commissioning	250,000
Treatment Operations	1,782,000
Demobilization	555,000
Total Cost	**$5,132,000**
Cost Per Ton of Extract (423 tons)	$12,132/ton

Allocated Capital Costs

Eco Logic typically amortizes the $8,550,000 cost of this potential application of their treatment unit over a five year period. To calculate the percentage of capital costs applicable to a potential cleanup of the Hot Spot sediments, the ratio of the time to complete treatment of the extract from the Hot Spot cleanup using the Eco Logic process, to the five year amortization period was multiplied by $8,550,000. The total project duration of 33 weeks results in an allocated capital cost of $1,085,000. The schedule estimate includes 19 weeks for treatment activities and 14 weeks for mobilization, commissioning and demobilization.

Mobilization/Commissioning/Demobilization

The costs for mobilization, commissioning and permitting are quite similar to those for the Eco Logic unit including the TRM and are discussed above.

Treatment Operations

The operational treatment costs presented above in Table 4-53 include similar components as the complete treatment process (Table 4-52). The difference in these costs is primarily due to the duration on site, 19 weeks for the SBV/reactor application to treat the 423 tons of oil extract as compared to 61 weeks for the TRM/reactor to treat 18,000 tons of sediment.

4.7 Bench Scale Stabilization Studies

In addition to the pilot scale studies described in the above section, a bench scale study was conducted to evaluate solidification and stabilization as a potential remedy for future consideration. The bench scale study is discussed and summarized in this section. A complete report on the bench scale tests including how they were conducted and the testing results is included in the Technical Memorandum provided in Appendix A. Supporting data and field notes are included as attachments to the Technical Memorandum. An outline of the overall test objectives is given below. The bench scale testing procedures are described in Section 4.7.1, the results of testing are discussed in Section 4.7.2, and the potential for full-scale application is discussed in Section 4.7.3.

Bench scale testing of the Hot Spot sediment was conducted primarily to determine whether solidification and/or stabilization (S/S) was a viable treatment process to consider for further testing. The objectives of the testing are summarized as follows:

- Evaluate and quantify the effectiveness of stabilization/solidification (S/S) technologies to immobilize the PCBs and heavy metals present in the contaminated material.

- Evaluate the potential for the S/S process to reduce the toxicity, mobility, or volume of the hazardous constituents.

The bench scale test was intended to determine whether the solidification/stabilization process was an option for consideration for treating the Hot Spot sediment directly from the CDF. In addition, solidification / stabilization was considered for stabilizing residuals from the treatment processes, should such residuals require additional treatment, especially for metals. Both the solvent extraction and thermal desorption processes have the potential to concentrate and/or mobilize metals during the treatment process. Such treatment residual may require additional treatment to reduce the leachability of metals.

4.7.1 Bench Scale Treatability Testing Elements

Foster Wheeler Environmental conducted the bench scale treatability testing of three solidification/stabilization admixtures to determine their effectiveness in immobilizing the PCBs and heavy metals present in the New Bedford Harbor Hot Spot sediments. The engineering and field execution aspects of the treatability study included the following activities:

- Conducting bench scale testing utilizing S/S reagents provided by two subcontractors. In addition to the S/S subcontracts, Foster Wheeler Environmental conducted an S/S evaluation using commercially available Portland cement as an admixture.

- Implementing the bench scale treatability studies as well as the sampling and analytical testing in accordance with the site-specific Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPjP).

- Compilation of the physical/chemical data gathered during the bench scale studies.

The following subsections discuss the untreated sediment, the stabilization admixtures and the testing process. Section 4.7.2 discusses the results of the testing in terms of overall effectiveness. Effectiveness was measured by the analytical testing of treated materials and by physical characteristics of the treated material.

4.7.1.1 Untreated Hot Spot Sediments

Sediment for the bench scale treatability study was manually removed from five locations in the CDF and placed in a wheelbarrow for mixing. The sediment was thoroughly mixed, sampled in duplicate for PCBs and then transferred to 5 gallon plastic buckets. PCB results for the samples collected from the wheelbarrow averaged approximately 12,000 ppm. This concentration was determined to be appropriate for the bench scale testing. Subsequently, a sample was collected from each of the five buckets that were to be used for the testing. Results for the samples from the five buckets ranged from 4,800 ppm to 18,800 and averaged approximately 10,000 ppm PCB.

4.7.1.2 Solidification/Stabilization Reagents

The following seven (7) admixtures from Foster Wheeler Environmental, MARCOR Environmental and World Environmental were utilized during the bench scale treatability study:

Foster Wheeler	MARCOR	World
Portland Cement	HWT-27	LPC II
Absorbent Clay		Clarion SM399
		Zoneco - P1
		OT - P2

A brief description of each reagent is provided in Appendix A. In general, the Portland cement and absorbent clay were commercially available materials used by Foster Wheeler to solidify the sediment. The MARCOR and World reagents were solid and liquid materials designed to bond with organic and inorganic contaminants in a resulting solid inert material.

4.7.1.3 Bench Scale Chemical and Compressive Strength Testing Procedures

On November 30 and December 4, 1995, bench scale treatability tests were conducted on the New Bedford Harbor Hot Spot sediments using S/S reagents supplied by Foster Wheeler Environmental, MARCOR and World. Each S/S reagent was added, mixed and cured in accordance with the instructions provided by each vendor. The proportions of each mix to the untreated sediment is described below. The details of the mixing and curing times are given in the Technical Memorandum provided in Appendix A.

Each group of reagents was mixed in three proportions (batches) to determine whether the proportion of reagents had an impact on the effectiveness results. Samples from each batch were analyzed for TCLP using both EPA Method 1311 and the steel cage method (40CFR, Part 268). The difference in the two methods is described in Section 4.3 and summarized in Section 4.7.2.1 below. Each mixture was analyzed in triplicate to provide an indication of the variability within the batch. In addition, each mixture was analyzed for compressive strength.

Portland Cement/Absorbent Clay

Foster Wheeler Environmental utilized a stabilization/solidification admixture consisting of Portland cement and an absorbent clay. Each reagent was added to the sediment in the following proportions:

Batch	Sediment	Portland Cement	Absorbent Clay
#1	3,000 g	600 g (20 %)	0 g
#2	3,000 g	600 g (20%)	75 g (2.5%)
#3	3,000 g	750 g (25%)	75 g (2.5%)

MARCOR Environmental

The MARCOR Environmental stabilization/solidification admixture was added in a slurry form at mix ratios of 12.5%, 17.5% and 25% (by weight) to 2,500 grams of sediment.

World Environmental

Three stabilization/solidification mixtures were recommended by World Environmental for the bench scale testing:

Batch	Sediment	LPC II	SM399	P1	P2
#1	2,000 g	360 g (18%)	40 g (2%)	40 g (2%)	0 g
#2	2,000 g	360 g (18%)	40 g (2%)	0 g	40 g (2%)
#3	2,000 g	300 g (15%)	40 g (2%)	20 g (1%)	0 g

The sediment and reagents were well mixed using an electric mixer. The resulting mixtures were transferred to glass jars and allowed to cure for more than 30 days. After the mixtures solidified, the jars were shipped to the laboratory for analysis. The laboratory was responsible for breaking the jar and analyzing the solidified product for TCLP analytes and compressive strength. The results of the testing are summarized in Section 4.7.2.

4.7.1.4 Bulking Factor Test Procedures

Bulking factor tests were conducted with the stabilization/solidification reagents utilized in the Bench Scale Treatability Studies for the Hot Spot sediments on December 13, 1995. The highest reagent ratio utilized during the Bench Scale Treatability Studies was used for the bulking factor tests. Using

sediment with a concentration of approximately 10,500 ppm PCBs and a moisture content of 40%, the reagents and sediment were mixed in the following proportions:

Foster Wheeler:	sediment	= 622 g
	2.5% Oil Dry	= 15 g
	25% Portland Cement	= 156 g
MARCOR:	sediment	= 610 g
	25% HWT-27 slurry	= 153 g
World:	sediment	= 646 g
	18% LPC II	= 116 g
	2% SM-399	= 13 g
	2% P1	= 13 g

The mixtures were measured for weight and volume and allowed to cure for 34 days. After the curing period, weight and volume were measured again. The results from the bulking factor tests are discussed in Section 4.7.2.4.

4.7.2 Effectiveness Evaluation

The results from solidification/stabilization testing are discussed in the following subsections. Effectiveness was measured in terms of the ability of the process to reduce the leachability of PCBs, other organics and metals and also in terms of the physical characteristics of the treated material. As discussed below, the results from the chemical testing were not favorable and this means of treatment is not likely to be pursued further. Accordingly, the physical testing of the treated material is somewhat inconsequential and is only briefly summarized below.

4.7.2.1 Chemical Analysis

Samples were collected of untreated sediment, stabilization/solidification (S/S) admixtures, make-up water, and the stabilized material. Sediment samples were analyzed for PCBs, TCL Semivolatiles (SVOCs), TAL metals and TPH to characterize the material prior to treatment. The samples were also analyzed for particle size and moisture content to determine bulking ratios and treatment handling requirements. Both the reagents and make-up water were analyzed for PCBs, SVOCs, and metals to ensure that these components were not contributing additional contamination to the sediment. None of these reagents were found to have significant concentrations of contaminants that would affect the results for the treated product.

To evaluate the overall effectiveness of stabilization/solidification, the feed sediment and treated material were analyzed in triplicate using the TCLP leaching procedure, EPA Method 1311. Treated material was also analyzed using the steel cage method. The steel cage procedure suspends the solidified material intact in the leachate solution, whereas the 1311 method requires that the sample be pulverized to pass through a 9.5 mm sieve before leaching. Both methods use an acidic leaching solution intended to simulate the natural leaching that would occur in a landfill situation. The TCLP leachates from both these methods were analyzed for PCBs, TCL SVOCs, and TAL metals. The analytical results for the TCLP analyses are summarized and discussed below.

TCLP (Method 1311) results for selected analytes are reported on Table 4-54 and are discussed below. A complete TCLP data set is included in Appendix A. Results from the routine TCLP leaching procedure, where the samples were pulverized prior to leaching, were chosen for this summary discussion. This routine leaching procedure was expected to be a more conservative measure of leachability than the steel cage, as the samples were physically pulverized prior to leaching. In fact, results from the steel cage leaching were not significantly different from the routine leaching results, with the exception of some metals results which suggest contamination from the cage material. Therefore, the routine TCLP (Method 1311) results were selected for this evaluation.

Table 4-54
Summary of Solidification/Stabilization TCLP Results

ANALYTE	TCLP Regulatory Limit	Untreated Sediment Average	Sample ID								
			MARCOR			Foster Wheeler			World		
			M1	M2	M3	FW1	FW2	FW3	W1	W2	W3
PCB	NC	11	49	38	46	27	33	45	43	25	30
1,4-DCB	7,500	102	127	82	94	173	153	88	92	97	122
Arsenic	5,000	54	18	7	8	3	3	3	3	3	11
Cadmium	1,000	147	131	133	35	ND	ND	ND	ND	ND	ND
Chromium	5,000	226	207	158	59	19	21	14	14	14	14
Copper	NC	161	706	798	688	731	726	820	1,353	1,340	1,497
Lead	5,000	1,630	964	393	67	2	4	6	3	2	7
Zinc	NC	18,050	18,307	20,933	10,235	13	17	61	14	9	16

Results are reported in units of ug/L
Results are the average of three replicate samples
NC = No Criteria
ND = Not Detected

TCLP PCBs

TCLP PCB data for the raw sediment and solidified materials are summarized in Table 4-54. No regulatory standard for TCLP PCB analysis is available, therefore, data are used for comparison purposes only. Untreated raw sediment PCB results were 11 ug/L (ppb) in the TCLP leachate solution. This is consistent with the results for the pilot study feed material, where the TCLP results for sediment with approximately 2,300 ppm PCBs gave a TCLP result of 15 ppb and sediment with an average PCB concentration of 5,700 ppm gave an average TCLP result of 27 ppb. Based on these ratios of untreated sediment results to TCLP results and assuming a linear relationship, maximum Hot Spot sediment concentrations of 200,000 ppm (see Section 2.2) would give a maximum TCLP PCB result of approximately 1.1 ppm (mg/L).

In summary, the high concentrations of PCBs in the sediment are not readily leachable using the TCLP process, presumably because the high concentration of oil and other organics in the sediment preferentially retain the PCBs rather than allowing them to dissolve in the acidic TCLP leachate solution.

TCLP PCB results for the solidified materials were higher than for the initial raw sediment for each group of stabilization materials. Average TCLP PCB results for stabilized material ranged from 25 to 49 ppb, double to greater than quadruple those found for the untreated sediment. Although the reason for the greater leachability in the treated material cannot be determined based on the limited available data, one possible reason is that the solidification process absorbs some of the oily, organic fraction of sediment making the PCBs more mobile in the aqueous phase. Based on these results, none of the stabilization/solidification mixes is an effective method of treating the PCBs in the Hot Spot sediment.

TCLP Metals

Results for selected TCLP metals in untreated and stabilized sediment are provided in Table 4-54. None of the TCLP metals results for untreated raw Hot Spot sediment approached the respective TCLP regulatory criteria. This is consistent with the pilot study feed material data (Section 2.2), where no sample results approached the TCLP criteria. The metal of greatest concern from a TCLP perspective was lead with a TCLP concentration of 1,630 ppb detected during this bench scale study. The regulatory criteria for lead is 5,000 ppb. TCLP lead results from the pilot study feed materials ranged from 470 ppb to 940 ppb, significantly less than the criteria.

Other metals of concern in the Hot Spot sediment included arsenic, cadmium, chromium, copper, and zinc. Solidification/stabilization does reduce the TCLP concentration of most of these metals of concern. Both the World Environmental and the Foster Wheeler Portland cement mixtures effectively reduced the TCLP concentrations of arsenic, cadmium, chromium, lead, and zinc. The MARCOR mixture was less effective at reducing the mobility of the metals.

All three S/S mixtures appear to result in an increased concentration of copper in the leachate solution, although the results from World Environmental were the highest. Copper is not included on the RCRA list of metals and has no associated regulatory criteria. Because the laboratory does not typically include copper in the TCLP analysis, the results for this analyte may be biased high due to laboratory error.

The Foster Wheeler prepared mixture of Portland cement and clay appears to be at least as or perhaps more effective at treating metals as the World mixtures. The MARCOR mixture appears to be less effective, based on the bench scale results.

In summary, the solidification/stabilization process may reduce the concentration of TCLP metals in the Hot Spot sediment. The raw, untreated Hot Spot sediment did not exceed criteria for TCLP metals. Therefore, in its current state in the CDF, Hot Spot sediment requires no further treatment for metals contamination. The results from the pilot scale tests indicate that treated product from the three tested technologies studies is also not likely to exceed TCLP metals criteria. However, it is possible that one of treatment technologies ultimately selected to treat the PCB contamination may provide a treated sediment material with increased mobility of metals. In the event that treated sediments require additional treatment for metals, it appears that solidification/stabilization might be a treatment technology for future consideration.

TCLP Semivolatiles

TCLP results for 1,4-dichlorobenzene (1,4-DCB) in untreated and solidified sediment are provided in Table 4-54. This was the only semivolatile compound with a TCLP regulatory criterion that was detected at significant concentrations during the leaching studies. Similar to the TCLP PCB results, solidification/stabilization does not appear to appreciably reduce the concentration of this semivolatile in the TCLP leachate.

Semivolatile concentrations in the Hot Spot sediment are somewhat inconsequential in comparison with the PCBs. They were considered in this evaluation in order to provide a complete review of the solidification stabilization process. TCLP semivolatile results for the untreated sediment do not approach the TCLP regulatory limit for semivolatiles and it is reasonable to presume that treated sediment resulting from a process that removes PCBs is not likely to exceed TCLP criteria for semivolatiles.

4.7.2.2 Unconfined Compressive Strength

In addition to the TCLP leaching procedures, the compressive strength of the treated material was also determined. The unconfined compressive strength data for each S/S admixture is provided in Table 4-55. Of the three admixtures tested, Portland cement provided the highest compressive strength and MARCOR provided the lowest compressive strength. The average compressive strength for Portland cement, MARCOR and World were 222 psi, 58 psi and 162 psi, respectively.

Table 4-55
Compressive Strength Data for the Solidification/Stabilization Testing

Process	Batch No.	Compressive Strength Batch Average (psi)	Process Average (psi)
Foster Wheeler	1	200	
	2	195	222
	3	270	
MARCOR Environmental	1	45	
	2	50	58
	3	80	
World Environmental	1	200	
	2	125	162
	3	160	

4.7.2.3 Mixing and Curing

All three admixtures mixed relatively easily with the Hot Spot sediments. The addition of Portland cement and World's reagents produced a slightly pasty mixture which could present some material handling difficulties at full scale. Since MARCOR's reagent was added in a slurry form, the resultant mixture was more fluid than the other two mixtures and may be slightly easier to handle on a full-scale.

After approximately one week of air curing, samples containing Portland cement and the World reagents had set up to a relatively hard material. However, the MARCOR samples were still soft and pliable. By the end of the 30 day curing period all the samples appeared dry and solid.

4.7.2.4 Bulking Factor Test

Based on the results of the bulking factor study, the MARCOR reagent provided the largest percentage decrease in weight (7.4 %) and volume (13 %). The least amount of reduction was observed in the samples prepared with Foster Wheeler Environmental's reagents, 1.14% and 0 % for weight and volume, respectively. The sediment treated with the World Environmental reagents had weight and volume decreases of 1.5 % and 4.5 %, respectively.

4.7.3 Solidification/Stabilization Full-Scale Applications Discussion

Based on the data obtained from the bench scale treatability study, it does not appear that stabilization/solidification is a viable treatment method for the Hot Spot sediments. At the mix ratios tested, the admixtures in most cases, increased the leachability of PCBs. A high reagent to sediment ratio may decrease the leachability of the PCBs, however, the treatment cost would also increase as well as the volume of material which must ultimately be disposed.

5. DEVELOPMENT OF ALTERNATIVES

5. DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

This section of the FS Addendum presents the development and screening of remedial alternatives to address the 15,000 cubic yards of contaminated Hot Spot sediment currently stored in the CDF. As an FS Addendum, the document does not develop remedial alternatives from ground zero. Rather, the remedial technologies and alternatives used the 1990 ROD and 1995 ESD to form the initial basis.

In summary, the development of remedial alternatives is based on the 1990 Hot Spot ROD and 1995 ESD, the results of the recently completed site specific treatability study program and the general development of remedial treatment technologies as they may have progressed over the past eight year period. It is also important to note that the treatability study program was explicitly designed to capture technology developments and improvements over the period since the original technology evaluation was completed. The treatability study test program was advertised on a national basis to ensure that all potential vendors of sediment/soil treatment technologies were aware of the opportunity to participate. This method of communicating with the vendor community was highly successful, as over sixty potential participants requested bid packages and multiple proposals were received. Additional details of the test program are provided in Section 4 of this document.

This section includes a summary of the remedial technologies identified and screened in the 1989 Hot Spot Feasibility Study (FS) and a description of how the results of the more recent site specific treatability studies modified the list of current candidate remedial technologies. The section also discusses the formulation of the remedial alternatives that will be evaluated in detail in Section 6 of this FS Addendum report.

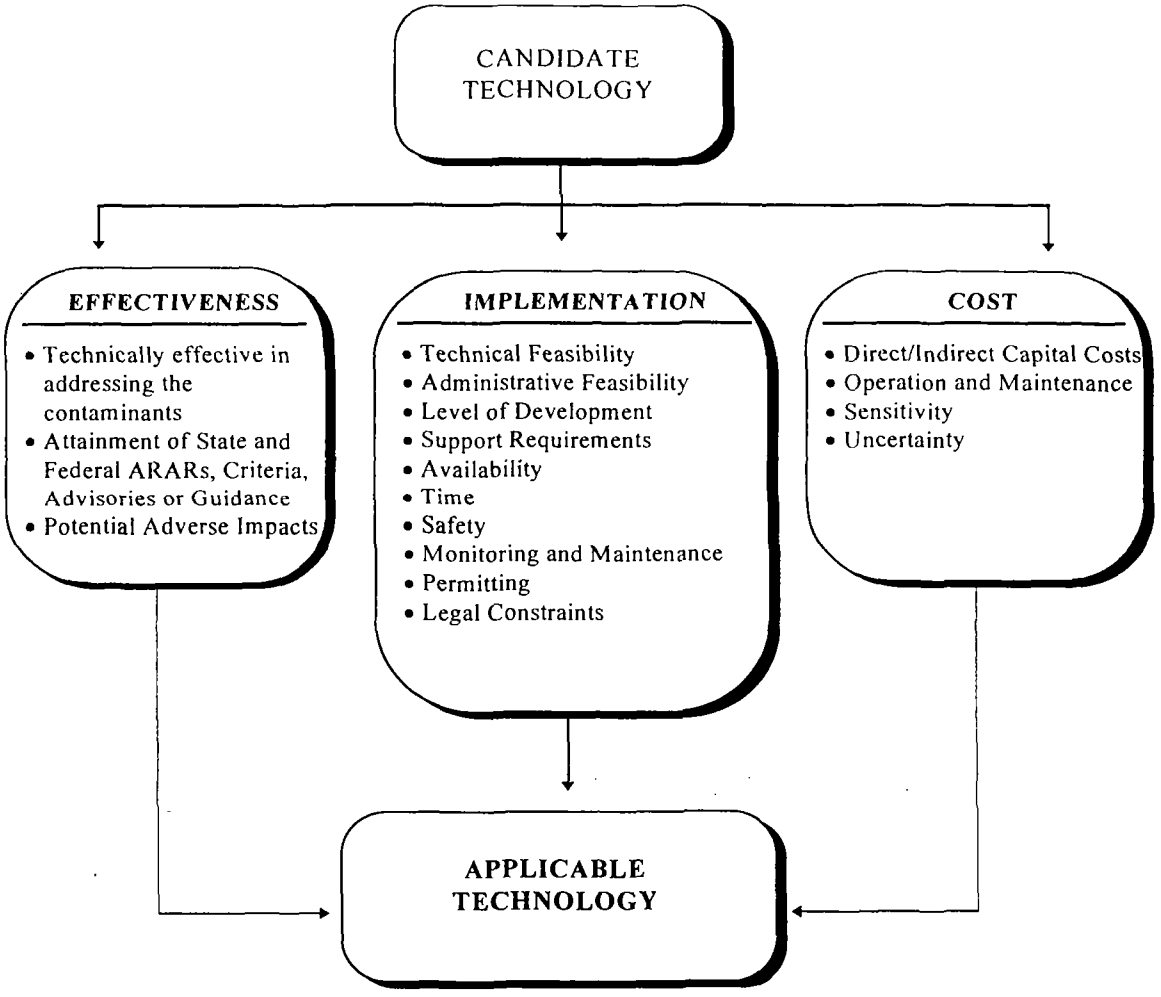
5.1 Remedial Technology Identification and Screening

This section provides a summary of the technology evaluation process used to prepare the 1989 Hot Spot FS. This 1989 FS report was a critical technical support document for the 1990 Hot Spot ROD. This section also provides an overview of the recently conducted treatability study program and how the results of this program have modified the list of technologies available to create complete remedial alternatives.

5.1.1 Hot Spot Remedial Technology Identification and Screening

The remedial alternatives presented in the 1989 Hot Spot FS were assembled from a comprehensive evaluation of remedial technologies. This evaluation included an extended literature search on the universe of potential technologies and performance results from a series of site specific treatability studies including both bench and pilot scale testing. Two of the technologies evaluated during the recently completed treatability study test program (solvent extraction and vitrification) were also involved in these earlier treatability studies. Much of the previous work in evaluating and screening potential remedial technologies for the Hot Spot sediment is chronicled in the Detailed Analysis of Remedial Technologies for the New Bedford Harbor Feasibility Study (Ebasco, 1987) and the Hot Spot Feasibility Study (Ebasco, 1989). These reports contain a detailed description of the treatment technologies and the three primary criteria used in the screening process. These criteria included effectiveness, implementability and cost. These three criteria and the different factors that were considered under each criterion are presented in Figure 5-1.

Figure 5-1
1989 Hot Spot FS Technology Evaluation Criteria (from Ebasco, 1989)



The overall technology evaluation process for the 1989 Hot Spot FS included over 100 potential technologies under four categories of general response actions for both sediment and water. These general response actions included removal, containment, treatment, and disposal. This range of response actions and the resulting technology types from the 1989 Hot Spot FS are presented in Figure 5-2. The list of individual technologies potentially applicable for treatment of sediment and water is presented in Table 5-1. Through a comprehensive screening and evaluation process that is presented in the 1989 Hot Spot FS, the list of technology types and process options were reduced to those presented in Figure 5-3. Under the general response action of treatment, several approaches were applicable including solvent extraction, incineration and solidification. The response action for disposal included two options, an off-site permitted disposal facility and shoreline disposal in a CDF. The technology included under the response action of containment was in-place capping. Also included as a possible response action was the no action approach. These technologies were later used in the development of the remedial alternatives in the 1989 Hot Spot FS.

It is important to note that the removal component for the Hot Spot sediments has already been completed. As such, any future consideration of remedial technologies and alternatives will address the Hot Spot sediment as it is currently stored in the CDF.

5.1.2 Recent Hot Spot Treatability Studies

A series of site specific treatability studies were conducted over the past two years to assist in evaluating the current state of remedial technologies potentially applicable to the Hot Spot sediment currently stored in the CDF. These studies were conducted to develop a critical understanding of effectiveness, implementability and cost for each technology. The treatability studies were conducted for two general approaches to treatment: (i) destruction of the contaminants; and, (ii) separation and destruction of the contaminants. The terminology associated with these approaches was developed by the forum group formed to enhance community participation in revising the ROD for the Hot Spot sediments. In this section of the report, the technologies tested are discussed under the technology types and process options originally used within the 1989 Hot Spot FS (e.g. physical, thermal, chemical, etc.). This was done to facilitate incorporation of the recent treatability study results within the existing body of FS work. The treatability study program and the results are discussed in detail within Section 4 of this report.

In summary, the treatability studies confirmed that several remedial technologies demonstrate the potential to treat the Hot Spot sediments. These technologies, by and large, treat the PCBs and other organic contaminants generally leaving the heavy metals in the treated solids. However, the treated solids pass TCLP testing and additional treatment steps do not appear to be necessary. The studies also demonstrated that one of the technologies originally retained for detailed analysis in the 1989 Hot Spot FS (solidification) was not effective in reducing the leaching of organic contaminants (PCBs) from the sediment and was therefore, eliminated from further consideration.

The results of the treatability study program provided several new treatment technologies to use in assembling remedial alternatives. These included thermal desorption, vitrification, chemical dechlorination with a metal reagent, and gas phase dechlorination. While the vitrification and chemical dechlorination technologies were initially considered in the 1989 Hot Spot FS, they were not included in the development of the remedial alternatives due to concerns regarding potential materials handling difficulties and availability of commercial process equipment. It is interesting to note that both

Figure 5-2
1989 Hot Spot FS Range of Potential Response Actions (Ebasco, 1989)

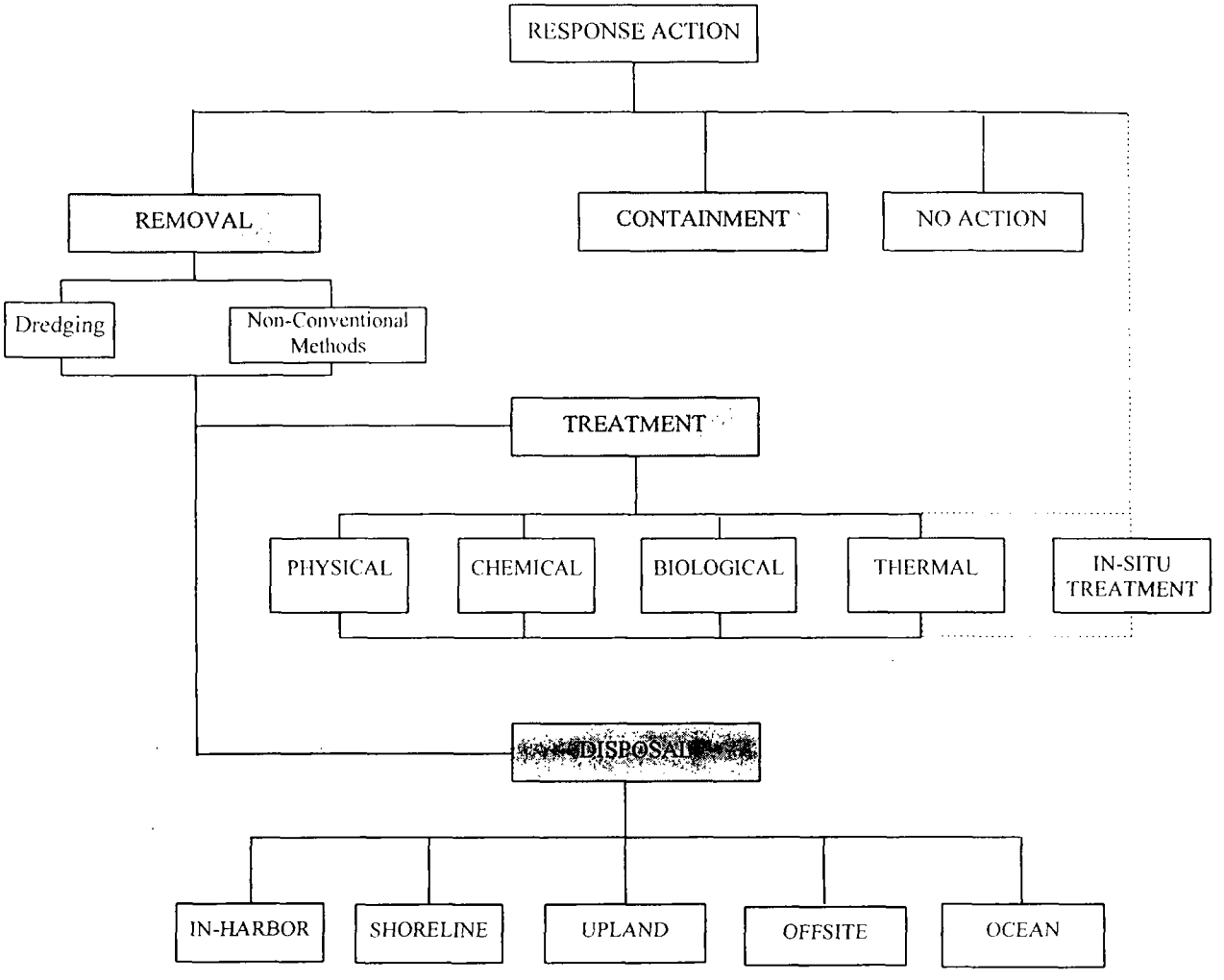


Table 5-1
Potentially Applicable Treatment Technologies
From the 1989 Hot Spot FS (Ebasco, 1989)

Technology	Sediment Matrix	Water Matrix
Biological		
Advanced Biological Methods	X	
Aerobic Biological Methods	X	
Anaerobic Biological Methods	X	
Composting	X	
Land Spreading	X	
Physical		
Soil Aeration	X	
Carbon Adsorption		X
Flocculation/Precipitation		X
Evaporation	X	
Centrifugation	X	
Extraction	X	
Filtration	X	
Solidification	X	
Granular Media Filtration		X
In-Situ Adsorption	X	
Ion Exchange		X
Molten Glass	X	
Steam Stripping	X	
Supercritical Extraction	X	
Vitrification	X	
Particle Radiation	X	
Microwave Plasma	X	
Crystallization	X	
Dialysis/Electrodialysis	X	
Distillation	X	
Resin Adsorption		X
Reverse Osmosis		X
Ultrafiltration		X
Acid Leaching	X	
Catalysis	X	

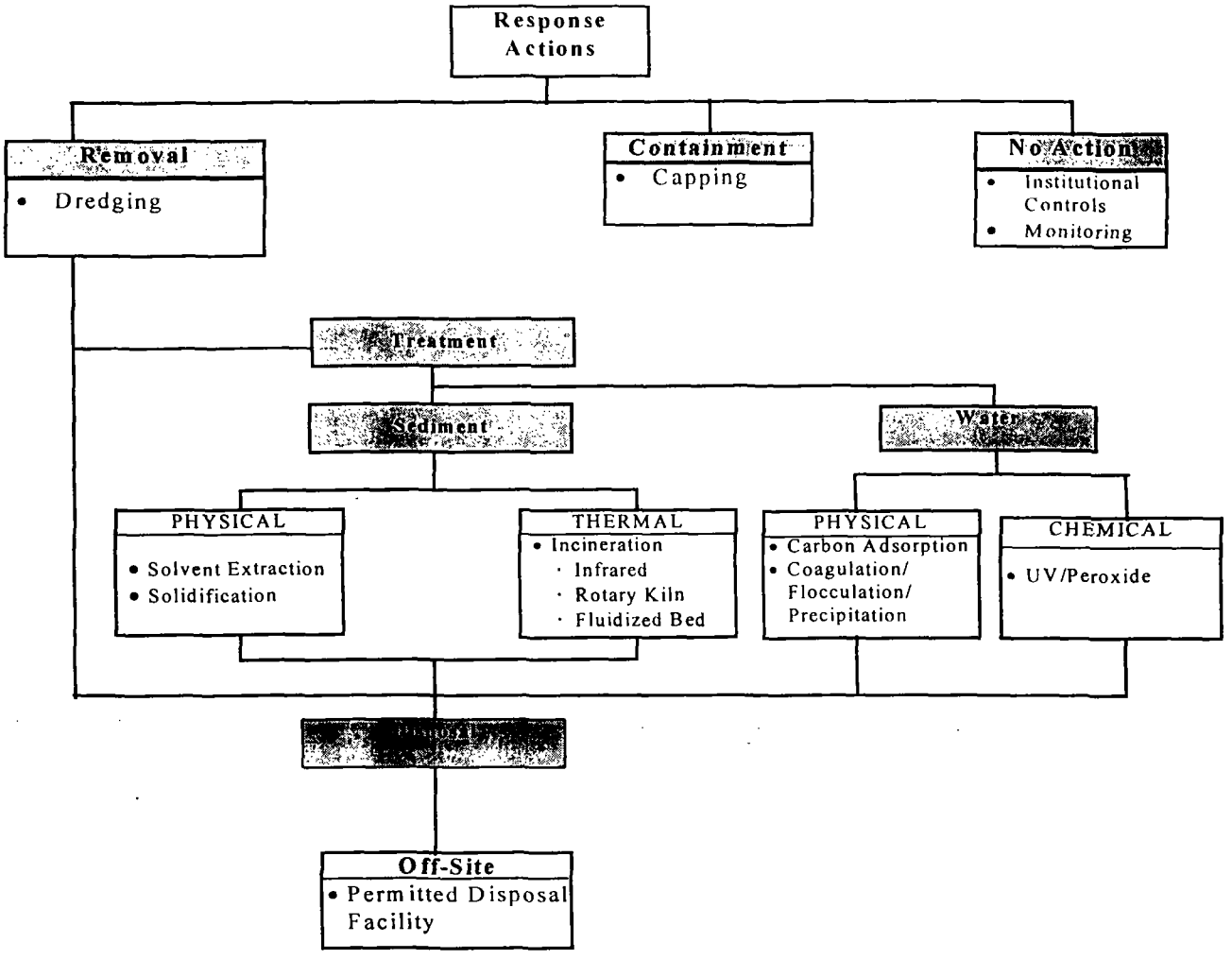
X - donates potentially applicable technology for the matrix

Table 5-1
Potentially Applicable Treatment Technologies
From the 1989 Hot Spot FS (Ebasco, 1989)
(continued)

Technology	Sediment Matrix	Water Matrix
Chemical		
Alkali Metal Dechlorination	X	
Alkaline Chlorination	X	
Catalytic Dehydrochlorination	X	
Electrolytic Oxidation	X	
Hydrolysis	X	
Chemical Immobilization	X	
Neutralization		X
Oxidation/Hydrogen Peroxide		X
Ozonation		X
Polymerization	X	
Ultraviolet Photolysis		X
Thermal		
Electric Reactors	X	
Fluidized Bed Reactors	X	
Fuel Blending	X	
Industrial Boilers	X	
Infrared Incineration	X	
In Situ Thermal Destruction	X	
Liquid Injection Incineration	X	
Molten Salt	X	
Multiple Hearth Incineration	X	
Plasma Arc Incineration	X	
Pyrolysis Processes	X	
Rotary Kiln Incineration	X	
Wet Air Oxidation	X	
Supercritical Water Oxidation	X	

X - donates potentially applicable technology for the matrix

Figure 5-3
Technology Types and Process Options
Remedial Alternatives Development for the 1989 Hot Spot FS (Ebasco, 1989)



technology types were evaluated as a part of site specific treatability study testing conducting during the late 1980s. It is clear that these technologies have undergone considerable development since then. The

results of recent studies also confirmed that solvent extraction was a viable physical treatment approach and that significant process engineering and development has occurred since the 1989 Hot Spot FS. Similarly, significant advancements in thermal desorption processes, particularly with systems that are indirectly heated have occurred over the past eight years. It is interesting to note that thermal desorption, which was not previously included within the thermal treatment technology type, has now been included because detailed process engineering, design, testing and commercial application have occurred since the late 1980s. Gas phase dechlorination is another technology that has by and large, been developed since the 1989 Hot Spot FS.

While sediment treatment technologies have generally progressed over the past eight years, they all require additional process development and testing prior to their application to the Hot Spot sediments. While this work could be conducted during the design portion of a Hot Spot cleanup, it could significantly impact schedule and increase the performance risks of the remedy. The treatability study program also developed cost estimates reflective of current pricing trends for sediment treatment. These estimates are considerably higher than the initial estimates contained in the 1989 Hot Spot FS.

5.2 Development of Remedial Alternatives

The general response actions and technology types to address the Hot Spot sediments within the CDF are presented in Figure 5-4. The technology types and process options are further refined in Figure 5-5 to reflect the technologies used in assembling the overall remedial alternatives. It is important to keep in mind that the technologies are used as building blocks to construct complete remedial alternatives to address the Hot Spot sediments in their entirety.

The remedial alternatives for the Hot Spot FS Addendum have been developed based on the technologies presented in Figure 5-5 and the remedial response objectives presented in Section 3 of this document. The range of alternatives include treatment, disposal and containment response actions. Also included is no further action with the sediments remaining in their current location. The treatment alternatives include a larger range of options than the previous Feasibility Study, including both on-site alternatives and an off-site alternative. The range of on-site treatment alternatives includes a number of technological approaches. A single disposal alternative at a permitted off-site disposal facility is also included. The complete list of remedial alternatives is presented in Table 5-2. These alternatives are evaluated in detail in Section 6 of this document.

Figure 5-4
Hot Spot FS Addendum Range of Potential Response Actions

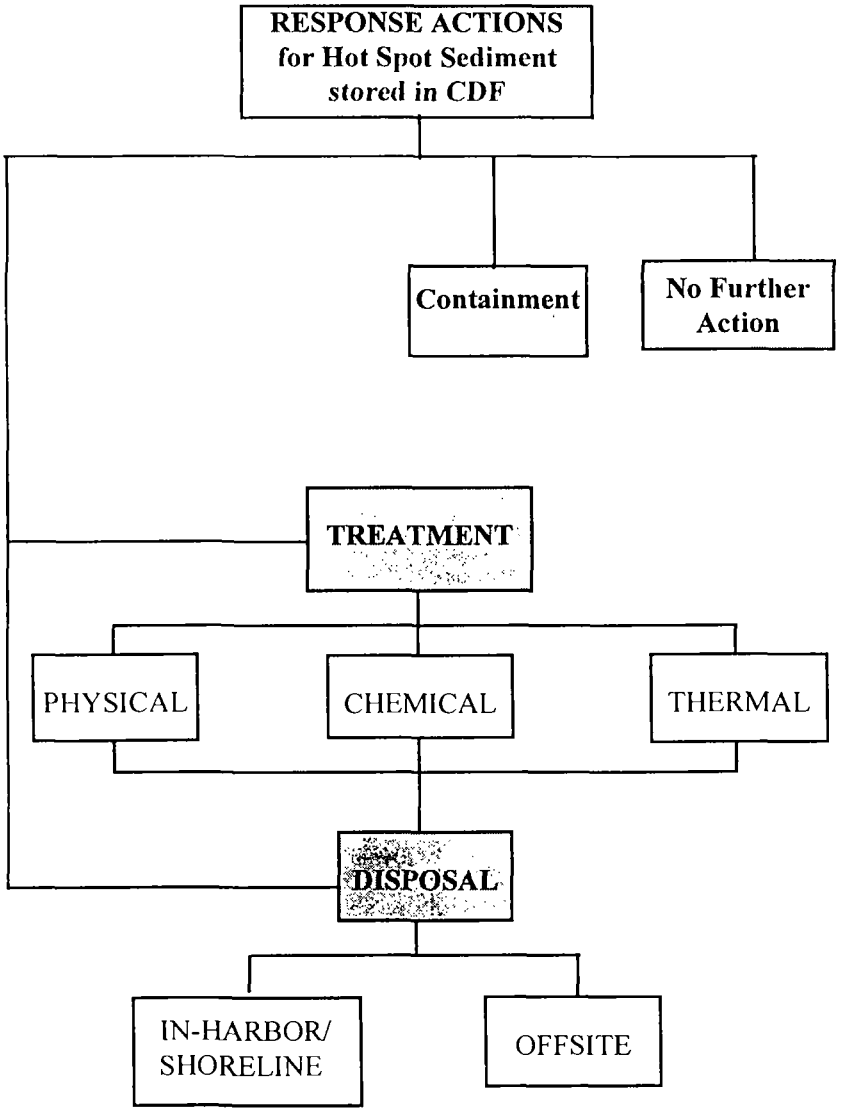


Figure 5-5
Technology Types and Process Options for the Development of Remedial Alternatives

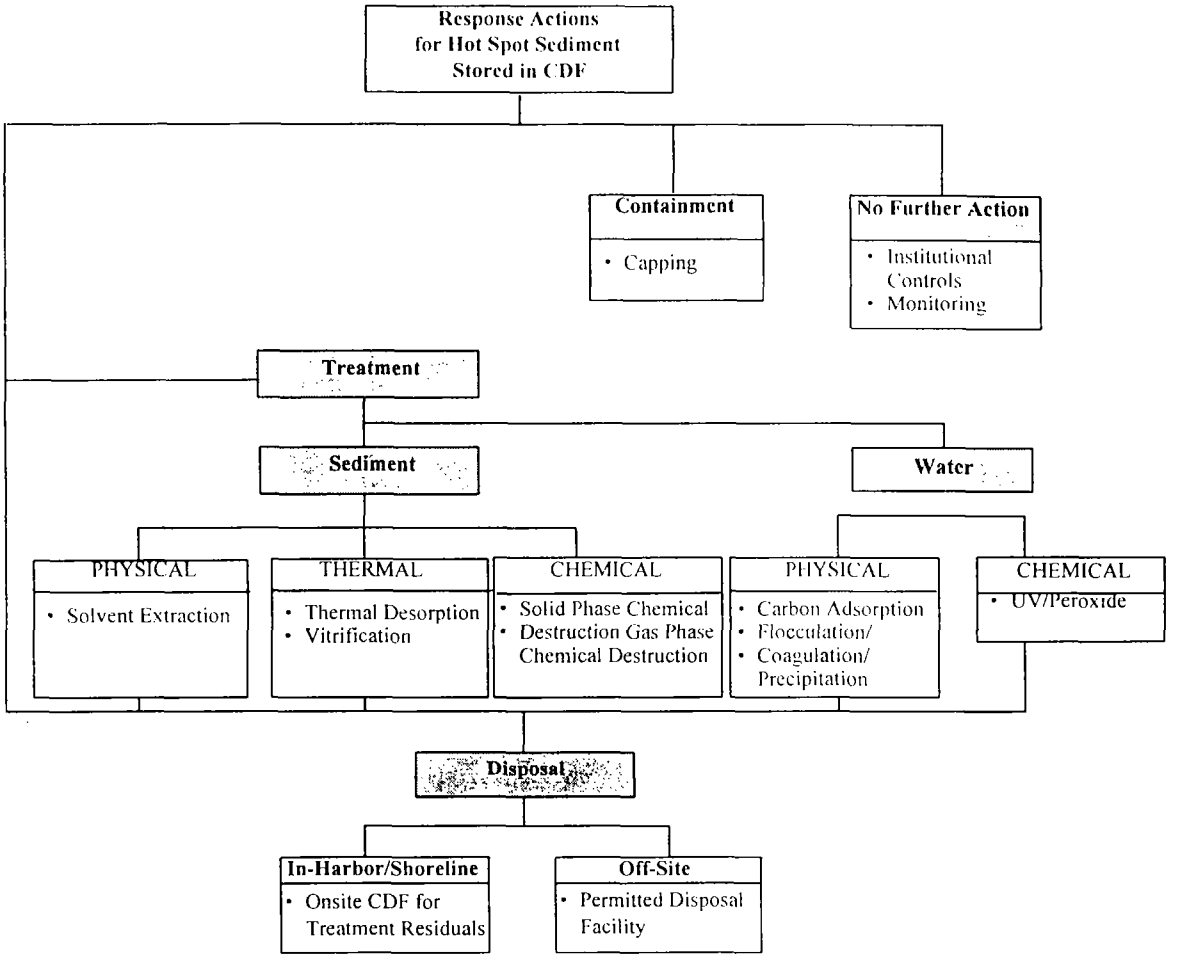


Table 5-2
Remedial Alternatives for Detailed Analysis: Hot Spot FS Addendum

Remedial Alternative	Alternative Description
HS-1	No Further Action
HS-2A	Solvent Extraction and Solid Phase Chemical Destruction
HS-2B	Solvent Extraction and Gas Phase Chemical Destruction
HS-2C	Solvent Extraction and Off-site Incineration
HS-3A	Thermal Desorption and Solid Phase Chemical Destruction
HS-3B	Thermal Desorption and Gas Phase Chemical Destruction
HS-3C	Thermal Desorption and Off-site Incineration
HS-4	Staged Vitrification
HS-5	In-place Capping
HS-6	Off-site Landfilling
HS-7	Off-site Incineration

The list of remedial alternatives provides an appropriate range of alternatives. The alternatives also use the terminology developed by the forum group (i.e., chemical separation and destruction; and chemical destruction) whenever possible. This was done given the complex technical content of this document and the wide audience that may read the document including members of the forum group. The range of alternatives also includes two alternatives with three sub-alternatives (i.e., Alternatives 2A, 2B and 2C; and, Alternatives 3A, 3B and 3C). This was done to maximize the number of potential alternatives and associated technological options within the same general remedial approach. The sub-alternatives were organized by alternatives that shared a common first step in the treatment process. For example, solvent extraction is the first treatment step for Alternatives 2A, 2B and 2C; and thermal desorption is the first treatment step for Alternatives 3A, 3B, and 3C.

5.3 Screening of Alternatives

In summary, the technology evaluation process was effective in providing remedial technologies to construct a full range of alternatives including no further action, containment and treatment alternatives. In addition, the range of alternatives includes on-site and off-site approaches and a variety of potential treatment options.

6. DETAILED ANALYSIS OF ALTERNATIVES

6. DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

The objective of the detailed analysis of remedial action alternatives is to provide a comparative evaluation to assist in the selection of an appropriate plan to meet the remedial objectives. Section 6.1 presents a description of the evaluation process required by CERCLA, and further detailed in the NCP. In Section 6.2, the eleven remedial alternatives developed in Section 5 are described and evaluated individually with respect to the evaluation criteria described in Section 6.1. The comparative analysis of remedial alternatives is summarized in Section 6.3. In the comparative analysis, each of the remedial alternatives is assessed against the others with respect to the criteria set forth in the NCP, as described below.

6.1 Evaluation Process

During the Detailed Analysis, each remedial alternative is assessed with respect to the evaluation criteria mandated by CERCLA. These criteria, as set forth in the NCP, 40 CFR Sec. 300.430 (e)(9), and described more fully in the RI/FS Guidance (EPA, 1988), are:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility and Volume
5. Short Term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

There are a number of different factors under each criterion that are considered when conducting the evaluation. These factors, along with the relevant criteria, are summarized in Table 6-1.

Overall protection of human health and the environment and compliance with ARARs are considered threshold criteria, in that each remedial alternative must meet them. State and community acceptance will be considered by the EPA in the Proposed Plan and ROD and are not included in the following detailed analysis.

6.2 Detailed Analysis

This section presents a detailed description of the eleven alternatives developed in Section 5 and evaluates each against the seven criteria identified in Section 6.1. The remedial alternatives range from no further action to several cleanup alternatives including removal and treatment of the Hot Spot sediment. The range includes eight alternatives involving some form of treatment. Three of these treatment alternatives include a component of treatment off-site, the remaining components of treatment are all on-site. Containment is utilized in two of the remedial alternatives including both an on-site capping alternative and off-site disposal at a permitted landfill. The major components of the eleven alternatives are presented in Table 6-2.

Table 6-1
Factors For Detailed Analysis of Alternatives

Criteria	Considerations
1. Overall Protection of Human Health and the Environment	• How an alternative, as a whole, achieves and maintains protection of human health and the environment.
2. Compliance with ARARs	• Compliance with chemical-specific ARARs. • Compliance with location-specific ARARs. • Compliance with action-specific ARARs. • Compliance with other criteria, advisories, and guidance.
3. Long-Term Effectiveness and Permanence	• Magnitude of residual risks remaining from untreated waste or treatment residuals at the conclusion of remedial activity. • Adequacy and reliability of controls used to manage wastes at the site.
4. Reduction of Toxicity, Mobility, or Volume through Treatment	• Amount of hazardous materials destroyed or treated. • Degree of expected reductions in toxicity, mobility, and volume. • Degree to which treatment is irreversible. • Type and quantities of residual remaining after treatment. • Treatment process used and materials treated. • Whether the alternative would satisfy the statutory preference for treatment as a principle element.
5. Short-term Effectiveness	• Time until remedial action objectives are achieved. • Protection of community during remedial action. • Protection of workers during remedial actions. • Adverse environmental impacts that may result from the implementation of an alternative.
6. Implementability	• Technical feasibility of operating and constructing the technology. • Ease of undertaking additional remedial action if necessary. • Ability to monitor effectiveness of remedy. • Coordination with other agencies. • Availability of off-site treatment, storage, and disposal services and capacity. • Availability of necessary equipment and specialists. • Availability of services and materials.
7. Cost	• Capital cost. • Costs of operation and maintenance. • Present-worth cost.
8. State Acceptance* (*to be assessed in the ROD)	• Features of the alternative the state supports. • Features of the alternative the state has reservations about. • Features of the alternative the state strongly opposes.
9. Community Acceptance* (*to be assessed in the ROD)	• Features of the alternative the community supports. • Features of the alternative the community has reservations about. • Features of the alternative the community strongly opposes.

Table 6-2
Hot Spot Feasibility Study
Addendum Remedial Alternatives

Alternative	Description
HS-1: No Further Action	The site would be operated and maintained as it is today. This includes maintenance of the cover, the current institutional controls of fencing and periodic security checks. A routine monitoring program to evaluate groundwater and air quality is also included.
HS-2A: Solvent Extraction and Solid Phase Chemical Destruction	Removal of the Hot Spot sediments from the CDF and physical separation of the PCBs and other organics through solvent extraction. The concentrated oily extract would subsequently be treated on-site with solid phase chemical dechlorination to destroy the PCBs. The final step involves placement of the treatment residuals within a shoreline CDF.
HS-2B: Solvent Extraction and Gas Phase Chemical Destruction	Removal of the Hot Spot sediments from the CDF and physical separation of the PCBs and other organics through solvent extraction. The concentrated oily extract would then be heated such that the waste would be transformed into a vapor and subsequently treated with an on-site gas phase reduction reactor to destroy the PCBs. The final step involves placement of the treatment residuals within a shoreline CDF.
HS-2C Solvent Extraction and Off-Site Incineration	Removal of the Hot Spot sediments from the CDF and physical separation of the PCBs and other organics through solvent extraction. The concentrated oily extract would then be transported off-site for incineration at a permitted TSCA facility to destroy the PCBs. The treatment residuals from the solvent extraction process would be redeposited within a shoreline CDF.
HS-3A: Thermal Desorption and Solid Phase Chemical Destruction	Removal of the Hot Spot sediments from the CDF followed by a mechanical dewatering step. The PCBs and other organics would then be separated through thermal desorption. The concentrated oily extract generated by the thermal desorption process would subsequently be treated on-site with a solid phase chemical dechlorination agent to destroy the PCBs. The final step involves placement of the treatment residuals within a shoreline CDF.
HS-3B: Thermal Desorption and Gas Phase Chemical Destruction	Removal of the Hot Spot sediments from the CDF and separation of the PCBs and other organics into a vapor phase waste stream via thermal desorption. The separated contaminants would subsequently be destroyed on-site in a gas phase reduction unit. The treatment residuals would be redeposited within a shoreline CDF.
HS-3C: Thermal Desorption and Off-Site Incineration	Removal of the Hot Spot sediments from the CDF followed by a mechanical dewatering step. The PCBs and other organics would be separated through thermal desorption. The concentrated oily extract would be transported off-site for incineration at a permitted TSCA facility to destroy the PCBs. The treatment residuals from the thermal desorption process would be redeposited within a shoreline CDF.
HS-4: Staged Vitrification	Removal of the Hot Spot sediments from the CDF followed by a thermal dewatering step to significantly reduce the moisture content. The dried sediments would be redeposited (staged) within a portion of the CDF and treated through vitrification.
HS-5: In-Place Capping	Following in-place dewatering of the sediments with wick drains, the sediments would be capped in-place using a multiple layer impermeable cap. The alternative includes a significant long-term monitoring program for leachate production, groundwater quality and potential air releases.
HS-6: Off-site Landfilling	Removal of the Hot Spot sediments from the CDF followed by a mechanical dewatering step. The sediments would be transported off-site for landfill disposal in a permitted TSCA facility.
HS-7: Off-site Incineration	Removal of the Hot Spot sediments from the CDF followed by a mechanical dewatering step. The sediments are then transported off-site for incineration in a permitted TSCA facility to destroy the PCBs.

6.2.1 Alternative HS-1: No Further Action

Alternative HS-1 is the no further action alternative that considers leaving the Hot Spot sediments in the CDF as they are today. The development and evaluation of a "no-action" alternative is required under the NCP. The no-action case serves as the baseline alternative, which assesses the potential risk to human health and the environment if no additional measures are taken to prevent exposure. A true no-action alternative typically does not include actions taken to reduce exposure (e.g., monitoring, fencing and site security inspections). In this case, many of the controls to reduce exposure are already in place. As a result, a true no action scenario does not apply and therefore, these existing controls are considered in the evaluation. The term "no further action" is used in this FS Addendum and also reflects the actions taken to date to remove the sediment from the Estuary and isolate them from the environment in the existing double-lined CDF cell. The sediments are being stored in the CDF on an interim basis as EPA evaluates a range of potential remedial actions including no further action.

6.2.1.1 General Description

The controls associated with no further action include actions taken to date in association with the dredging and storing of the Hot Spot sediments in the Sawyer Street CDF. The existing controls associated with alternative HS-1 include fencing and occasional site inspections for evidence of vandalization. In evaluating the no further action alternative, it has been assumed that EPA's proposed cleanup measures for the remainder of the site (i.e., ROD II cleanup) presented in the November 1996 Proposed Plan (EPA, 1996) will be implemented. It is also assumed the existing institutional controls on consumption of shellfish and finfish from the Estuary, Lower Harbor and Bay areas of the site will also continue for some period of time. This ban would remain in effect until the hazards associated with ingestion of contaminated seafood have been reduced to a satisfactory level. Environmental monitoring planned as a part of the ROD II clean-up would be conducted on a periodic basis until this level has been met. Additional controls anticipated for the no further action remedial alternative include: continued maintenance; continued monitoring of the sediment, air and surface water; continued site security inspections; continued public awareness programs; site review once every five years.

Public awareness programs would be implemented to educate the public on the potential health hazards associated with the Hot Spot sediment. The programs would include periodic meetings and presentations in local neighborhoods, and bilingual pamphlets.

A regular monitoring program would be implemented to assess long-term trends in sediment, groundwater and air PCB concentrations, and whether surface water in the Estuary was affected. For remedial actions which leave contaminated sediments on site, CERCLA legislation requires that the site be reviewed every five years. Data collected as part of the environmental monitoring program would be evaluated during the five year reviews. Recommendations for potential remedial actions would be formulated, as needed, based on the review.

6.2.1.2 Overall Protection of Human Health and the Environment

The no further action alternative has been protective of human health and the environment but provides limited long-term protection of human health and the environment. The limitation in long-term protection is due, primarily, to the limitations of the existing cover in containing the Hot Spot sediments for a long

period of time. The CDF facility is currently operated as a temporary storage facility and does not include a cover system which will provide long-term isolation of contaminants within the CDF.

6.2.1.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-1. Complete listings of these respective ARARs are presented in Tables B-1-1, B-1-2 and B-1-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-1. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.)*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste disposal and the treatment facility discharges. These ARARs include PCB disposal requirements under TSCA (40 CFR 761) and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards (310 CMR 30.00).

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. Alternative HS-1, as an alternative disposal remedy, requires approval by the Regional Administrator, based on the requirements of TSCA. If properly maintained and

monitored, alternative HS-1 should provide the same level of adequate protection to health and the environment as it currently provides.

HS-1 must comply with relevant and appropriate TSCA chemical waste landfill standards, which apply to the permanent disposal of PCB contaminated dredge spoil. TSCA allows for specific requirements for the landfill ARAR to be waived upon a finding by the Regional Administrator that the facility will not present an unreasonable risk of injury to health or the environment. To use the present CDF facility as a permanent disposal facility, waivers are required regarding hydrologic conditions, flood protection, and leachate collection. The present facility's design that includes double impermeable bottom and side liners, a monitoring system for leak detection, and top-of-berm elevation two feet higher than the 100-year flood elevation should meet waiver standards for the prevention of injury to health or the environment.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Discharges from monitoring, operations, and/or maintenance of the facility under alternative HS-1 will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants (federal Clean Air Act, 42 USC 7401 *et seq.*, 40 CFR Part 61 and state air standards, 301 CMR 6.00 and 7.00). Air emissions from alternative HS-1 may potentially result from releases from the CDF. Air emissions will be addressed through monitoring and proper management of the CDF disposal cell, including maintaining water on top of the cover during the summer months to reduce heating of the sediments and degradation of the cover.

Water discharges are regulated under state and federal water quality ARARs (federal Clean Water Act (CWA), 33 USC 1342, 40 CFR 122-125, 131 and state water standards, 314 CMR 1.00-7.00). Water treatment may be required if surface run-off comes in contact with the contaminated sediments, particularly in the cooling pool maintained above the cover. Alternative HS-1 potentially may produce contaminated water that will require treatment at the facility's on-site water treatment plant. Operation of the treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the CWA, Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its

Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than offset by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels.

6.2.1.4 Long Term Effectiveness and Permanence

Alternative HS-1 will provide limited long term effectiveness. The existing cover system is not considered to be adequate for long term containment of highly contaminated sediments such as the hot spot sediments. During the warm months, increased volatile PCB emissions occur at the edges of the cover. The current design calls for a constant water layer over the cover to minimize the emissions. While the integrity of the water layer and cover can be effectively maintained for the interim period, wind and sun damage to the relatively thin cover will cause long term maintenance problems and the long term integrity of the cover will be difficult to ensure.

6.2.1.5 Reduction in Mobility, Toxicity, and Volume

Alternative HS-1 does not include sediment treatment and therefore, no reduction in mobility, toxicity or volume of the PCBs would be achieved through treatment.

6.2.1.6 Short Term Effectiveness

Protection of the community and the workers while implementing the no further action alternative are considered under this criterion. The primary remedial components of alternative HS-1 are environmental monitoring, periodic security and long term maintenance of the cover system. These activities would pose no risk to the community or the environment. However, the workers conducting the activities may require protective equipment which would be specified in a site-specific Health and Safety Plan.

6.2.1.7 Implementability

The implementability of the no further action alternative includes the technical and administrative feasibility and the availability of the services and materials. Implementability concerns for the institutional controls and environmental monitoring aspects of the no further action alternative are relatively few. The personnel and equipment to perform the services are readily available. Coordination with federal, state and local officials prior to conducting the public awareness programs and environmental monitoring would be required to ease implementation of sampling programs.

Monitoring the effectiveness of this alternative may be somewhat hindered by the existing double liner system and the shoreline setting of the CDF. It may be somewhat difficult to assess a liner failure given groundwater levels and the potential impact of tidal fluctuations on the monitoring well network. In addition, it is not currently possible to detect liquid material between the two layers of liner.

6.2.1.8 Cost

The costs associated with the no further action alternative include the Operation and Maintenance (O&M) costs for the Sawyer Street CDF facility for a thirty-year period. The costs were anticipated to include efforts to conduct the regular environmental monitoring, implement public outreach and educational programs, perform occasional security inspections, and conduct five-year reviews.

The costs were estimated using a percentage of EPA's current costs to conduct similar activities at the site. The costs were estimated on an annual basis for a thirty-year period and then presented as a Net Present Worth (NPW) cost using a discount rate of seven percent. The first five years of no further action were estimated at EPA's current costs to maintain the site of $840,000 (i.e., 100% of current costs). No further action support activities for the next five-year period were assumed at one half of this cost ($420,000/year). Years eleven through fifteen were estimated at ($210,000/year). This process was used throughout the thirty-year period. The resulting NPW cost would be approximately $5.4 million as presented in Table 6-3.

6.2.1.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.1.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-3
Cost Estimate: Remedial Alternative HS-1
No Further Action

ACTIVITY	COST ($)
DIRECT COSTS	
- included in O&M Costs	0
TOTAL DIRECT COST (TDC)	**$0**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	0
B. Legal, Administration, Permitting (@ 10% of TDC)	0
C. Engineering (@ 10% of TDC)	0
D. Services During Construction (@ 10% of TDC)	0
E. Turnkey Contractor Fee (@ 15% of TDC)	0
TOTAL INDIRECT COST (TIC)	**$0**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$0**
CONTINGENCY (@ 20% of TDC + TIC)	0
TOTAL CAPITAL COST	**$0**
O&M COST	$8,568,750
TOTAL O&M COST (present worth @ 7% for 30 years)	**$5,448,991**
TOTAL COST - REMEDIAL ALTERNATIVE HS-1	**$5,448,991**

6.2.2 Alternative HS-2A: Solvent Extraction and Solid Phase Chemical Destruction

This section of the FS Addendum describes Remedial Alternative HS-2A and evaluates the alternative against the detailed evaluation criteria. Remedial Alternative HS-2A involves removal of the Hot Spot sediment from the CDF and treatment through a combination of solvent extraction and solid phase chemical destruction. The solvent extraction process would separate the organic contaminants including the PCBs into a concentrated oil extract. This extract would then be treated through solid phase chemical destruction. Solid phase residuals from both processes would subsequently be placed in the CDF.

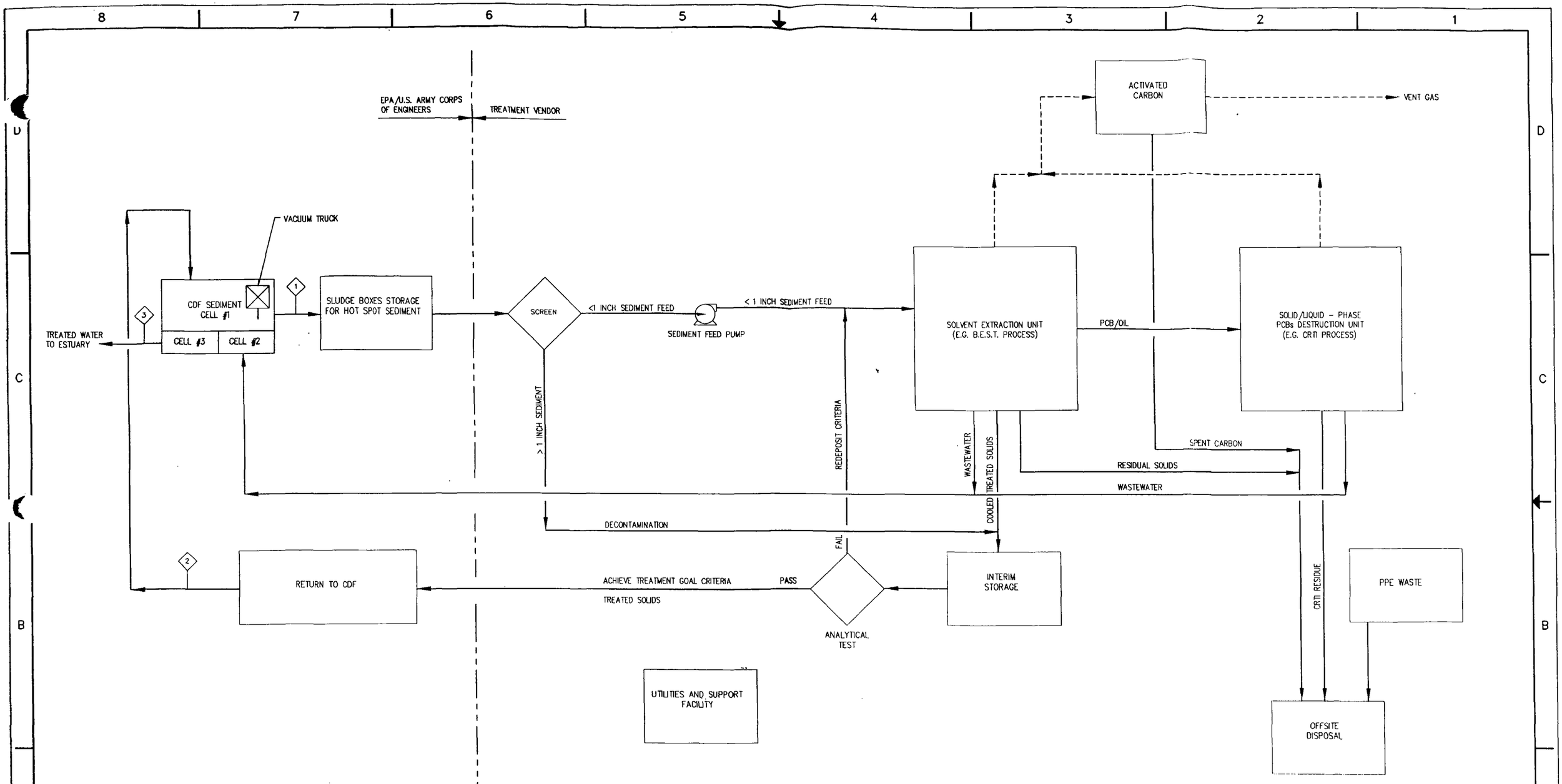
In developing this remedial alternative, the Ionics RCC B.E.S.T.® solvent extraction and CRTI SET® solid phase chemical destruction processes were used as representative treatment processes. It is important to note that discussion of these particular technology vendors is for illustrative purposes only.

6.2.2.1 General Description

Remedial Alternative HS-2A is a removal and treatment alternative with all treatment activities occurring at the site. The removal and treatment operations include the following activities: withdrawal of the Hot Spot sediments from the CDF, staging the sediments for treatment in sealed containers, screening the sediment to remove over-sized material, treating the contaminated sediments through solvent extraction, treating the resulting oil extract with solid phase chemical destruction, and placement of the treated residuals in a CDF. Overall movement of materials from the CDF through the various treatment processes and back to the CDF is presented in Figure 6-1.

The first step in the site cleanup process would be upgrading the existing site facilities to accommodate the materials handling and treatment operations. The site already has many of the typical facilities and utilities required to support cleanup activities. These facilities include multiple office trailers, an on-site laboratory, a decontamination pad and trailer, and site security features. The site security features include a guard station, extensive lighting and fencing. The site also has a 350 gallon per minute (gpm) water treatment facility that is assumed to be available and operating. This is based on the assumption that the ROD II cleanup activities will be proceeding on a separate but parallel track. The predominant features of the facility upgrade would include construction of a series of treatment pads and access roads which are presented in Figure 6-2.

The contaminated sediments would first be removed from the CDF with a vacuum truck equipped with vapor phase treatment system. This equipment successfully removed approximately 15 tons of Hot Spot sediment from the CDF to support the treatability study program. This equipment has several features which result in minimal disruption/destruction to the existing cover system on the CDF, minimal decontamination of construction equipment and the truck, and also provides transport to the staging area in a sealed vessel. These features provide benefits which are primarily targeted towards reducing the potential for worker and/or community exposure to PCBs, including air emissions. A picture of a typical vacuum truck is presented in Exhibit 6-1.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER
CUBIC YARDS	15,000	7,000	---
TONS	18,000	9,000	---
MM GALLONS	---	---	2.2

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CADDFILE NO. 8860a014.DWG
FWENC. CONTRACT NO. 68-W9-0034
DRAWN BY FPZ — DATE 8/25/97
CHECKED BY — DATE
PROJ/DES ENG — DATE
ENG APPROVAL — DATE

FOSTER WHEELER ENVIRONMENTAL CORPORATION
470 ATLANTIC AVENUE
BOSTON, MA. 02210

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-2A
SOLVENT EXTRACTION AND SOLID PHASE
CHEMICAL DESTRUCTION

SIZE — REV

FIGURE 6-1

SCALE: NONE — PLOTDATE 9/16/97 — SHEET 1 OF 1

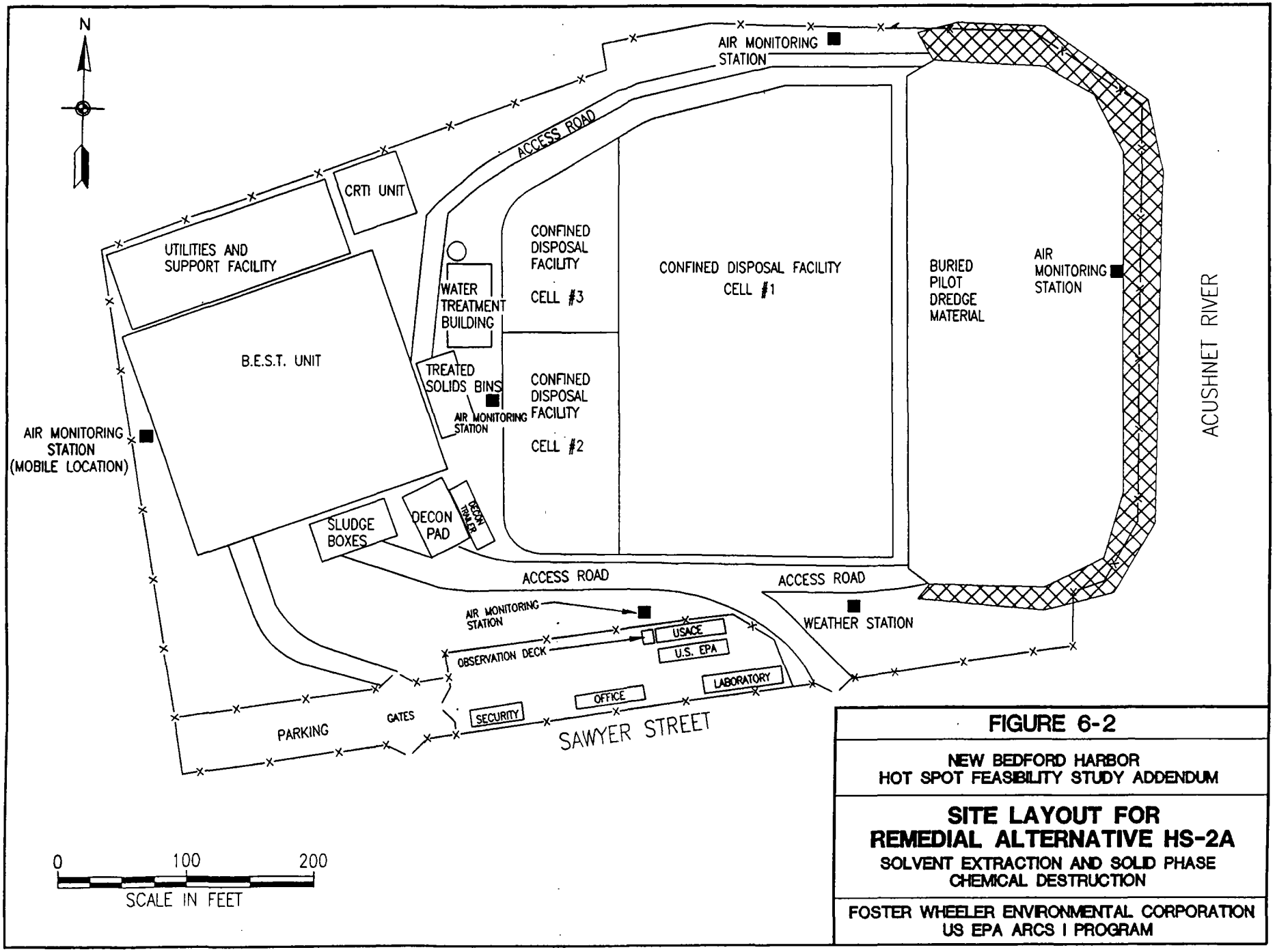


FIGURE 6-2

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-2A

SOLVENT EXTRACTION AND SOLID PHASE CHEMICAL DESTRUCTION

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A025.DWG
DATE: 9/17/97

Exhibit 6-1
Typical Vacuum Truck

The sediments would be transported to the staging area in the vacuum truck and temporarily stored in a series of sealed roll-off containers, or sludge boxes. These containers would hold enough sediment for one to two days of treatment activities. The sludge boxes would be vented through carbon canisters to facilitate materials handling operations and prevent PCB emissions. From the sludge boxes, the sediments would be pumped to the treatment area to be screened to remove oversize particles, in this case, assumed to be material not passing a one inch screen. Based on the treatability studies, the plus one inch material is not expected to be a significant portion of the waste stream. This material can either be crushed to size or decontaminated using other means such as high pressure steam cleaning. This decision can be made during field operations and to some degree will be dependent on the nature of this material (shell fragments versus rocks) and the actual volume of material. Again, this is not anticipated to be a significant issue.

The treatment approach includes solvent extraction of the 15,000 cubic yards (18,000 tons) of contaminated sediment from the CDF. The representative solvent extraction process uses diisopropylamine as a solvent to separate the oil and water from the sediment. Following this extraction step, the solvent would be separated from the oil and water fractions and recycled within the process. The results of the treatability studies demonstrated that the technology was quite capable of achieving the PCB treatment goal of less than 50 ppm.

The small quantity of water generated during treatment operations (approximately 10 gpm) is relatively clean and can be polished by the 350 gpm water treatment system already constructed at the site. The solvent extraction unit is expected to treat approximately 136 tons of wet sediment per day and operate on a 24 hour per day, seven day a week schedule. This results in treatment of the sediment over a five month period. Additional details of the solvent extraction process are in Section 4.2 of this document along with the results of the site specific treatability study and discussions of potential full scale implementation.

The 9,000 tons of treated solids from the solvent extraction process would be tested to confirm the treatment goal had been met and then placed in a CDF. If the results indicate that the treatment goal was not met, the solids would require re-treatment until compliance was achieved. The solvent extraction process does not treat heavy metal contamination in the sediment. However, based on pilot study data, the treated solids pass TCLP testing and as a result, a final step of solidification would not appear to be required. The treated solids could be placed in the pilot dredge material cell at the eastern end of the Sawyer Street CDF, or in CDF C, if available through ROD II cleanup activities. CDF C is part of EPA's proposed plan for the ROD II cleanup and is proposed to be constructed along the New Bedford shoreline just north of the Coggeshall Street bridge. Either of these locations is relatively proximate and would be appropriate for the disposal of this material.

The solid phase chemical destruction process would treat approximately 3.2 tons per day of highly contaminated oil extract generated by the solvent extraction process. This estimated quantity is based on observations during the Hot Spot treatability study program and the projected throughput of the solvent extraction system of 136 tons of wet sediment per day. The observed generation rate for the oil extract from the treatability studies was a ratio equivalent to approximately five to six gallons of concentrated extract for each ton of wet sediment treated. This results in a total of 423 tons of highly contaminated oil extract to be treated with solid phase chemical destruction.

The representative solid phase destruction process material utilizes elemental sodium and ammonia to destroy the chlorinated organics, including the PCBs. The results of the treatability study demonstrated that the technology was capable of treating the extracted oil from initial PCB concentrations of approximately 50,000 ppm down to the 1 to 5 ppm range. Additional details on the process, related treatment equipment and potential full scale treatment operations are presented in Section 4.2.

On-site disposal of the treated residuals from the solid phase chemical destruction step may potentially be more problematic. The treatment residual from this process is estimated to be only 600 cubic yards. While this is a relatively small quantity, the issue of whether or not it can be disposed of in a CDF without addition treatment could be a much larger issue and one that is currently unresolved. During the pilot scale studies, the reactive nature and high pH of this product made handling complex. While CRTI is working to resolve these issues, the potential impacts of a reactive, high pH waste residual include requiring additional controls during treatment operations to ensure worker safety and health and potential cost impacts. These impacts are associated with the potential need to perform additional conditioning and/or disposal of the residuals in an off-site permitted disposal facility. It is important to note that the potential cost impact for off-site disposal could exceed $500,000.

6.2.2.2 Overall Protection of Human Health and the Environment

Remedial alternative HS-2A will achieve and maintain protection of human health and the environment. This will be accomplished through permanent treatment of over 99% of the PCBs associated with the hot spot sediments. The hot spot sediments will be treated to below the treatment goal of 50 ppm. Disposal of the treated sediments in an on-site CDF will greatly reduce the potential risks due to direct contact, and inhalation. Disposal of the treated sediments in an on-site CDF will also protect the environment.

6.2.2.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-2A. Complete listings of these respective ARARs are presented in Tables B-2A-1, B-2A-2 and B-2A-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-2A. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal

method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. HS-2A qualifies as an alternative disposal remedy that requires approval by the Regional Administrator, based on the requirements of TSCA.

HS-2A will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-2A will require PCB contaminated sediments to be stored on site for approximately five years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the treated sediments containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction and treatment technologies, and handling of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment will be required for the process discharges and possibly for surface run off becoming contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other

conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF)and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.2.4 Long Term Effectiveness and Permanence

Alternative HS-2A will provide long term effectiveness through treatment of the Hot Spot sediments with a combination of solvent extraction and solid phase chemical destruction. Treated sediment will have PCB concentrations less than 50 ppm and will be disposed of in an on-site CDF. Presuming that the residuals from the solid phase destruction process will be solid, non-reactive and have a pH less than 11.5, these will also be disposed of on-site. Should these residuals be unacceptable for on-site disposal, they will be shipped off-site in a manner that is protective of human health and the environment.

The on-site controls to manage the residuals are sufficient. The on-site CDF will isolate the treated sediments from direct contact and potential volatilization. The CDFs are underlain by a relatively impermeable harbor sediment that would act as a barrier for leaching and finally, the CDF will be designed with an impermeable side wall as an additional control measure. It should also be noted that the metals that remain in the sediment are not expected to be leachable in significant quantities as they successfully passed TCLP testing.

6.2.2.5 Reduction in Mobility, Toxicity, and Volume

This alternative will significantly reduce the volume and toxicity of the hot spot sediments. The volume reduction is expected to be greater than 97% through solvent extraction. The solid phase destruction step will significantly reduce the toxicity of the hot spot sediments by destroying over 99% of the PCBs removed through solvent extraction.

6.2.2.6 Short Term Effectiveness

The time to complete the remedial actions under alternative HS-2A is approximately five years. This estimate includes one to two years of design and procurement activities and a three year period to fabricate the treatment equipment and complete the clean-up operations.

Protection of the community and the workers conducting the remediation are also considered under this criterion. The primary remedial components of alternative HS-2A are sediment removal and treatment operations. The process of removing the sediments from the CDF and handling them prior to treatment could generate air emissions. This potential for air emissions will be minimized by using a vacuum truck equipped with a vapor phase treatment system and storage of the sediments in sludge boxes vented to carbon canisters prior to treatment.

The use of the solvents such as diisopropylamine and the solid phase chemical destruction reagents such as elemental sodium and ammonia pose potential risks to on-site workers and nearby residents. These risks can be greatly minimized through compliance with appropriate industry standards, the development and compliance with appropriate procedures and controls, and a complete HAZOP analysis of the treatment equipment prior to the start of treatment operations. In addition, treatment equipment operations would be monitored to ensure compliance with applicable emissions criteria.

There are also potential short-term effectiveness concerns with the treatment residuals from the solid phase destruction process including high pH and reactivity. If the treated product demonstrates the characteristics observed during the pilot studies, additional safety measures will be required during full-scale operations.

Worker health and safety would be addressed through requirements specified in a site-specific Health and Safety Plan (HASP). This plan will stipulate the appropriate personnel protective equipment and monitoring criteria. A site wide air monitoring program would also be implemented to ensure protection of workers and area residents.

No adverse environmental impacts are anticipated while implementing alternative HS-2A.

6.2.2.7 Implementability

The implementability of alternative HS-2A includes the technical and administrative feasibility of the alternative and the availability of the services and materials. The solvent extraction system could take up to eighteen months to fabricate and test prior to delivery at the site. In theory, the time to construct a solid phase chemical destruction unit is considerably less. However, the eighteen month time-frame for the solvent extraction unit would provide a reasonable amount of time to complete a solid phase chemical destruction unit and work through some of the materials handling difficulties experienced during the New Bedford Harbor treatability study program.

The results of the pilot scale treatability studies also indicated that there may be materials handling difficulties associated with solid chemical dechlorination. It is important to note that these difficulties not be representative for all solid phase dechlorination processes. In either case, these difficulties appear to be resolvable through additional process engineering, development and testing.

Technologies are readily available to confirm that solvent extraction can treat the Hot Spot sediment to a residual PCB concentration of 50 ppm or less. Similar technologies are also readily available to confirm successful treatment of the oily waste generated through solvent extraction and compliance with any relevant emissions criteria.

There is also some risk that the competitive process for solvent extraction may be somewhat limited by the number of potential vendors with full-scale treatment units or the ability to construct a viable full-scale unit. This should be thoroughly discussed during the planning phases to maximize the competitive process.

Given the hazardous nature of process operations and reagents, a significant level of effort is anticipated to coordinate with local emergency officials including police, fire, EMTs, Hazmat team, and local hospitals. Significant coordination will also be required with state, federal and local officials.

6.2.2.8 Cost

The costs for alternative HS-2A include the capital costs to upgrade the site facilities, remove and treat the sediment using solvent extraction and solid phase chemical destruction, conduct treated materials handling operation and perform air monitoring. Estimated costs for this alternative are summarized in Table 6-4. The total cost of $27.1 million is heavily influenced by the $13 million in direct treatment costs alone. Out of this $13 million, approximately $9 million is associated with the capital cost to produce a treatment unit for the project. As a percentage of total direct treatment costs, this is on the high end of the range for most treatment technologies. The estimated costs for solid phase chemical destruction may be low if the treatment residuals require additional conditioning before placement in a CDF or to meet standards for off-site disposal.

The costs also contain a number of indirect costs including health and safety, legal, engineering, construction services and profit. A contingency factor of 20% is applied to the total of direct and indirect costs to cover items not anticipated at this time.

6.2.2.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.2.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-4
Cost Estimate: Remedial Alternative HS-2A
Solvent Extraction and Solid Phase Chemical Destruction

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Solvent Extraction	10,548,000
D. Solid Phase Chemical Destruction	2,422,098
E. Treated Materials Handling	337,115
F. Air Monitoring	1,152,000
TOTAL DIRECT COST (TDC)	**$15,037,513**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	751,876
B. Legal, Administration, Permitting (@ 10% of TDC)	1,503,751
C. Engineering (@ 10% of TDC)	1,503,751
D. Services During Construction (@ 10% of TDC)	1,503,751
E. Turnkey Contractor Fee (@ 15% of TDC)	2,255,627
TOTAL INDIRECT COST (TIC)	**$7,518,757**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$22,556,270**
CONTINGENCY (@ 20% of TDC + TIC)	4,511,254
TOTAL CAPITAL COST	**$27,067,523**
TOTAL COST - REMEDIAL ALTERNATIVE HS-2A	**$27,067,523**

6.2.3 Alternative HS-2B: Solvent Extraction and Gas Phase Chemical Destruction

This section of the FS Addendum describes Remedial Alternative HS-2B and evaluates the alternative against the detailed evaluation criteria. Remedial HS-2B involves removal of the Hot Spot sediment from the CDF and treatment through a combination of solvent extraction and gas phase chemical destruction. The solvent extraction process would separate the organic contaminants including the PCBs into a concentrated oil extract. This extract would then be treated through gas phase chemical destruction. Solid residuals will be generated primarily by the solvent extraction step and will subsequently be placed in the CDF.

In developing this remedial alternative, the Ionics RCC B.E.S.T.® solvent extraction and Eco Logic gas phase chemical destruction processes are used as representative treatment processes. It is important to note that discussion of these particular technology vendors is for illustrative purposes only.

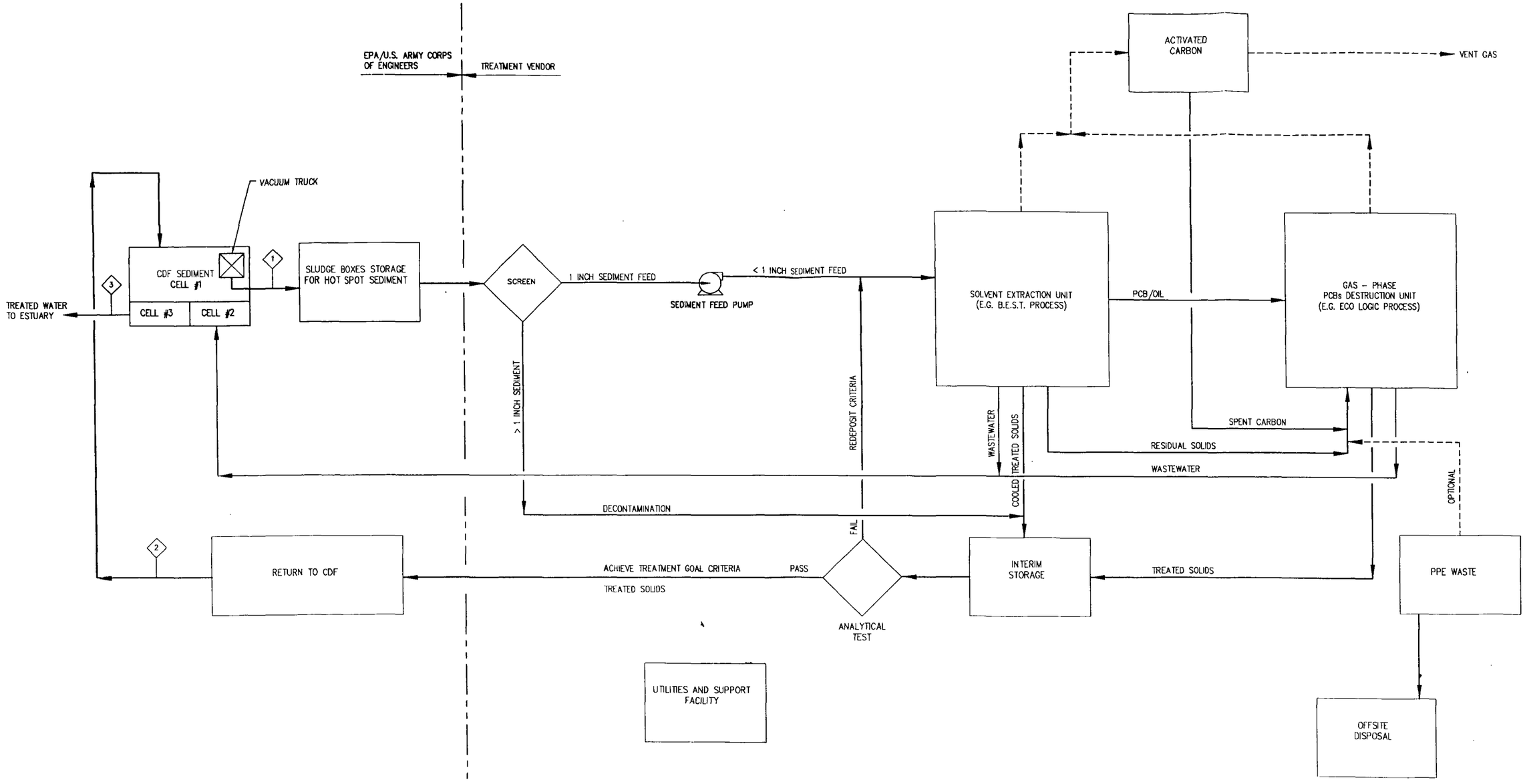
6.2.3.1 General Description

Remedial Alternative HS-2B is a removal and treatment alternative with all treatment activities occurring at the site. The removal and treatment operations would include the following activities: withdrawal of the Hot Spot sediments from the CDF, staging the sediments for treatment in sealed containers, screening the sediment to remove over-sized material, treating the contaminated sediments through solvent extraction, treated the resulting oil extract through gas phase chemical destruction, and placement of the treated residuals in a CDF. Overall movement of materials from the CDF through the various treatment processes and back to the CDF is presented in Figure 6-3.

The initial treatment steps for alternative HS-2B are the same as those described for HS-2A in Section 6.2.2. These initial steps encompass the activities conducted from the initial upgrade of the site through the solvent extraction treatment and disposal of treated sediment in an on-site CDF. The first step in the cleanup process would be to upgrade existing site conditions to accommodate the materials handling and treatment operations. As with alternative HS-2A, the predominant feature of this initial step is the construction of a series of treatment pads and access roads, as shown on Figure 6-4. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2. An important consideration for alternative HS-2A is the size limitations of the site. These limitations pose potential health and safety concerns that must be addressed for the two treatment processes to be operated in such close proximity.

Activities associated with the solvent extraction treatment process include removing the sediment from the CDF using a vacuum truck, transporting the sediment to the storage area and treatment unit, screening the sediment to remove oversize material, and treating the sediment using solvent extraction. Treated sediment would be tested for acceptability and returned to a CDF for ultimate disposal. Water generated from the treatment process would be treated using the on-site water treatment system. As discussed for alternative HS-2A, the solvent extraction process concentrates the organic fraction of the sediment into a highly contaminated oil product that requires additional treatment. Additional detail on the steps to conduct the solvent extraction process is provided in Section 6.2.2.

Alternative HS-2B incorporates on-site gas phase chemical destruction as the method for treatment of the contaminated oil product generated from the solvent extraction process. The gas phase chemical



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER
CUBIC YARDS	15,000	7,000	---
TONS	18,000	9,000	---
MM GALLONS	---	---	2.2

LEGEND

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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-2B
SOLVENT EXTRACTION AND
GAS PHASE CHEMICAL DESTRUCTION

SIZE | FIGURE 6-3 | REV

SCALE: NONE | PLOTDATE 9/16/97 | SHEET 1 OF 1

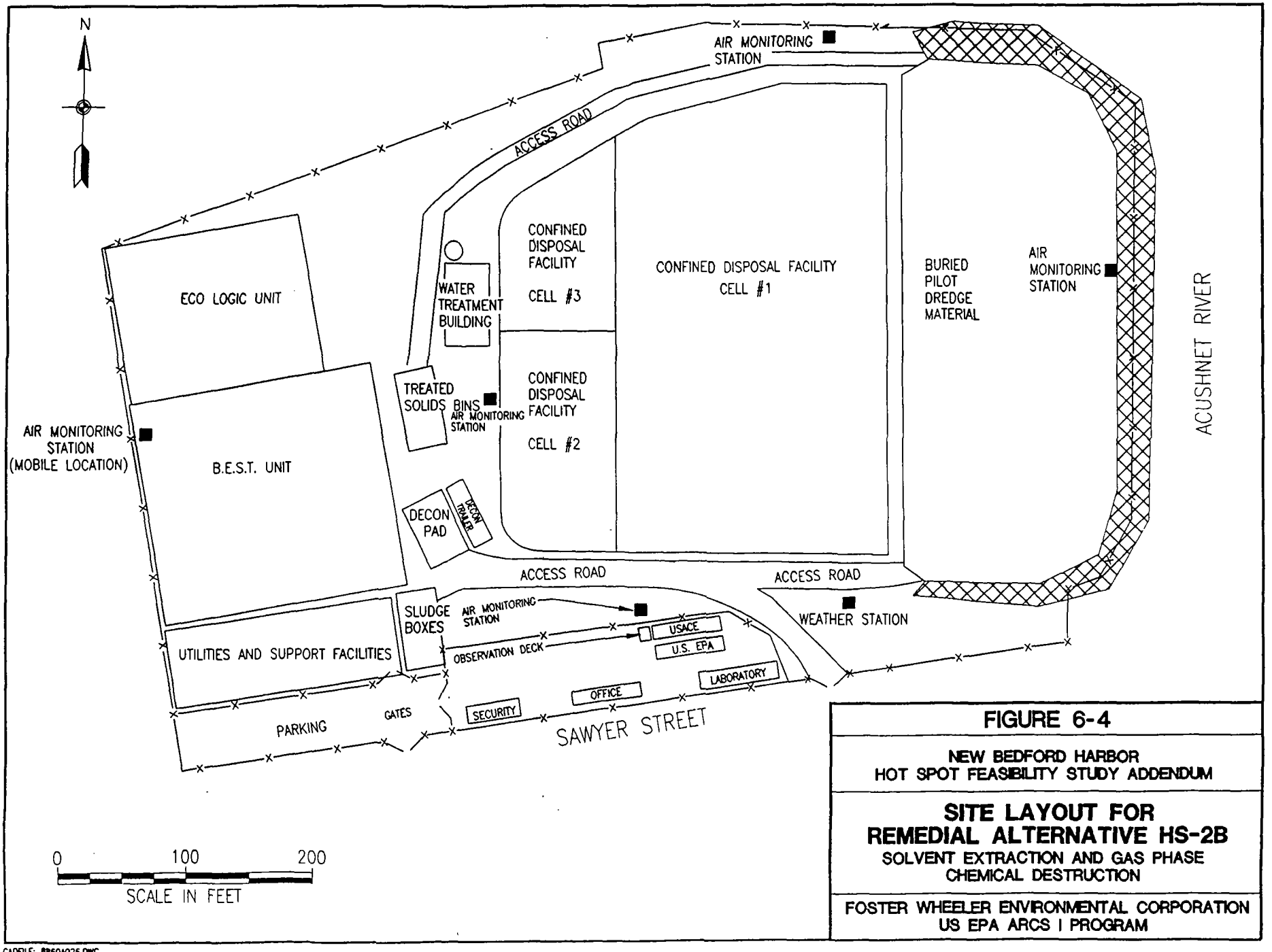


FIGURE 6-4

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-2B
SOLVENT EXTRACTION AND GAS PHASE CHEMICAL DESTRUCTION

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 88604026.DWG
DATE: 9/16/97

destruction process would treat approximately 3.2 tons per day of highly contaminated oil extract generated by the solvent extraction process. This estimated quantity is based on observations during the Hot Spot treatability study program and the projected throughput of the solvent extraction system of 136 tons of wet sediment per day. The observed generation rate for the oil extract from the treatability studies was approximately five to six gallons of concentrated extract for each ton of wet sediment treated. This results in a total of 423 tons of highly contaminated oil extract to be treated through gas phase chemical destruction.

The representative gas phase destruction process material utilizes a reducing environment of hydrogen and high temperature (900°C) to destroy the chlorinated organics including the PCBs. The results of the treatability studies demonstrated that the technology was effective in treating PCBs in the gas phase. The average Destruction and Removal Efficiencies (DRE) for four treatment runs was 99.99989%. The oily waste would likely be placed in the Sequential Batch Vaporizer (SBV) which is a heated autoclave-type chamber. The SBV vaporizes the contaminated oil into the hydrogen-rich hot recirculation gas.

The resulting vapor stream is drawn into the reactor chamber where the destruction of the PCBs and other chlorinated organic compounds occurs. The residence time in the reactor is on the order of seconds with the product gas routed to off-gas treatment system. The off-gas system would be designed to treat the reaction products and includes several scrubbers and a boiler system (thermal oxidizer). The conceptual off-gas treatment system for the oil extract from the Hot Spot sediments includes three scrubbers and a boiler system to ensure that any particulates, hydrochloric acid, hydrogen sulfide, benzene and naphthalene are removed from the off-gas.

A portion of the off-gas could be recirculated within the system and the remaining off-gas stored, tested and used as fuel for the boiler system to heat ancillary system components. Process effectiveness is evaluated on a real-time basis through the measurement of monochlorobenzene in the off-gas. This compound is used as a surrogate to estimate PCB destruction. Theoretically, monochlorobenzene is generated during the last step in the break-down of the PCBs within the process before final dechlorination to benzene.

The New Bedford Hot Spot treatability study involving the gas phase reactor was conducted using thermal desorption as the separation step rather than the solvent extraction process that would be used for this alternative. The SBV application that would be appropriate for this alternative was not tested on a site specific basis. However, this is not anticipated to be a problem as the gas phase chemical destruction component of the treatability study was successful and the SBV application has a successful track record in treating highly concentrated PCB wastes at full scale. This experience base includes such wastes as PCB transformer oil. Additional details on the gas phase chemical destruction process, related treatment equipment and potential full scale treatment operations are presented in Section 4.4

6.2.3.2 Overall Protection of Human Health and the Environment

Remedial alternative HS-2B will achieve and maintain protection of human health and the environment. This will be accomplished through permanent treatment of over 99% of the PCBs associated with the hot spot sediments. The hot spot sediments will be treated to below the treatment goal of 50 ppm. Disposal of the treated sediments in an on-site CDF will greatly reduce the potential risks due to direct contact, and inhalation. Disposal of the treated sediments in an on-site CDF will also protect the environment.

6.2.3.3 *Compliance with ARARs*

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-2B. Complete listings of these respective ARARs are presented in Tables B-2B-1, B-2B-2 and B-2B-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-2B. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. HS-2B qualifies as an alternative disposal remedy that requires approval by the Regional Administrator, based on the requirements of TSCA.

HS-2B will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-2B will require PCB contaminated sediments to be stored on site for approximately five years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the treated sediments containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction and treatment technologies, and handling of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment will be required for the process discharges and possibly for surface run off becoming contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its

Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF)and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.3.4 Long Term Effectiveness

Alternative HS-2B would provide long term effectiveness through treatment of the Hot Spot sediments with a combination of solvent extraction and gas phase chemical destruction. Treated residuals would be less than 50 ppm PCB and will be disposed of in an on-site CDF.

The on-site controls to manage the residuals are sufficient and would isolate the sediments from direct content and potential volatilization. The CDFs also are underlain by a relatively impermeable harbor sediment that will act as a barrier for leaching and finally, the CDF would be designed with an impermeable side wall as an additional control measure. It should also be noted that the metals that remain in the sediment are not expected to be significantly leachable as they successfully passed TCLP testing.

6.2.3.5 Reduction in Mobility, Toxicity, and Volume

This alternative will significantly reduce the volume and toxicity of the hot spot sediments. The volume reduction is expected to be greater than 97% through solvent extraction. The gas phase destruction step will significantly reduce the toxicity of the hot spot sediments by destroying over 99% of the PCBs removed through solvent extraction.

6.2.3.6 Short Term Effectiveness

The time to complete the remedial actions under alternative HS-2B is approximately five years. This estimate includes one to two years of design and procurement activities and a three year period to fabricate the treatment equipment and complete the clean-up operations.

Protection of the community and the workers conducting the remediation are also considered under this criterion. The primary remedial components of alternative HS-2B are sediment removal and treatment operations. The process of removing the sediments from the CDF and handling them prior to treatment could generate air emissions. This potential for air emissions will be minimized by using a vacuum truck equipped with a vapor phase treatment system and storage of the sediments in sludge boxes vented to carbon canisters prior to treatment.

The use of the solvents such as diisopropylamine, hydrogen and the combination of other process components, such as boilers, pose potential risks to on-site workers and nearby residents. These risks can be greatly minimized through compliance with appropriate industry standards, the development and compliance with appropriate procedures and controls, and a complete HAZOP analysis of the treatment equipment prior to the start of treatment operations. In addition, treatment equipment operations would be monitored to ensure compliance with applicable emissions criteria.

An implementability concern discussed below for Alternative HS-2B is also reflected in the short term effectiveness criterion as it relates to worker and community safety. This concern is the small size of the available treatment area and two processes that each have significant hazard potential. Again, this would have to be reviewed in significant detail within a formal HAZOP review.

Worker health and safety would be addressed through requirements specified in a site-specific Health and Safety Plan (HASP). This plan will stipulate the appropriate personnel protective equipment and monitoring criteria. A site wide air monitoring program would also be implemented to ensure protection of workers and area residents.

6.2.3.7 Implementability

The Implementability of alternative HS-2B includes the technical and administrative feasibility of the alternative and the availability of the services and materials. The solvent extraction system could take up to eighteen months to fabricate and test prior to delivery at the site. The gas phase destruction unit could also be delivered within this eighteen month time frame.

An aspect of implementability that would have to be further evaluated during design is the limited space available at the site. This may potentially impact how these two technologies would be implemented and is related to the nature of their treatment operations, their associated reagents and industry standards for spacing between certain types of process components. For example, flammable solvents and the potential for open flames. Again, this would have to be addressed as part of the design process to ensure safety.

Technologies are readily available to confirm that solvent extraction can treat the Hot Spot sediment to a residual PCB concentration of 50 ppm or less. Similar technologies are also readily available to confirm successful treatment of the oily waste generated through solvent extraction and compliance with any relevant emissions criteria.

Implementation of these processes will take a significant level of coordination with local, police, fire, hazmat and hospital personnel, given the operational aspects of these two processes. Significant coordination would also occur between the federal and state agencies responsible for overall implementation of the alternative.

The limited number of potential vendors that could successfully implement these technologies needs to be considered in evaluating this treatment approach. As a result, the competitive bidding process could be somewhat limited.

6.2.3.8 Cost

The costs for alternative HS-2B include site preparation, sediment removal operations, solvent extraction, gas phase chemical destruction, treated materials handling and air monitoring. The total alternative cost of approximately $31.9 million includes the direct costs for the activities mentioned above and indirect costs to cover nonconstruction related items such as engineering, health and safety and legal and permitting (Table 6-5). A twenty percent contingency factor has also been included to cover items not anticipated at this time.

Since the treated residuals will be placed in an on-site CDF, Operation and Maintenance (O&M) costs to monitor and maintain the treated solids are not included.

6.2.3.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.3.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-5
Cost Estimate: Remedial Alternative HS-2B
Solvent Extraction and Gas Phase Chemical Destruction

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Solvent Extraction	10,548,000
D. Gas Phase Chemical Destruction	5,131,836
E. Treated Materials Handling	337,115
F. Air Monitoring	1,152,000
TOTAL DIRECT COST (TDC)	**$17,747,251**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	887,363
B. Legal, Administration, Permitting (@ 10% of TDC)	1,774,725
C. Engineering (@ 10% of TDC)	1,774,725
D. Services During Construction (@ 10% of TDC)	1,774,725
E. Turnkey Contractor Fee (@ 15% of TDC)	2,662,088
TOTAL INDIRECT COST (TIC)	**$8,873,626**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$26,620,877**
CONTINGENCY (@ 20% of TDC + TIC)	5,324,175
TOTAL CAPITAL COST	**$31,945,052**
TOTAL COST REMEDIAL ALTERNATIVE HS-2B	**$31,945,052**

6.2.4 Alternative HS-2C: Solvent Extraction and Off-Site Incineration

This section of the FS Addendum describes Remedial Alternative HS-2C and evaluates the alternative against the detailed evaluation criteria. Alternative HS-2C involves removal of the Hot Spot sediment from the CDF and treatment through a combination of solvent extraction (on-site) and off-site incineration. The solvent extraction process would separate the organic contaminants including the PCBs into a concentrated oil extract. This extract would then be shipped off-site to permitted incineration facility for destruction of the PCBs and other organic contaminants. Solid phase treatment residuals from the solvent extraction process would be placed in an on-site CDF.

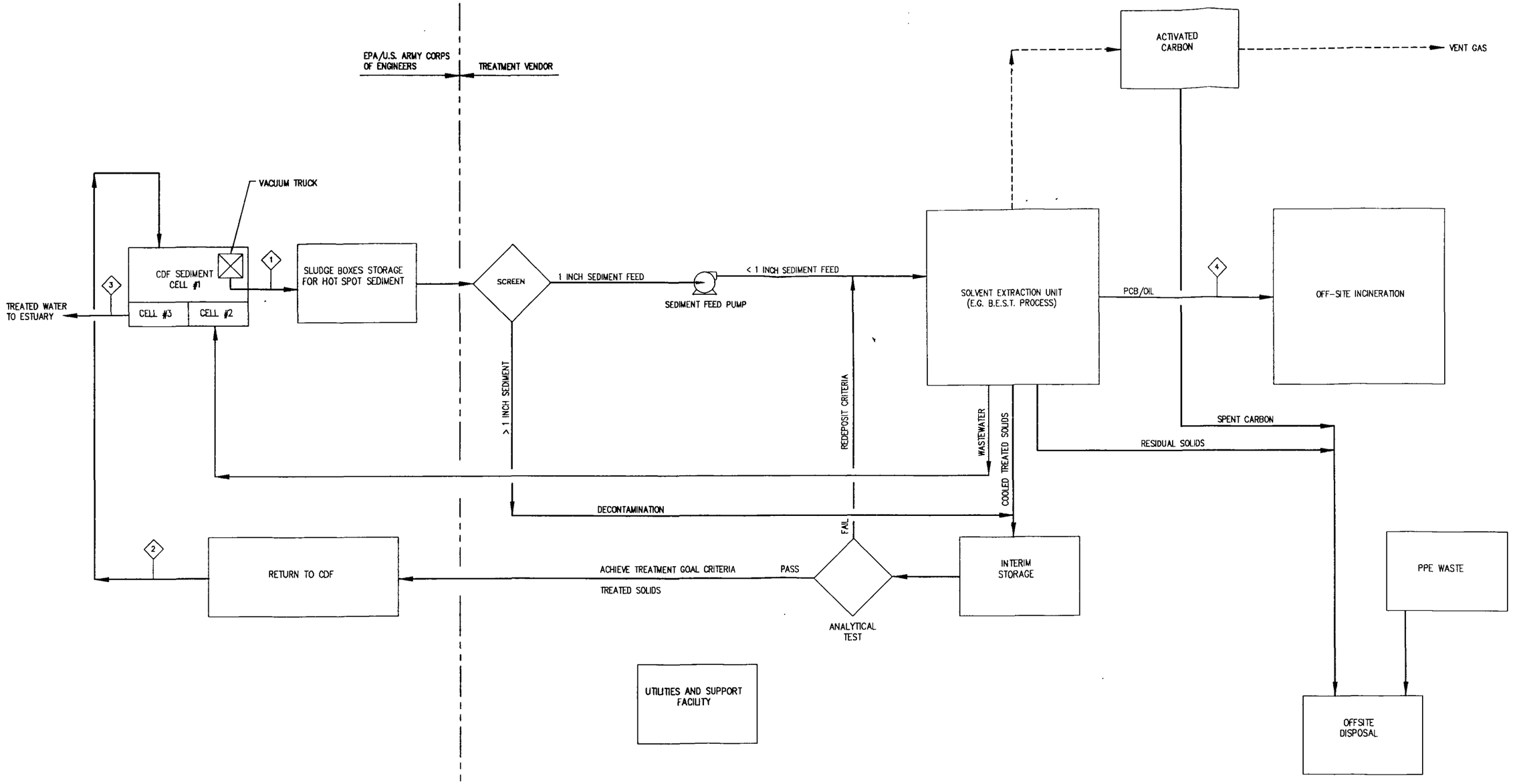
In developing this remedial alternative, the Ionics RCC B.E.S.T.® solvent extraction is used as representative treatment processes. It is important to note that discussion of this particular technology vendor is for illustrative purposes only.

6.2.4.1 General Description

Remedial Alternative HS-2C is a removal and treatment alternative with the separation component of the treatment activities occurring on the site and the contaminant destruction component occurring at a permitted off-site facility. The removal and treatment operations at the site would include the following activities; withdrawal of the Hot Spot sediments from the CDF, staging the sediments for treatment in sealed containers, screening the sediment to remove over-sized material, treating the contaminated sediments through solvent extraction, collecting and packaging the contaminated oil extract for shipment off-site and placement of the treated residuals in a CDF. Overall movement of materials from the CDF through the solvent extraction process and placement in the CDF is presented in Figure 6-5.

The initial treatment steps for alternative HS-2C are the same as those described for HS-2A in Section 6.2.2. These initial steps encompass the activities conducted from the initial upgrade of the site through the solvent extraction treatment and disposal of treated sediment in an on-site CDF. The first step in the cleanup process would be to upgrade existing site conditions to accommodate the materials handling and treatment operations. As with alternative HS-2A, the predominant feature of this initial step is the construction of a series of treatment pads and access roads, as shown on Figure 6-6. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2.

Other activities associated with the solvent extraction treatment process include removing the sediment from the CDF using a vacuum truck, transporting the sediment to the storage area and treatment unit, screening the sediment to remove oversize material, and treating the sediment using solvent extraction.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER	4 PCB/OIL
CUBIC YARDS	15,000	7,000	---	---
TONS	18,000	9,000	---	423
MM GALLONS	---	---	2.2	---

LEGEND

SOLID/SEMI-SOLID

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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-2C
SOLVENT EXTRACTION AND
OFF-SITE INCINERATION

SIZE — REV

FIGURE 6-5

SCALE: NONE — PLOTDATE 9/16/97 — SHEET 1 OF 1

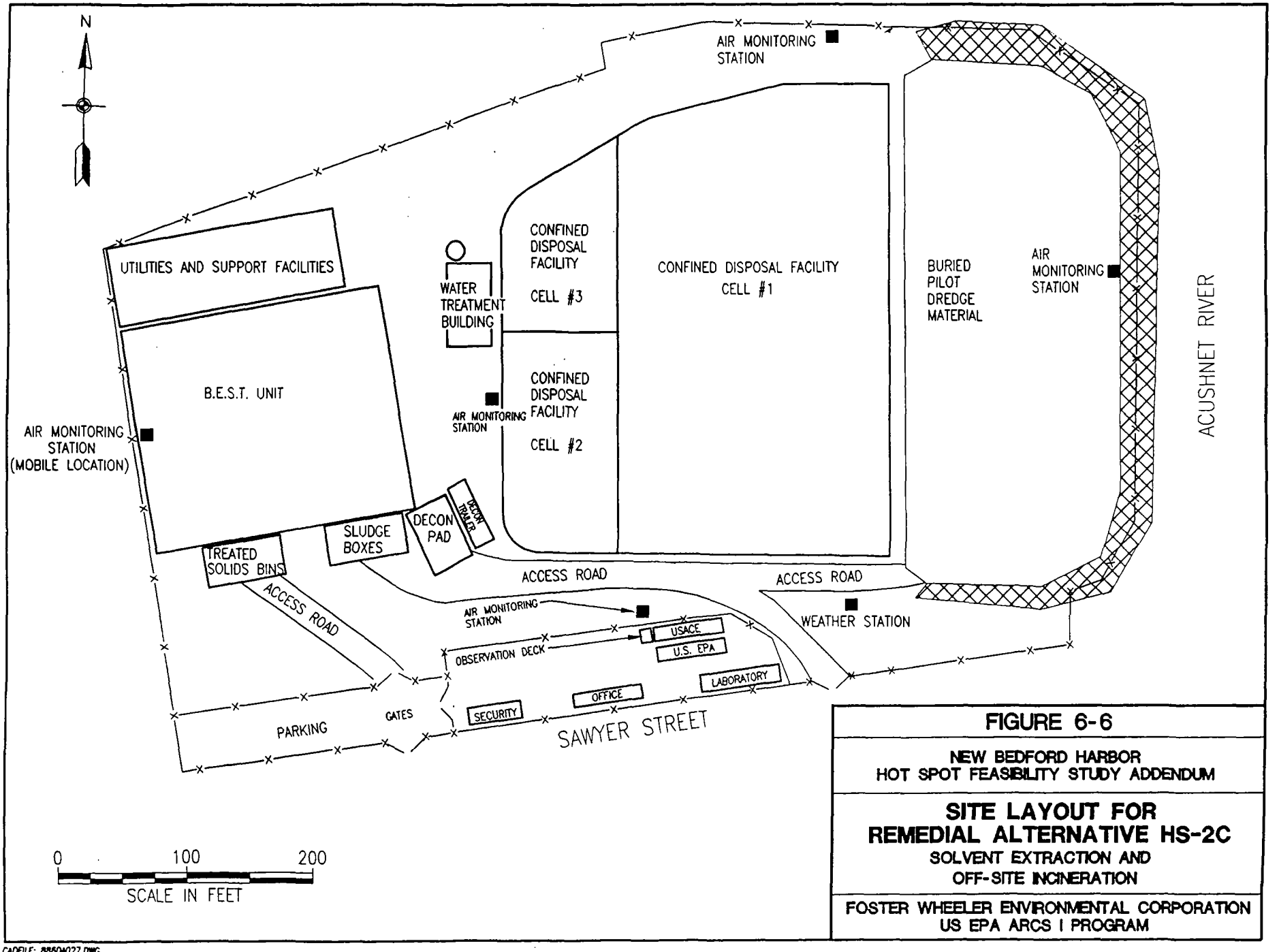


FIGURE 6-6

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-2C
SOLVENT EXTRACTION AND OFF-SITE INCINERATION

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A027.DWG
DATE: 9/25/97

The waste oil extract from the solvent extraction process would be placed in 55-gallon drums for interim storage and shipped regularly from the site (twice per week) to minimize the build-up of this highly contaminated material at the site. The off-site incineration will take place at a permitted off-site disposal facility specifically designed to accommodate wastes such as the oil extract from the Hot Spot sediments. The material is expected to have a high BTU content and treatment is expected to be relatively straight forward using this method. The primary performance criteria for the destruction of the PCBs will be a DRE of 99.9999%. Since the majority of the heavy metals will remain in the treated solids associated with the solvent extraction process, the oil waste is not expected to produce volatile metals emissions during incineration.

6.2.4.2 Overall Protection of Human Health and the Environment

Remedial alternative HS-2C will achieve and maintain protection of human health and the environment. This will be accomplished through permanent treatment of over 99% of the PCBs associated with the hot spot sediments. The hot spot sediments will be treated to below the treatment goal of 50 ppm. Disposal of the treated sediments in an on-site CDF will greatly reduce the potential risks due to direct contact, and inhalation. Disposal of the treated sediments in an on-site CDF will also protect the environment.

6.2.4.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-2C. Complete listings of these respective ARARs are presented in Tables B-2C-1, B-2C-2 and B-2C-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-2C. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidances are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. HS-2C qualifies as utilization of an approved incinerator for the ultimate destruction of PCBs under TSCA.

HS-2C will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-2C will require PCB contaminated sediments to be stored on site for approximately five years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). PCB oil extracted by the solvent extraction process will be shipped regularly to the incinerator facility so to minimize on-site storage. Storage of the PCB dredge spoil and extracted PCB oil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does <u>not</u> meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the treated sediments containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction technologies, and handling of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment will be required for the process discharges and possibly for surface run off becoming contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF)and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.4.4 Long Term Effectiveness

Alternative HS-2C will provide long term protection of public health and the environment. This will be accomplished through treatment of the Hot Spot sediments with a combination of solvent extraction and off-site incineration at an approved TSCA facility. Treated sediment will contain less than 50 ppm PCB and will be disposed of in on-site CDF.

The on-site controls to manage the residuals are sufficient and will isolate the sediments from direct content and potential volatilization. The CDF is underlain by a relatively impermeable harbor sediment that would act as a barrier for any leaching and finally, the CDF would be designed with an impermeable side wall as an additional control measure. It should also be noted that the metals that remain in the sediment are not expected to be significantly leachable as they successfully passed TCLP testing.

6.2.4.5 Reduction in Mobility, Toxicity, and Volume

This alternative will significantly reduce the volume and toxicity of the hot spot sediments. The volume reduction is expected to be greater than 97% through solvent extraction. Off-site incineration will significantly reduce the toxicity of the hot spot sediments by destroying over 99% of the PCBs removed through solvent extraction. The processes are both irreversible and produce treatment residuals that pose little risk.

6.2.4.6 Short Term Effectiveness

The time to complete the remedial actions under alternative HS-2C is approximately five years. This estimate includes one to two years of design and procurement activities and a three year period to fabricate the treatment equipment and complete the clean-up operations.

Protection of the community and the workers conducting the remediation are also considered under this criterion. The primary remedial components of alternative HS-2C are sediment removal, on-site treatment operations, interim storage of the extracted PCBs and off-site shipment to an incinerator. The process of removing the sediments from the CDF and handling them prior to treatment could generate air emissions. This potential for air emissions will be minimized by using a vacuum truck equipped with a vapor phase treatment system and storage of the sediments in sludge boxes vented to carbon canisters prior to treatment.

The use of the solvents such as diisopropylamine could pose potential risks to on-site workers and nearby residents. These risks can be greatly minimized through compliance with appropriate industry standards, the development and compliance with appropriate procedures and controls, and a complete HAZOP analysis of the treatment equipment prior to the start of treatment operations. In addition, treatment equipment operations would be monitored to ensure compliance with applicable emissions criteria.

Worker health and safety would be addressed through requirements specified in a site-specific Health and Safety Plan (HASP). This plan will stipulate the appropriate personnel protective equipment and monitoring criteria. A site wide air monitoring program would also be implemented to ensure protection of workers and area residents.

No adverse environmental impacts are anticipated while implementing alternative HS-2C.

6.2.4.7 Implementability

The implementability of alternative HS-2C includes the technical and administrative feasibility of the alternative and the availability of the services and materials. The solvent extraction process has been implemented at full-scale, yet a new full-scale unit would have to be built for this project. Given one to two years for design and procurement, it will take five years to fabricate and test the solvent extraction unit and implement the removal and treatment activities. The reliability of the technology is expected to be reasonable for innovative treatment technology equipment. This is based on the unit process components of the system that are widely available in the market place and have a long operating history.

At the writing of this document, off-site incineration is available to treat hazardous wastes. It is possible that facilities may not be available in the future to incinerate the wastes. One of the largest treatment units in the country recently indicated that it would no longer be accepting wastes.

Technologies are readily available to confirm that solvent extraction can treat the Hot Spot sediment to a residual PCB concentration of 50 ppm or less. Similar technologies are also readily available to confirm compliance with any relevant emissions criteria.

On-site implementation of solvent extraction will require the coordination of federal, state and local officials. The local coordination will likely extend to the police and fire departments; hazmat team and EMTs; and the local hospital.

Given the limited number of full-scale solvent extraction systems for hazardous waste treatment, there is concern regarding the competitiveness of the bidding process for this alternative.

6.2.4.8 Cost

The costs for alternative HS-2C include the capital costs to upgrade the site facilities, removal of the sediment from the CDF, treatment through solvent extraction, off-site incineration of the concentrated oil extract, materials handling of the treated solids, and air monitoring.

The total estimated cost for this alternative is approximately $24.9 million, includes the direct costs described above and indirect costs to cover nonconstruction related items such as engineering, health and safety and legal and administrative (Table 6-6) costs. A contingency factor has also been included to cover items not anticipated at this time.

6.2.4.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.4.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-6
Cost Estimate: Remedial Alternative HS-2C
Solvent Extraction and Off-Site Incineration

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Solvent Extraction	10,548,000
D. Off-Site Incineration	1,202,685
E. Treated Materials Handling	337,115
F. Air Monitoring	1,152,000
TOTAL DIRECT COST (TDC)	**$13,818,100**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	690,905
B. Legal, Administration, Permitting (@ 10% of TDC)	1,381,810
C. Engineering (@ 10% of TDC)	1,381,810
D. Services During Construction (@ 10% of TDC)	1,381,810
E. Turnkey Contractor Fee (@ 15% of TDC)	2,072,715
TOTAL INDIRECT COST (TIC)	**$6,909,050**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$20,727,150**
CONTINGENCY (@ 20% of TDC + TIC)	4,145,430
TOTAL CAPITAL COST	**$24,872,580**
TOTAL COST REMEDIAL ALTERNATIVE HS-2C	**$24,872,580**

6.2.5 Alternative HS-3A: Thermal Desorption and Solid Phase Chemical Destruction

This section and the following sections (6.2.6 and 6.2.7) discuss three remedial alternatives involving thermal desorption of contaminants from the Hot Spot and the subsequent chemical destruction of those contaminants. Several thermal desorption units are potentially available and applicable to treat the Hot Spot sediments, including the Eco Logic unit tested at pilot scale. Those processes most applicable to the Hot Spot sediment were chosen as representative technologies for evaluation purposes. The range of thermal desorption units, associated off-gas treatment systems and the units chosen for this evaluation are discussed in more detail in Section 6.2.5.1.

Section 6.2.5.2 of this FS Addendum describes Remedial Alternative HS-3A and evaluates the alternative against the detailed evaluation criteria. Alternative HS-3A involves removal of the Hot Spot sediment from the CDF and treatment through a combination of thermal desorption and solid phase chemical destruction. The thermal desorption process would separate the organic contaminants including the PCBs into a concentrated oil extract. This extract would then be treated through solid phase chemical destruction. Solid phase residuals from both processes would then placed in the CDF.

In developing remedial alternative HS-3A, the Maxymillian Technologies, Inc. Indirect Desorption System (IDS) and the CRTI SET® solid phase chemical destruction processes are used as representative treatment processes. It is important to note that discussion of these particular technology vendors is for illustrative purposes only.

6.2.5.1 Thermal Desorption Background

Before describing the details of remedial alternatives that use thermal desorption, it is important to review some basics of the process for treating contaminated sediment including: (i) how the technology works to separate the PCBs from the sediment; and, (ii) a description of several potential technical approaches. This background information is important to understanding how the representative thermal desorption processes presented in alternatives HS-3A, HS-3B and HS-3C fit into the wide range of potential equipment options.

Thermal desorption is a treatment technology that heats the sediment to separate (desorb) the contaminants from the sediment. At temperature levels of up to 1000°F, the contaminants vaporize from the sediment and are typically collected and treated. Most thermal desorption systems potentially applicable to PCB contaminated sediment provide the heat indirectly. In these systems, the contaminated sediment does not come into contact with a flame or combustion gas. Rather, the outside of a metal cylinder is often heated and the hot metal indirectly heats the sediment tumbling inside. Other means are available for indirectly heating the sediment, such as, the molten tin bath used by the Eco Logic system. This system was tested during the treatability study test program and is used as a representative thermal desorption process for remedial alternative HS-3B.

As the sediment is heated, the moisture and the contaminants vaporize and become part of the gas stream flowing through the desorber. Many systems use a gas such as nitrogen or hydrogen to reduce the oxygen content in the gas stream as a method of limiting the formation of dioxins and furans. Other systems such as the indirect system presented in this alternative do not use a flow through gas stream. Instead, the unit operates under negative pressure through induction type fan and steam/vapor mix that

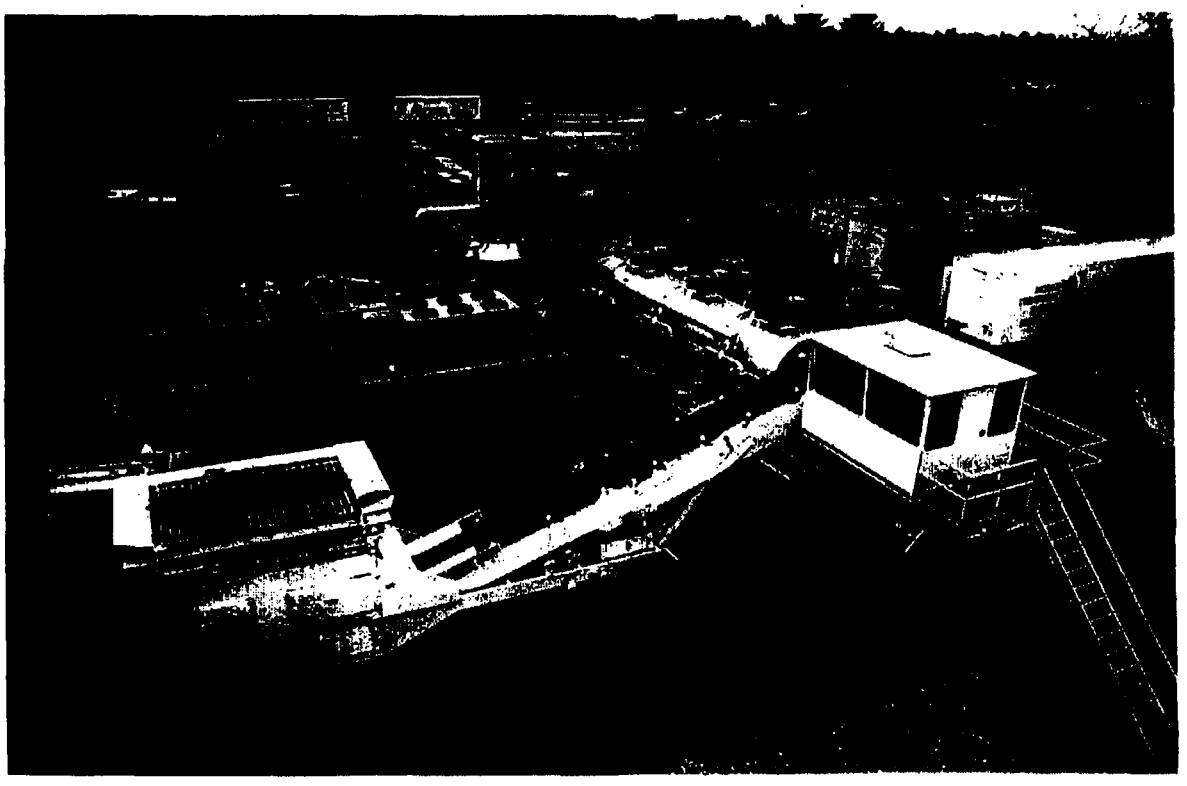
evolves during thermal separation and carries the contaminants out of the indirect desorption system and into the off-gas treatment system.

Treatment of the vapor phase organic contaminants such as PCBs can be accomplished through a variety of means including gas phase chemical destruction, collection on activated carbon, or recovery (of an organic oil-like product) in condensing equipment. In the latter two cases, the contaminants will require additional treatment through some other means such as incineration.

In addition to the treatment of organic contaminants, the thermal desorption off-gas will require additional treatment to address inorganic and particulate removal. Several potential off-gas treatment system components and their functions include; scrubbers to remove particulate and potential acids, condensing units to remove the moisture from the off-gas stream and reduce gas flow volumes, and baghouses and/or HEPA filters for particulate removal. These components are particularly important for the Hot Spot sediments which are fine grained, contain volatile metals such as lead, and will produce hydrogen sulfide and hydrochloric acid as the gases are cooled within the off-gas system.

Remedial Alternative HS-3A and HS-3C use an indirect thermal desorption system constructed by Maxymillian Technologies, Inc. as a representative process. The conceptual process flow diagram for the unit is presented in Figure 6-7. A Maxymillian unit recently treated PCB contaminated soils at throughput rates of up to 16 tons per hour at a hazardous waste site. The unit treated over 14,000 tons of PCB contaminated soils to residual concentrations below 2 ppm PCB. A photograph of the Maxymillian thermal desorption unit and related support equipment is presented in Exhibit 6-2.

Exhibit 6-2
Photograph of Maxymillian Thermal Desorption Unit



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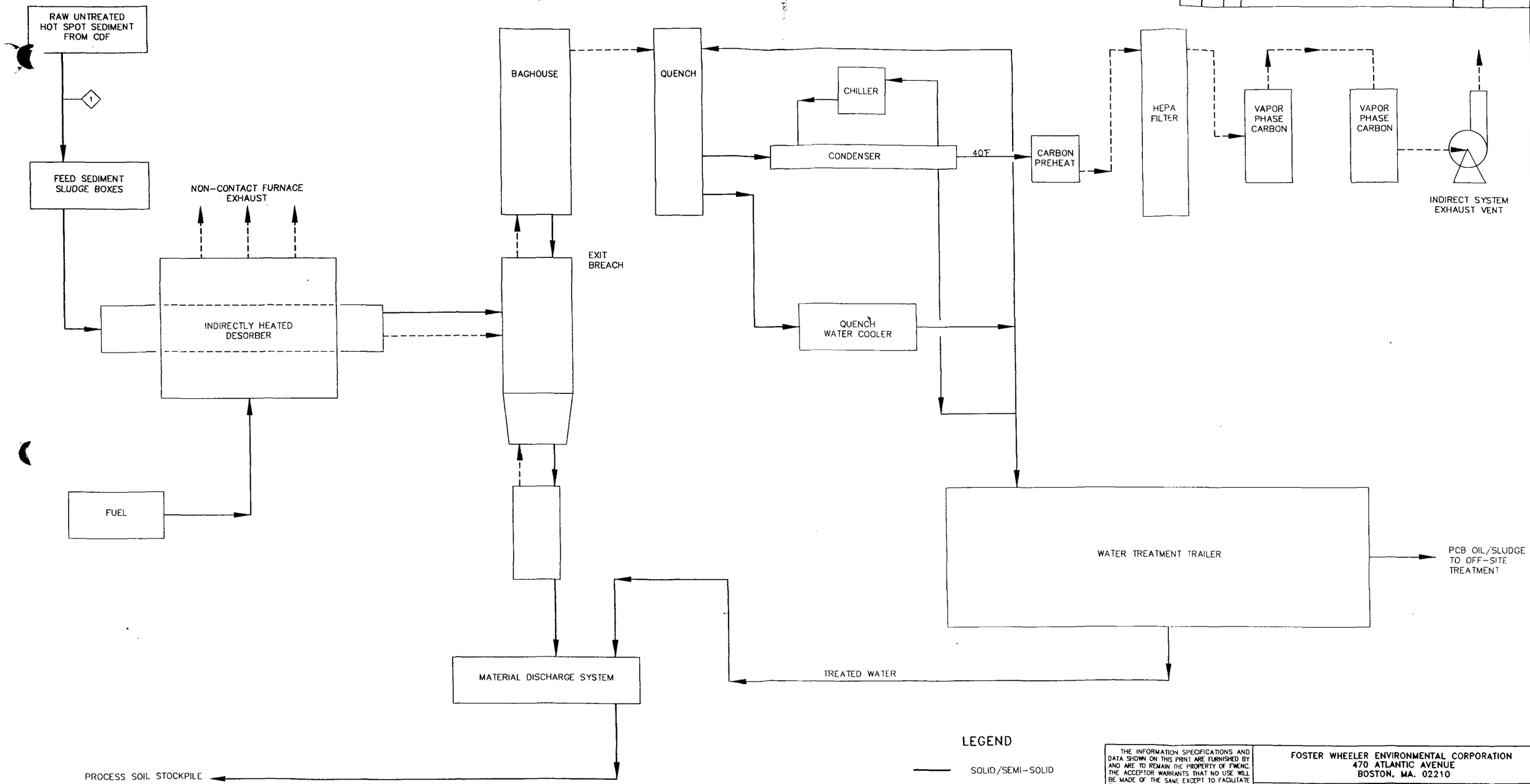

LEGEND

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LIQUID

NOTE:
PROCESS FLOW DIAGRAM WAS PREPARED BY MAXYMILLIAN TECHNOLOGIES, AND ADAPTED BY FOSTER WHEELER ENVIRONMENTAL CORPORATION.

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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

MAXYMILLIAN THERMAL DESORBER
FULL-SCALE PROCESS SCHEMATIC

SIZE		REV
D	FIGURE 6-7	—

SCALE: NONE | PLOTDATE 9/4/97 | SHEET 1 OF 1

6.2.5.2 General Description

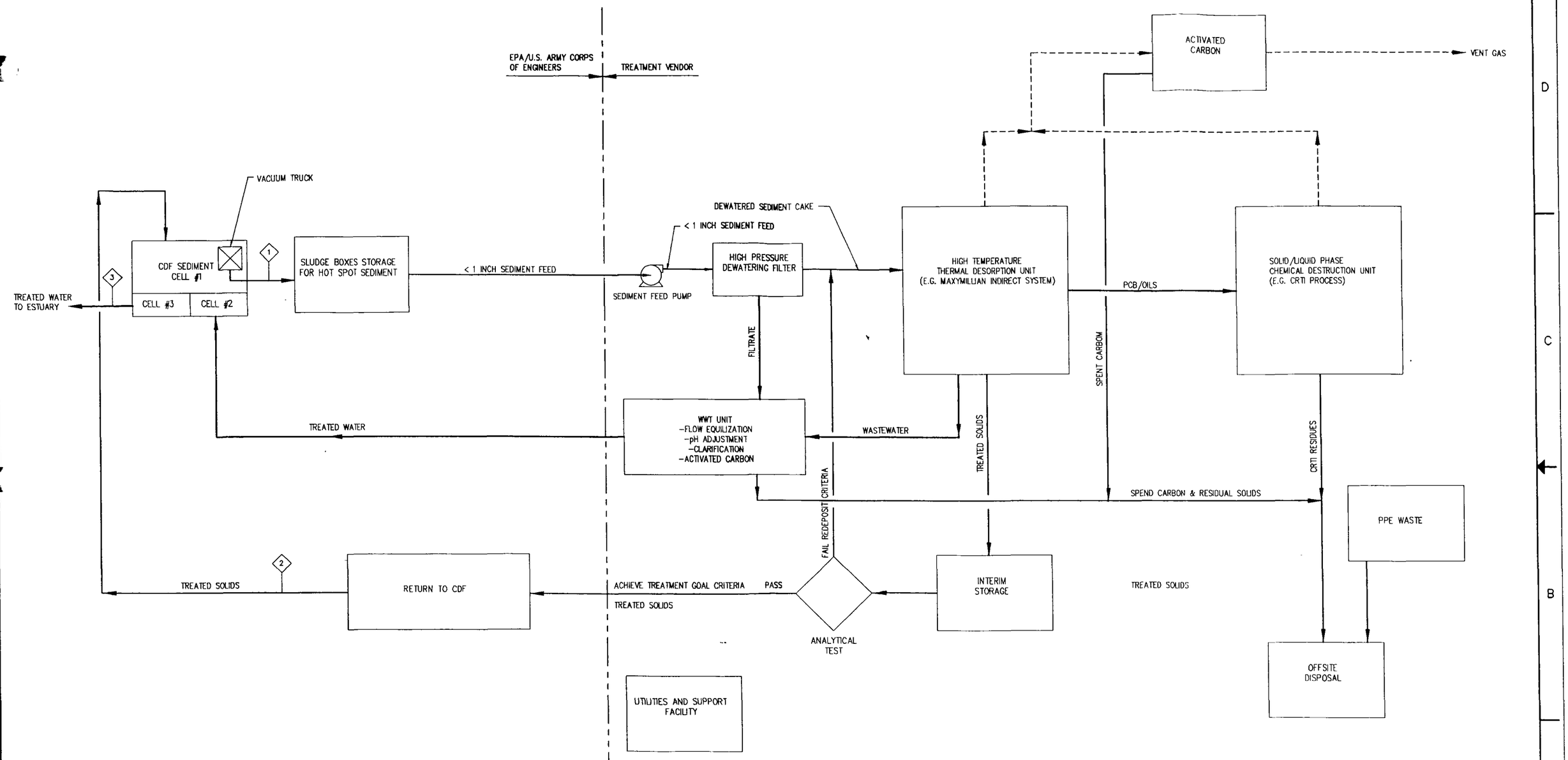
Remedial Alternative HS-3A is a removal and treatment alternative with all treatment activities occurring at the site. The removal and treatment operations includes the following activities: withdrawal of the Hot Spot sediments from the CDF, staging the sediments for treatment in sealed containers, mechanical dewaterings, treating the contaminated sediments using thermal desorption, treating the resulting oil extract with solid phase chemical destruction, and placement of the treated residuals in a CDF. Overall movement of materials from the CDF through the various treatment processes and back to the CDF is presented in Figure 6-8.

The initial treatment steps for alternative HS-3A are the same as those described for HS-2A in Section 6.2.2. These initial steps encompass the activities conducted from the initial upgrade of the site through staging and storing sediment prior to thermal desorption. The first step in the cleanup process will be to upgrade existing site conditions to accommodate the materials handling and treatment operations. As with alternative HS-2A, the predominant feature of this initial step is the construction of a series of treatment pads and access roads, as shown on Figure 6-9. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2.

Prior to the thermal desorption, the sediment would undergo a mechanical dewatering step to increase the solids content. In summary, the sediment is placed in an apparatus that squeezes the water out of the sediment. The dewatering step is done to decrease the treatment costs for thermal desorption as the utility costs, unit efficiency and processing time are directly related to amount of moisture in the sediment.

Mechanical dewatering is estimated to increase the solids content of the sediment from 50%, up to 62%. While this may not seem numerically significant, this increase is quite significant and results in the removal of over 800,000 gallons of water from the 18,000 tons of Hot Spot sediment. The dewatering estimate was developed using sediment from New Bedford Harbor and bench scale test equipment. The dewatering tests were conducted as part of a treatability study program conducted for the site during the late 1980s (Ebasco, 1989). During this study, sediment at 38% solids were increased to 62% solids. Accordingly, the above estimate of 62% solids may be biased on the low side given an expected initial solids content of 50%. However, dewatering is a technical matter that should be approached cautiously as 62% solids may be the upper limit using mechanical equipment, regardless of the starting point.

Following dewatering, the PCBs and other organics would be separated from the Hot Spot sediments using an indirectly heated thermal desorption unit operating at temperatures of up to 1000°F. The treated solids would be tested to determine if the target cleanup goal of 50 ppm has been reached. Residual solids will be disposed in a CDF if the target cleanup goal of 50 ppm is met. Additional treatment cycles will be required for those solids which do not meet the criteria. Based on the results of the pilot scale treatability study program, thermal desorption should be able to meet this goal. While the average residual PCB concentration achieved during the recent treatability studies was slightly above this goal (52 ppm), the mechanical difficulties experienced by the vendor (Eco Logic) seem to provide a reasonable explanation as to why these results were atypical. Based on the treatability studies, the residual solids from the thermal desorption process pass TCLP testing and additional treatment with solidification does not appear needed.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER
CUBIC YARDS	15,000	7,000	---
TONS	18,000	9,000	---
MM GALLONS	---	---	2.2M

LEGEND

- SOLID/SEMI-SOLID
- VAPOR
- LIQUID
- MATERIAL BALANCE

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HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-3A
THERMAL DESORPTION AND SOLID PHASE CHEMICAL DESTRUCTION

SIZE — FIGURE 6-8 — REV

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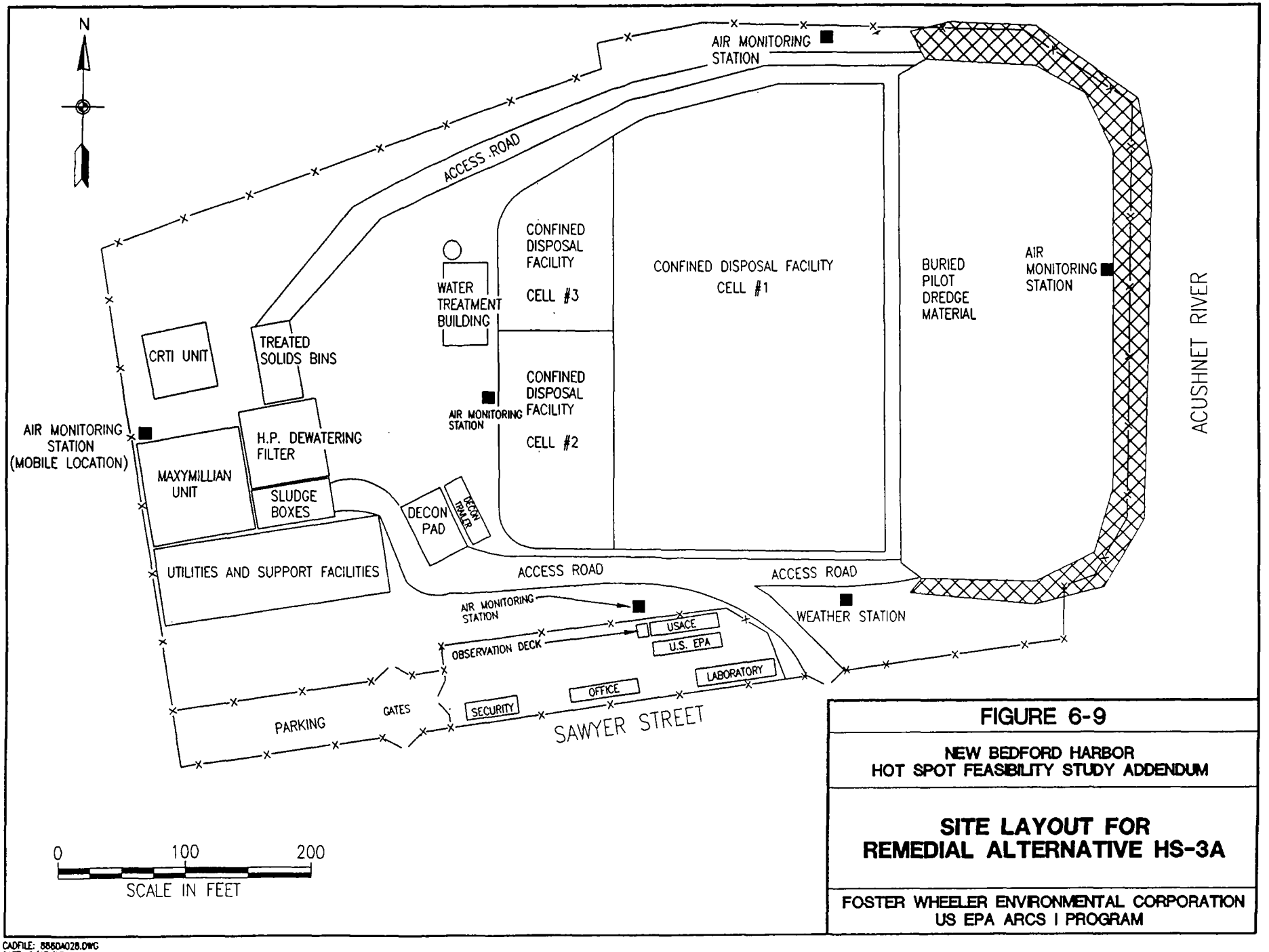

FIGURE 6-9

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-3A

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

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DATE: 9/17/97

The off-gas from the thermal desorption process would undergo subsequent treatment to remove the particulates, the vapor phase organics and heavy metals that may have volatilized. The Maxymillian Technology IDS uses a high temperature bag house as the first step in the off-gas treatment train to remove particulates. Given the high temperature of the off-gas at this location, the particulates captured are typically not contaminated and may be combined with the other solid phase treatment residuals. The particulate free off-gas is then subject to a quench cycle and passed through a shell and tube condenser which is maintained at a low temperature with a glycol based chiller system. The results of these processes are two waste streams, one liquid, and one vapor phase.

The liquid waste stream generated through quenching and condensing operations is likely to have two separate phase products, the high molecular weigh organic contaminants such as PCBs, in a separate oil phase, and a water phase. The separate oil phase product becomes the feed material for the solid phase chemical destruction process. The remaining water will undergo several additional treatment steps prior to discharge to the on-site treatment system for final polishing.

The vapor phase stream is then pre-heated to reduce the moisture content thereby increasing the efficiency of the carbon polishing step. The off-gas also passes through a HEPA filter for fine particulate removal including vapor phase heavy metals that may have re-condensed.

The solid phase chemical destruction process operates similarly to that described in Section 6.2.2 for alternative HS-2A (solvent extraction with solid phase chemical destruction). Although, the solid phase chemical destruction process was not tested in conjunction with the thermal desorption process, sufficient data were gathered during the pilot testing and are available from other implementation of the thermal desorption technology to make some generalized assumptions for the purpose of discussing the combination of thermal desorption and chemical destruction.

It is assumed that the solid phase chemical destruction process would treat the same mass of oil as alternative HS-2A, approximately 3.2 tons per day, or 423 tons in total. This estimated quantity is based on observations during the Hot Spot treatability study program and available data for the Hot Spot sediment.

The representative solid phase destruction process material utilizes elemental sodium and ammonia to destroy the chlorinated organics, including the PCBs. The results of the treatability study demonstrated that the technology was capable of treating the extracted oil from initial PCB concentrations of approximately 50,000 ppm down to the 1 to 5 ppm range. Additional details on the process, related treatment equipment and potential full scale treatment operations are presented in Section 4.2

On-site disposal of the treated residuals from the solid phase chemical destruction step may potentially be more problematic. The treatment residual from this process is estimated to only be 600 cubic yards. While this is a relatively small quantity, the issue of whether or not it can be disposed of in a CDF without addition treatment could be a much larger issue and one that is currently unresolved. During the pilot scale studies, the reactive nature and high pH of this product made handling complex. While CRTI is working to resolve these issues, the potential impacts of a reactive, high pH waste residual include additional controls during treatment operations to ensure worker safety and health and potential cost impacts. These impacts are associated with the potential need to perform additional conditioning and/or

disposal of the residuals in an off-site permitted disposal facility. It is important to note that the potential cost impact for off-site disposal could exceed $500,000.

6.2.5.3 Overall Protection of Human Health and the Environment

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Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. HS-3A qualifies as an alternative disposal remedy that requires approval by the Regional Administrator, based on the requirements of TSCA.

HS-3A will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-3A will require PCB contaminated sediments to be stored on site for approximately five years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does <u>not</u> meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the treated sediments containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction and treatment technologies, and handling/dewatering of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling, dewatering, and processing.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF)and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.5.5 Long-Term Effectiveness

Alternative HS-3A will provide long term effectiveness and permanence through treatment of the hot spot sediments with a combination of thermal desorption and solid phase chemical destruction. Treated residuals will be less than 50 ppm PCB and will be disposed of in an on-site CDF.

The on-site controls to manage the residuals are more than adequate. The on-site CDF will isolate the sediments from direct contact and potential volatilization. The treated sediments are also underlain by a relatively impermeable harbor sediment that would act as a barrier for leaching and finally, the CDF will be designed with an impermeable side wall as an additional control measure. It should also be noted that the metals that remain in the sediment are not expected to be significantly leachable as they successfully passed TCLP testing.

6.2.5.6 Reduction in Mobility, Toxicity and Volume

This alternative will significantly reduce the volume and toxicity of the hot spot sediments. The volume reduction is expected to be greater than 99% through thermal desorption. The solid phase destruction step will significantly reduce the toxicity of the hot spot sediments by destroying over 99% of the PCBs removed through thermal desorption. The results of the treatability studies indicated that while thermal desorption does increase the mobility of the metal in the treated solids they do not exceed the relevant TCLP criteria.

6.2.5.7 Short-Term Effectiveness

The time to complete the remedial actions under alternative HS-3A is approximately five years. This estimate includes one to two years of design and procurement activities and a three year period to fabricate the treatment equipment and complete the clean-up operations.

Protection of the community and the workers conducting the remediation are also considered under this criterion. The primary remedial components of alternative HS-3A are sediment removal and treatment operations. The process of removing the sediments from the CDF, dewatering and handling them prior to treatment could generate air emissions. This potential for air emissions will be minimized by using a vacuum truck equipped with a vapor phase treatment system and storage of the sediments in sludge boxes vented to carbon canisters prior to treatment.

The use of the solid phase chemical destruction reagents such as elemental sodium and ammonia pose potential risks to on-site workers and nearby residents. These risks can be greatly minimized through compliance with appropriate industry standards, the development and compliance with appropriate procedures and controls, and a complete HAZOP analysis of the treatment equipment prior to the start of treatment operations. In addition, treatment equipment operations would be monitored to ensure compliance with applicable emissions criteria.

There are also potential short-term effectiveness concerns with the treatment residuals from the solid phase destruction process including high pH and reactivity. If the treated product demonstrates the characteristics observed during the pilot studies, additional safety measures will be required during full-scale operations.

The thermal process separates the PCBs from the sediment at up to 1000°F, and as a result has the potential to volatilize metals such as lead. The possibility also exists for the creation of dioxins and furans. Although there compounds are already present in the Hot Spot sediment and will separate out with PCBs and water, there is still the potential for the creation of these compounds. These compounds along with the volatile metals can be effectively treated using commonly available off-gas control technologies.

Worker health and safety would be addressed through requirements specified in a site-specific Health and Safety Plan (HASP). This plan will stipulate the appropriate personnel protective equipment and monitoring criteria. A site wide air monitoring program would also be implemented to ensure protection of workers and area residents.

No adverse environmental impacts are anticipated while implementing alternative HS-3A.

6.2.5.8 Implementability

The implementability of alternative HS-3A includes the technical and administrative feasibility of the alternative and the availability of the services and materials. The thermal desorption system proposed for this alternative is currently available and the time frame for remedial activities is expected to be approximately four years, including design, procurement and treatment activities.

Technologies are readily available to confirm that thermal desorption can treat the Hot Spot sediment to a residual PCB concentration of 50 ppm or less. Similar technologies are also readily available to confirm successful treatment of the oily waste generated through thermal desorption and compliance with any relevant emissions criteria.

Given the hazardous nature of process operations and reagents, a significant level of effort is anticipated to coordinate with local emergency officials including police, fire, EMTs, Hazmat team, and local hospitals. Significant coordination will also be required with state, federal and local officials.

6.2.5.9 Cost

The costs to implement the alternative HS-3A include the following activities: site preparation, sediment removal, dewatering, thermal desorption, solid phase chemical destruction, treated materials handling and air monitoring. Estimated costs for this alternative are summarized in Table 6-7. The total cost for the alternative of $21.2 million also includes a number of indirect cost items and a 20% contingency on the direct and indirect cost total.

6.2.5.10 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.5.11 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-7
Cost Estimate Alternative - HS-3A
Thermal Desorption and Solid Phase Chemical Destruction

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Dewatering	1,035,000
D. Thermal Desorption	6,241,880
E. Solid Phase Chemical Destruction	2,422,098
F. Treated Materials Handling	337,115
G. Air Monitoring	1,152,000
TOTAL DIRECT COST (TDC)	**$11,766,393**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	588,320
B. Legal, Administration, Permitting (@ 10% of TDC)	1,176,639
C. Engineering (@ 10% of TDC)	1,176,639
D. Services During Construction (@ 10% of TDC)	1,176,639
E. Turnkey Contractor Fee (@ 15% of TDC)	1,764,959
TOTAL INDIRECT COST (TIC)	**$ 5,883,197**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$17,649,590**
CONTINGENCY (@ 20% of TDC + TIC)	3,529,918
TOTAL CAPITAL COST	**$21,179,507**
TOTAL COST - REMEDIAL ALTERNATIVE - HS-3A	**$21,179,507**

6.2.6 Alternative HS-3B: Thermal Desorption and Gas Phase Chemical Destruction

This section of the FS Addendum describes Remedial Alternative HS-3B and evaluates the alternative against the detailed evaluation criteria. Alternative HS-3B involves removal of the Hot Spot sediment from the CDF and treatment through a combination of thermal desorption and gas phase chemical destruction. The thermal desorption process would separate the organic contaminants including the PCBs into a concentrated oil extract. This extract would then be treated through gas phase chemical destruction. Solid residuals would be generated primarily from the thermal desorption process and would be disposed of on-site in a CDF.

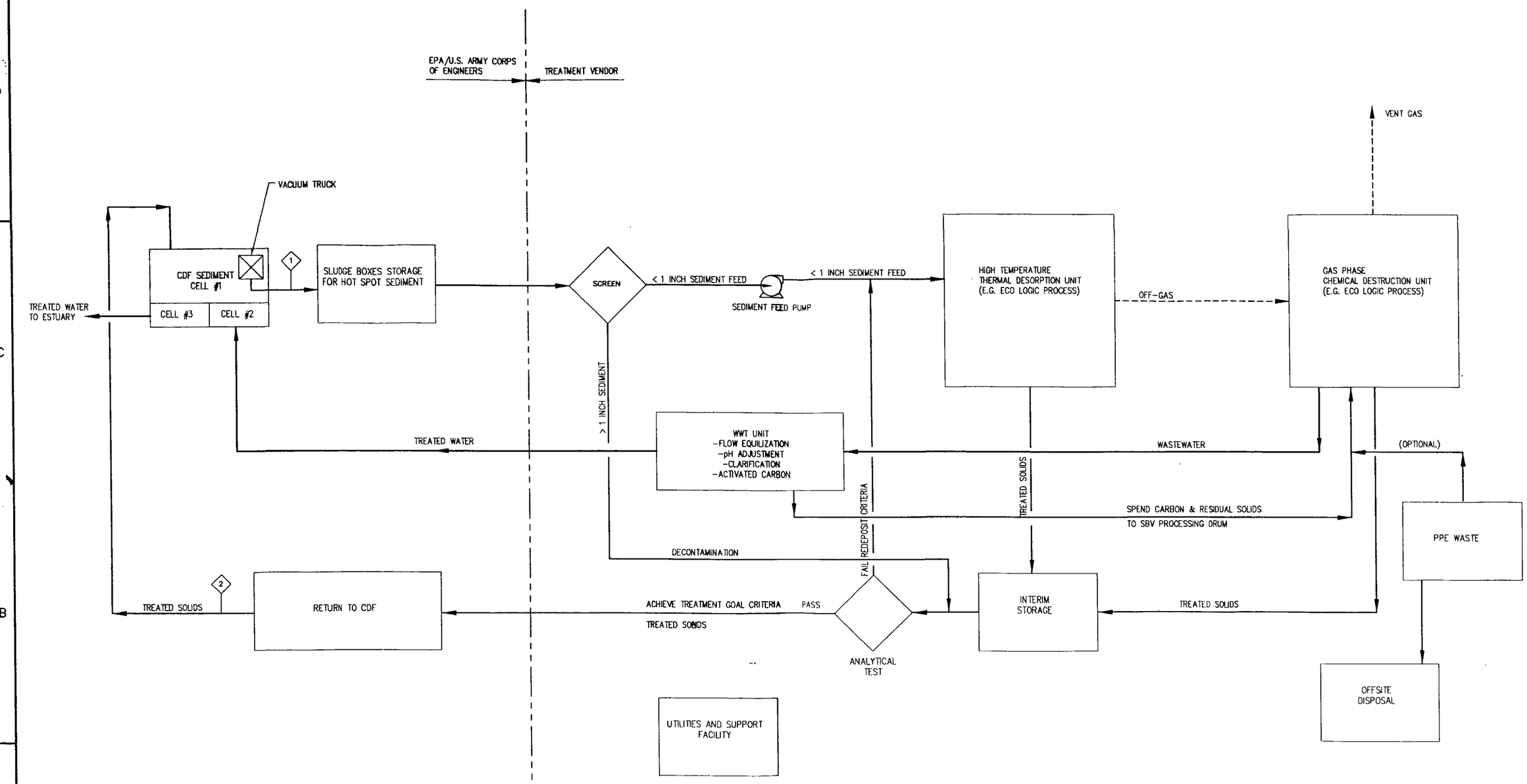
In developing this remedial alternative, the Eco Logic thermal desorption and gas phase reaction processes tested at pilot scale are used as representative treatment processes. It is important to note that discussion of this particular technology vendor is for illustrative purposes only.

6.2.6.1 General Description

Remedial Alternative HS-3B is a removal and treatment alternative with all treatment activities occurring on the site. The removal and treatment operations include the following activities: withdrawal of the Hot Spot sediments from the CDF using a vacuum truck, staging the sediments for treatment in sealed containers, screening the sediment to remove over-sized material, treating the contaminated sediments using the combination of thermal desorption and gas phase chemical destruction. Treated sediment would be tested for acceptability and returned to on-site CDF for ultimate disposal. Water generated from the treatment process will be treated using the on-site water treatment system. Overall movement of materials from the CDF through the various treatment processes and back to the CDF is presented in Figure 6-10.

The initial steps for alternative HS-3B are the same as those described for the other removal and treatment alternatives and include the activities conducted from the initial upgrade of the site through staging and storing sediment prior to thermal desorption. The first step in the cleanup process would be to upgrade existing site conditions to accommodate the materials handling and treatment operations. As with the other alternatives, the predominant feature of this initial step is the construction of a series of treatment pads and access roads, as shown on Figure 6-11. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2.

An overview discussion of thermal desorption technology is included in Section 6.2.5.1. The system assumed for alternative HS-3B would operate in a similar manner to the Eco Logic process operated during the pilot scale test. The thermal desorption unit would use an indirect heating source to desorb organics and water into the gaseous phase. The Eco Logic unit uses a hydrogen sweep gas to minimize the formation of dioxins and furans during the thermal desorption process. The thermal off-gas, comprised of hydrogen sweep gas, organic contaminants and water vapor would be discharged directly to the gas phase reactor for chemical destruction.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER
CUBIC YARDS	15,000	7,000	---
TONS	18,000	9,000	---
MM GALLONS	---	---	2.2M

LEGEND

- SOLID/SEMI-SOLID
- VAPOR
- LIQUID
- MATERIAL BALANCE

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PROJ/DES ENG	DATE	
ENG APPROVAL	DATE	

FOSTER WHEELER ENVIRONMENTAL CORPORATION
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BOSTON, MA. 02210

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-3B
THERMAL DESORPTION AND
GAS-PHASE
CHEMICAL DESTRUCTION

SIZE | FIGURE 6-10 | REV

SCALE: NONE | PLOTDATE 9/25/97 | SHEET 1 OF 1

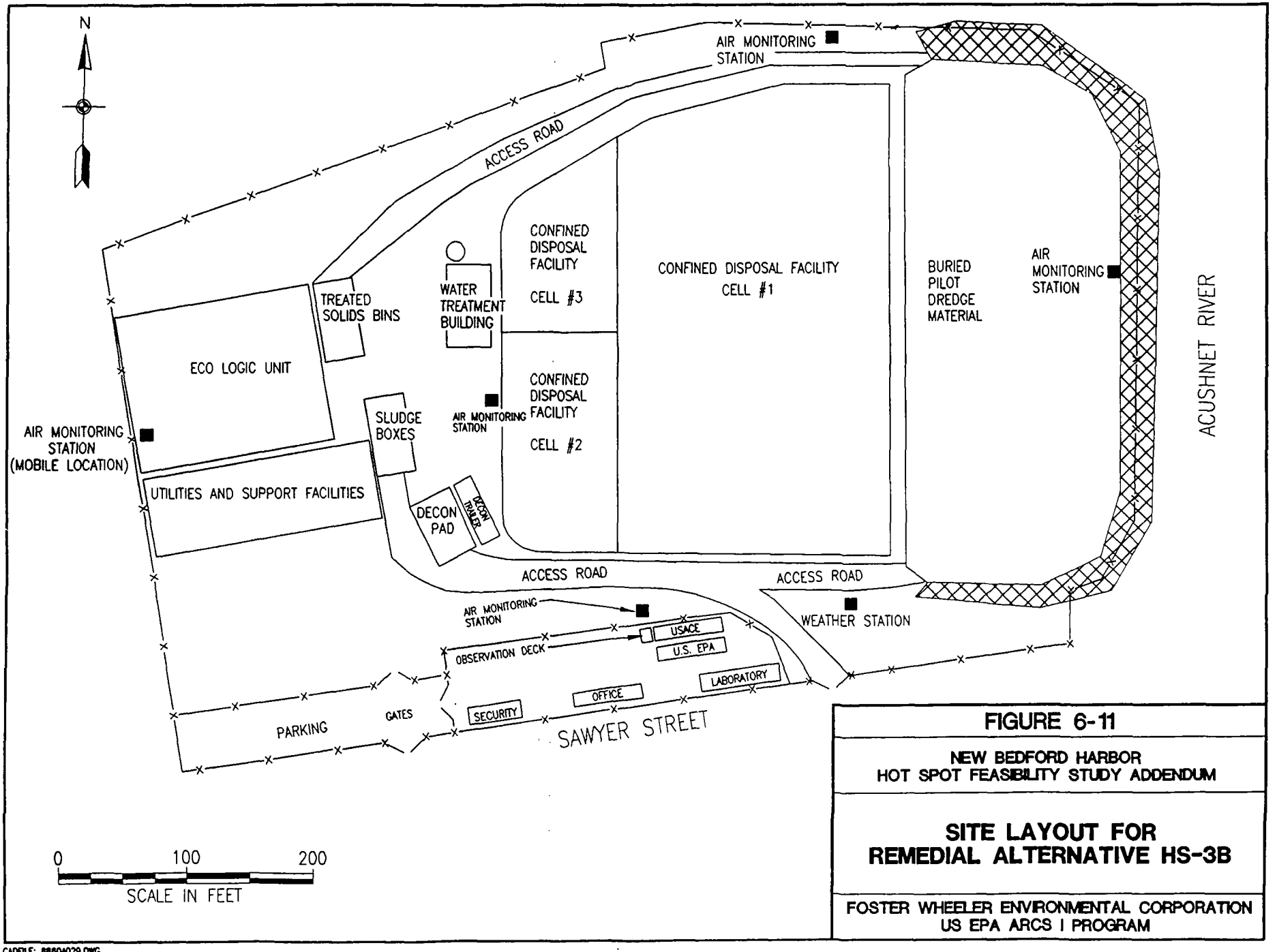


FIGURE 6-11

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-3B

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A029.DWG
DATE: 9/17/97

The two treatment steps (separation and chemical destruction) would be operated in conjunction with each other as a continuous process in the same manner as they were operated during the pilot test. The representative gas phase destruction process material utilizes a reducing environment of hydrogen and high temperature (900°C) to destroy the chlorinated organics, including the PCBs.

The results of the treatability studies demonstrated that the gas phase reactor technology was effective in treating PCBs in the gas phase. The average Destruction and Removal Efficiencies (DRE) for four treatment runs was 99.99989%. The residence time in the reactor is on the order of seconds with the product gas routed to off-gas treatment system. This system would be designed to treat the reaction products and includes several scrubbers and a boiler system (thermal oxidizer). The conceptual off-gas treatment system for the product gas following the reactor includes three scrubbers and a flame-fired boiler system to ensure that particulates, hydrochloric acid, hydrogen sulfide, benzene and naphthalene are removed from the off-gas.

A portion of the off-gas can be recirculated within the system and the remaining off-gas stored, tested and used as fuel for the boiler system to heat ancillary system components. Process effectiveness is evaluated on a real-time basis through the measurement of monochlorobenzene. This compound is used as a surrogate to estimate PCB destruction. Theoretically, monochlorobenzene is generated during the last step in the break-down of the PCBs within the process before final dechlorination to benzene.

6.2.6.2 Overall Protection of Human Health and the Environment

Remedial alternative HS-3B will achieve and maintain protection of human health and the environment. This will be accomplished through permanent treatment of over 99% of the PCBs associated with the hot spot sediments. The hot spot sediments will be treated to below the treatment goal of 50 ppm. Disposal of the treated sediments in an on-site CDF will greatly reduce the potential risks due to direct contact, and inhalation. Disposal of the treated sediments in an on-site CDF will also protect the environment.

6.2.6.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-3B. Complete listings of these respective ARARs are presented in Tables B-3B-1, B-3B-2 and B-3B-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-3B. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and

Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. HS-3B qualifies as an alternative disposal remedy that requires approval by the Regional Administrator, based on the requirements of TSCA.

HS-3B will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-3B will require PCB contaminated sediments to be stored on site for approximately five years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does <u>not</u> meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the treated sediments containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction and treatment technologies, and handling of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment will be required for the process discharges and possibly for surface run off becoming contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF)and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.6.4 Long Term Effectiveness and Permanence

Alternative HS-3B will provide long term effectiveness and permanence through treatment of the hot spot sediments with a combination of thermal desorption and gas phase chemical destruction. Treated residuals will be less than 50 ppm PCB and will be disposed of in an on-site CDF.

The on-site controls to manage the residuals are sufficient and will isolate the sediments from direct contact and potential volatilization. The treated sediments will also be underlain by a relatively impermeable harbor sediment that will act as a barrier for leaching and finally, the CDF will be designed with an impermeable side wall as an additional control measure. It should also be noted that the metals that remain in the sediment are not expected to be significantly leachable as they successfully passed TCLP testing.

6.2.6.5 Reduction of Toxicity, Mobility and Volume

This alternative will significantly reduce the volume and toxicity of the hot spot sediments. The volume reduction is expected to be greater than 99% through thermal desorption. The gas phase destruction step will significantly reduce the toxicity of the hot spot sediments by destroying over 99% of the PCBs removed through thermal desorption. The results of the treatability studies indicated that while thermal desorption does increase the mobility of the metals in the treated solids, they do not exceed the relevant TCLP criteria.

6.2.6.6 Short Term Effectiveness

The time to complete the remedial actions under alternative HS-3B is approximately five years. This estimate includes one to two years of design and procurement activities and a three year period to fabricate the treatment equipment and complete the clean-up operations.

Protection of the community and the workers conducting the remediation are also considered under this criterion. The primary remedial components of alternative HS-3B are sediment removal and treatment operations. The process of removing the sediments from the CDF, dewatering and handling them prior to treatment could generate air emissions. This potential for air emissions will be minimized by using a vacuum truck equipped with a vapor phase treatment system and storage of the sediments in sludge boxes vented to carbon canisters prior to treatment.

The very nature of the treatment processes and their reagents will place the site workers and nearby residents at risk. The risks are driven by heat, hydrogen and the combination of other process components, such as boilers. However, these risks can be greatly minimized through utilization of industry standards, appropriate operating procedures, monitoring and a detailed HAZOP review of the equipment prior to the start of treatment operations.

The potential for mechanical break-down and resulting reduced throughput of sediment for treatment is high with the representative thermal desorption unit used in this alternative. Accordingly, the overall technology performance risks of this alternative are high.

The thermal process separates PCBs from the sediment at up to 1000°F and, as a result has the potential to volatilize metals such as lead. The possibility also exists for the creation of dioxins and furans. Although these compounds are already present in the Hot Spot sediment and the thermal desorption process will separate them out with the PCBs and water, there remains the potential for the creation of these compounds. These compounds along with the volatile metals can be effectively treated using commonly available off-gas control technologies.

Worker health and safety would also be addressed through requirements specified in a site-specific Health and Safety Plan (HASP). This plan would stipulate the appropriate personnel protective equipment and monitoring criteria. In addition, a site wide air monitoring program would be implemented to ensure protection of workers and area residents. Treatment equipment operations would also be monitored to ensure compliance with applicable emissions criteria.

No adverse environmental impacts are anticipated while implementing alternative HS-3B.

6.2.6.7 Implementability

Alternative HS-3B is technically feasible and the treatment technologies are commercially available on a limited bases. The combined thermal desorption and gas phase destruction unit could be fabricated and delivered within an eighteen month time-frame. However, mechanical difficulties and materials handling problems experienced during the SAIC/Eco Logic pilot study may be symptomatic of issues that would have to be addressed during fabrication and start-up testing.

Technologies are readily available to confirm that thermal desorption can treat the Hot Spot sediment to a residual PCB concentration of 50 ppm or less. Similar technologies are also readily available to confirm successful gas phase treatment of the off-gases generated by the thermal desorption system and to confirm compliance with any relevant emissions criteria.

Implementation of these processes will take a significant level of coordination with local police, fire, HAZMAT and hospital personnel, given the operational aspects of these two processes. Significant coordination would also occur between the federal and state agencies responsible for overall implementation of the alternative.

6.2.6.8 Cost

The costs to implement alternative HS-3B includes the following activities: site preparation, sediment removal, dewatering, thermal desorption, gas phase chemical destruction, treated materials handling, and air monitoring. The estimated costs for this alternative are summarized in Table 6-8. The total estimated cost for the alternative is approximately $26.3 million also includes a number of indirect cost items and a 20% contingency on the direct and indirect cost total.

6.2.6.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.6.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-8
Cost Estimate: Remedial Alternative - HS-3B
Thermal Desorption and Gas Phase Chemical Destruction

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Thermal Desorption/Gas Phase Chemical Destruction	11,106,000
D. Treated Material Handling	979,895
E. Air Monitoring	1,958,400
TOTAL DIRECT COST (TDC)	**$14,622,595**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	731,130
B. Legal, Administration, Permitting (@ 10% of TDC)	1,462,260
C. Engineering (@ 10% of TDC)	1,462,260
D. Services During Construction (@ 10% of TDC)	1,462,260
E. Turnkey Contractor Fee (@ 15% of TDC)	2,193,389
TOTAL INDIRECT COST (TIC)	**$7,311,298**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$21,933,893**
CONTINGENCY (@ 20% of TDC + TIC)	4,386,779
TOTAL CAPITAL COST	**$26,320,671**
TOTAL COST REMEDIAL ALTERNATIVE -HS-3B	**$26,320,671**

6.2.7 Alternative HS-3C: Thermal Desorption and Off-site Incineration

This section of the FS Addendum describes Remedial Alternative HS-3C and evaluates the alternative against the detailed evaluation criteria. Alternative HS-3C involves removal of the Hot Spot sediment from the CDF and treatment through a combination of thermal desorption (on-site) and off-site incineration. The thermal desorption process would separate the organic contaminants including the PCBs into a concentrated oil extract. This extract would then be shipped off-site to permitted incineration facility for destruction of the PCBs and other organic contaminants. Solid phase treatment residuals from the thermal desorption process would be placed in a CDF.

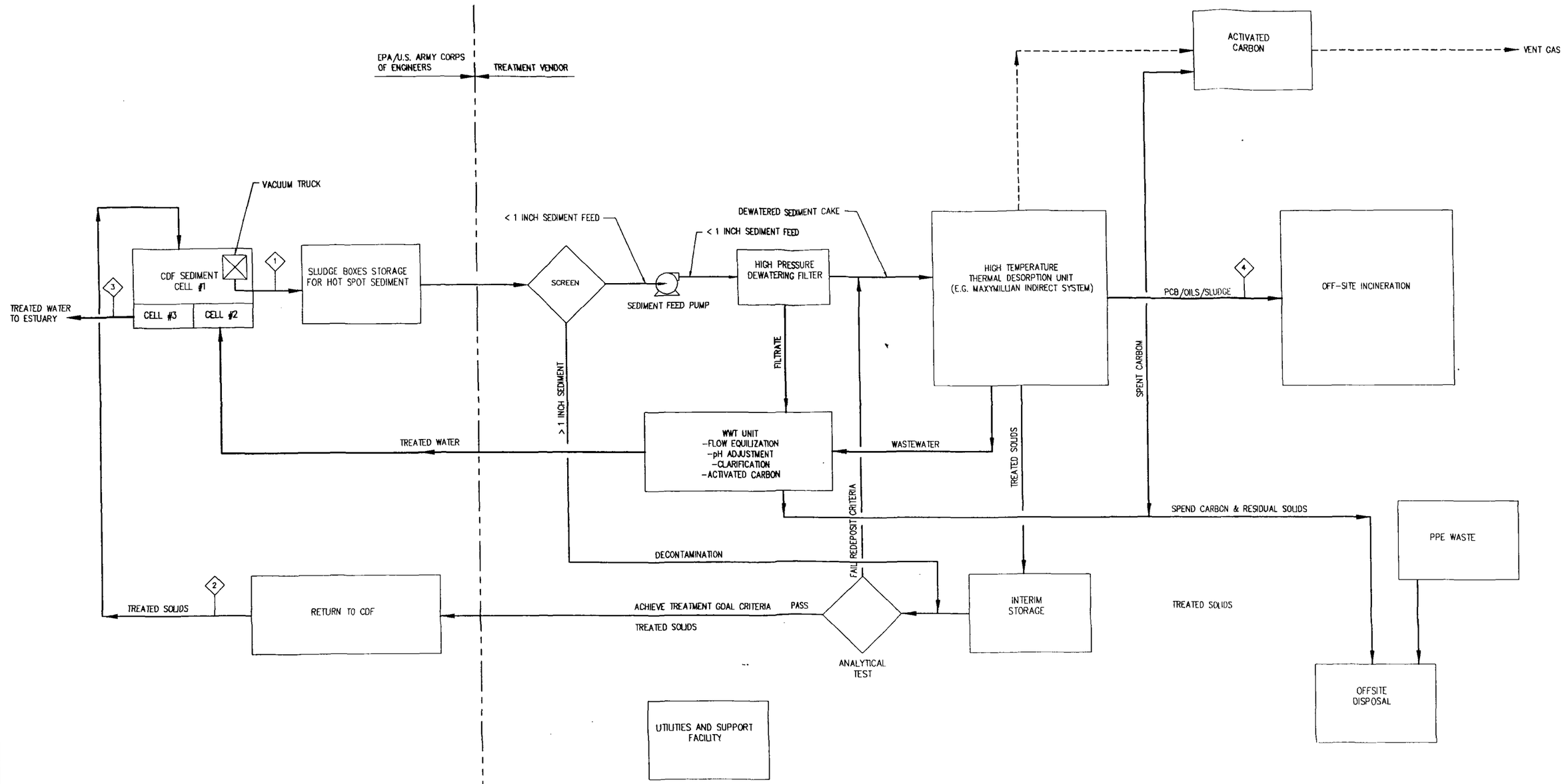
In developing remedial alternatives, the Maxymillian thermal desorption system was used as a representative treatment process. It is important to note that discussion of this particular technology vendor is for illustrative purposes only.

6.2.7.1 General Description

Remedial Alternative HS-3C is a removal and treatment alternative with treatment activities occurring both on-site and off-site. The removal and treatment operations includes the following activities: withdrawal of the Hot Spot sediments from the CDF using a vacuum truck, staging the sediments for treatment in sealed containers, mechanical dewatering, treating the contaminated sediments using thermal desorption; collecting and packaging the contaminated oil extract for shipment off-site and placement of the treated residuals in a CDF. Mechanical dewatering of the sediment is described in Section 6.2.5.2. Treated sediment would be tested for acceptability and returned to a CDF for ultimate disposal. Water generated from the treatment process would be treated using the on-site water treatment system. As discussed for alternative HS-3A, the thermal desorption process concentrates the organic fraction of the sediment into a highly contaminated oil product that requires additional treatment. Overall movement of materials from the CDF through the various treatment processes and back to the CDF is presented in Figure 6-12.

The initial steps for alternative HS-3C are the same as those described for the other removal and treatment alternatives, and include the activities conducted from the initial upgrade of the site through staging and storing sediment prior to thermal desorption. The first step in the cleanup process would be to upgrade existing site conditions to accommodate the materials handling and treatment operations. As with the other alternatives, the predominant feature of this initial step is the construction of a series of treatment pads and access roads, as shown on Figure 6-13. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2.

The waste oil extract from the thermal desorption process would be placed in 55-gallon drums for interim storage and shipped regularly from the site (twice per week) to minimize the build-up of this highly contaminated material at the site. The off-site incineration would take place at a permitted off-site disposal facility specifically designed to accommodate wastes such as the oil extract from the Hot Spot sediments.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER	4 PCB/OILS/ SLUDGE
CUBIC YARDS	15,000	7,000	---	---
TONS	18,000	9,000	---	423
MM GALLONS	---	---	2.2	---

LEGEND

- SOLID/SEMI-SOLID
- VAPOR
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BOSTON, MA. 02210

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-3C
THERMAL DESORPTION AND
OFF-SITE INCINERATION

SIZE | FIGURE 6-12 | REV

SCALE: NONE | PLOTDATE 9/25/97 | SHEET 1 OF 1

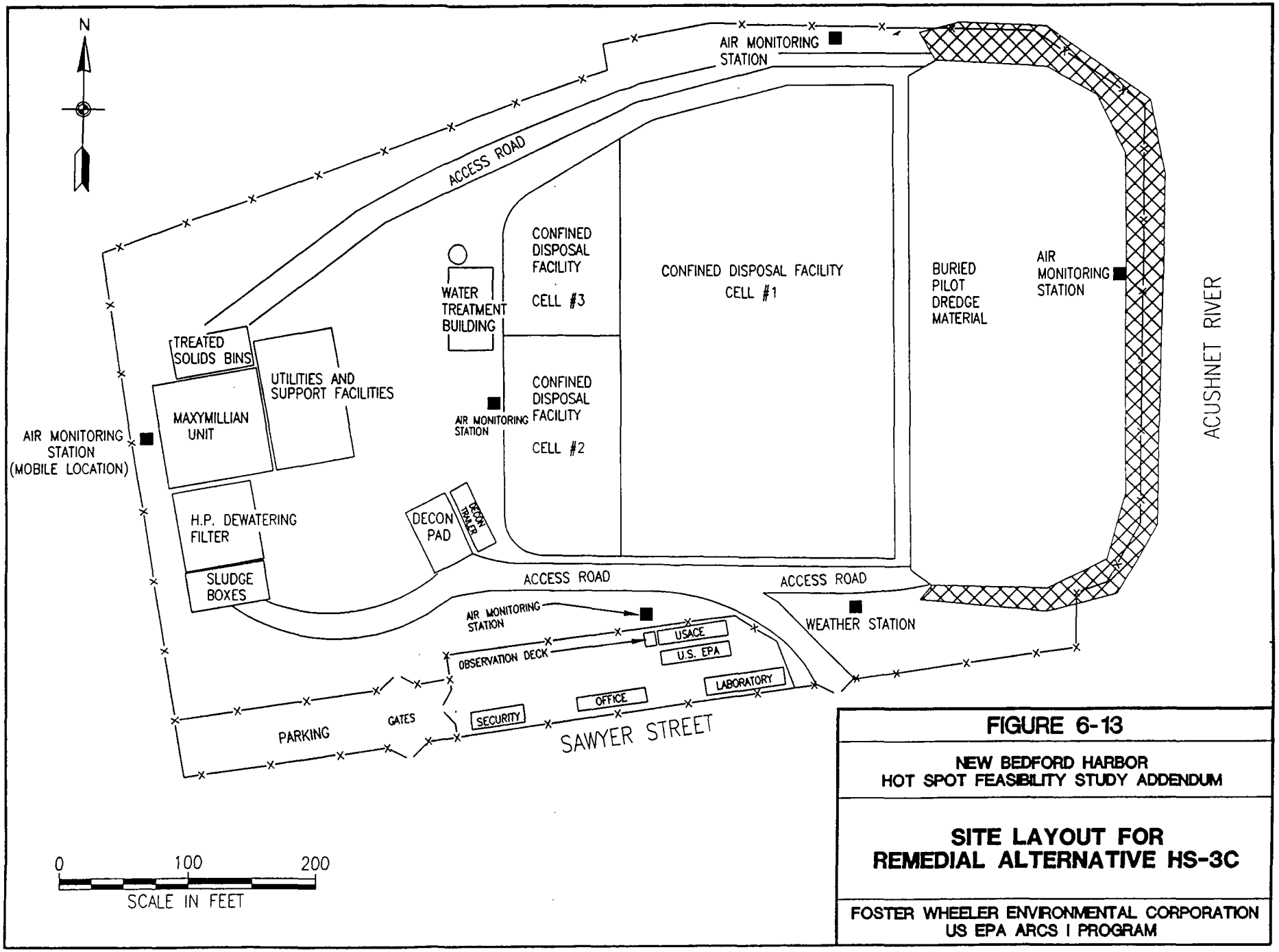


FIGURE 6-13

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-3C

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A030.DWG
DATE: 9/17/97

The material is expected to have a high BTU content and treatment is expected to be relatively straight forward using this method. The primary performance criteria for the destruction of the PCBs would be a DRE of 99.9999%. Since the majority of the heavy metals will remain in the treated solids associated with the thermal desorption process, the oil waste is not expected to produce volatile metals emissions during incineration.

6.2.7.2 Overall Protection of Human Health and the Environment

Remedial alternative HS-3C will achieve and maintain protection of human health and the environment. This will be accomplished through permanent treatment of over 99% of the PCBs associated with the hot spot sediments. The hot spot sediments will be treated to below the treatment goal of 50 ppm. Disposal of the treated sediments in an on-site CDF will greatly reduce the potential risks due to direct contact, and inhalation. Disposal of the treated sediments in an on-site CDF will also protect the environment.

6.2.7.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-3C. Complete listings of these respective ARARs are presented in Tables B-3C-1, B-3C-2 and B-3C-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-3C. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. HS-3C qualifies as utilization of an approved incinerator for the ultimate destruction of PCBs under TSCA.

HS-3C will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-3C will require PCB contaminated sediments to be stored on site for approximately five years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). PCB oil extracted by the solvent extraction process will be shipped regularly to the incinerator facility so to minimize on-site storage. Storage of the PCB dredge spoil and extracted PCB oil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the treated sediments containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternatives may result from releases from the storage facility, discharges from extraction technologies, and handling/dewatering of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment will be required for the dewatering/process discharges and possibly for surface run off becoming contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water

quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF) and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.7.4 Long Term Effectiveness and Permanence

Alternative HS-3C will provide long term effectiveness and permanence through treatment of the hot spot sediments with a combination of thermal desorption and off-site incineration at an approved TSCA facility. Treated residuals will be less than 50 ppm PCB and will be disposed of in an on-site CDF.

The on-site controls to manage the residuals are sufficient and will isolate the sediments from direct content and potential volatilization. The CDF is also underlain by a relatively impermeable harbor sediment that will act as a barrier for leaching and finally, the CDF will be designed with an impermeable side wall as an additional control measure. It should also be noted that the metals that remain in the sediment are not expected to be significantly leachable as they successfully passed TCLP testing.

6.2.7.5 Reduction of Toxicity, Mobility and Volume

This alternative will significantly reduce the volume and toxicity of the hot spot sediments. The volume reduction is expected to be greater than 99% through thermal desorption. Off-site incineration will significantly reduce the toxicity of the hot spot sediments by destroying over 99% of the PCBs removed through thermal desorption. The processes are both irreversible and produce treatment residuals that pose little risk. The results of the treatability studies indicated that while thermal desorption does increase the mobility of the metals in the treated solids, they do not exceed the relevant TCLP criteria.

6.2.7.6 Short Term Effectiveness

The time to complete the remedial actions under alternative HS-3B is approximately four to five years. This estimate includes one to two years of design and procurement activities and a two to three year period to fabricate the treatment equipment and complete the clean-up operations.

Protection of the community and the workers conducting the remediation are also considered under this criterion. The primary remedial components of alternative HS-3A are sediment removal and treatment operations. The process of removing the sediments from the CDF, dewatering and handling them prior to treatment could generate air emissions. This potential for air emissions will be minimized by using a vacuum truck equipped with a vapor phase treatment system and storage of the sediments in sludge boxes vented to carbon canisters prior to treatment.

The short term effectiveness issues for alternative HS-3C include protection of site workers and community from several potential risks. These include potential emissions from the CDF during the removal and dewatering of the sediment, hazards associated with the thermal desorption equipment and the unit process operations, and typical construction related hazards including slips, trips and falls.

These risks can be greatly minimized through proper planning and implementation of health and safety procedures. These site specific procedures and guidelines for personnel protective equipment (gloves, respirators, suits, etc.) will be contained in an overall health and safety plan. The plan will also specify monitoring equipment to be used to assess ambient conditions. This information, along with the results of the site wide ambient air monitoring program, will ensure protection of the community.

The time to achieve the response objectives is on the order of four to five years. This includes one to two years of design and procurement and two to three years to complete the clean-up related activities.

Alternative HS-3C uses thermal desorption to separate the PCBs and moisture from the sediment at temperatures up to 1000°F. At these temperatures, the volatile metals such as lead, will become part of the off-gas. Dioxins and furans may also form in this temperature range. Although these components already exist in the sediment at trace levels and will separate with the moisture and PCBs, there is still the potential for creation of these compounds. These compounds along with the volatile metals can be effectively removed using commonly available off-gas control technology.

No adverse environmental impacts are anticipated while implementing alternative HS-3B.

6.2.7.7 Implementability

The implementability of alternative HS-3C includes the technical and administrative feasibility of the alternative and the availability of services and materials.

A thermal desorption unit appropriate for treating the Hot Spot sediment is currently available. Overall, remediation will take approximately four to five years, including design and procurement activities and treatment. The implementability of this alternative is aided by the simplifying nature of having only one treatment process (thermal desorption) on-site.

Technologies are readily available to confirm that the treatment technologies are treating the Hot Spot sediment to a residual PCB concentration of 50 ppm or less. Similar technologies are also readily available to confirm with any relevant emissions criteria.

At the time of this writing, off-site incineration is available to treat the oil waste generated using thermal desorption. It is possible that facilities may not be available in the future to incinerate the wastes, as one of the largest treatment units in the country indicates that they will no longer be accepting wastes.

On-site implementation of thermal desorption will require the coordination of federal, state and local officials. The local coordination will likely extend to the police and fire departments; HAZMAT team and EMTs; and the local hospital.

6.2.7.8 Cost

The costs to implement alternative HS-3C includes the following activities: site preparation, sediment removal, dewatering, thermal desorption, off-site incineration, treated materials handling and air monitoring. The estimated costs for this alternative are summarized in Table 6-9. The total estimated cost for the alternative is approximately $18.9 million also includes a number of indirect cost items and a 20% contingency on the direct and indirect cost total.

6.2.7.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.7.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-9
Cost Estimate: Remedial Alternative HS-3C
Thermal Desorption and Off-Site Incineration

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Dewatering	1,035,000
D. Thermal Desorption	6,241,880
E. Off-Site Incineration	1,202,685
F. Treated Material Handling	337,115
G. Air Monitoring	1,152,000
TOTAL DIRECT COST (TDC)	**$10,546,980**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	527,349
B. Legal, Administration, Permitting (@ 10% of TDC)	1,054,698
C. Engineering (@ 10% of TDC)	1,054,698
D. Services During Construction (@ 10% of TDC)	1,054,698
E. Turnkey Contractor Fee (@ 15% of TDC)	1,582,047
TOTAL INDIRECT COST (TIC)	**$5,273,490**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$15,820,470**
CONTINGENCY (@ 20% of TDC + TIC)	3,164,094
TOTAL CAPITAL COST	**$18,984,564**
TOTAL COST - REMEDIAL ALTERNATIVE HS-3C	**$18,984,564**

6.2.8 Alternative HS-4: Staged Vitrification

This section of the FS Addendum describes Remedial Alternative HS-4 and evaluates the alternative against the detailed evaluation criteria. Alternative HS-4 involves removal of the Hot Spot sediment from the CDF, staging, dewatering, re-staging the sediment and treatment using vitrification. The vitrification process employs high temperature in the absence of oxygen to pyrolize (melt) the sediment. The molten mass hardens to an inert, glass or rock-like solid. The actual melting process will take place in a CDF, leaving a solid residual in place.

The vitrification was tested at pilot scale and is discussed and summarized in Section 4.3. Results from the pilot scale testing indicate that a comprehensive design scale testing program would be required to address the moisture induced difficulties that hampered performance prior to implementing this technology. However, at this point in time, many questions remain unanswered and as a result, the alternative presented below uses a conservative approach for evaluating this process. The design scale testing will evaluate the following data gaps identified during the initial pilot scale test:

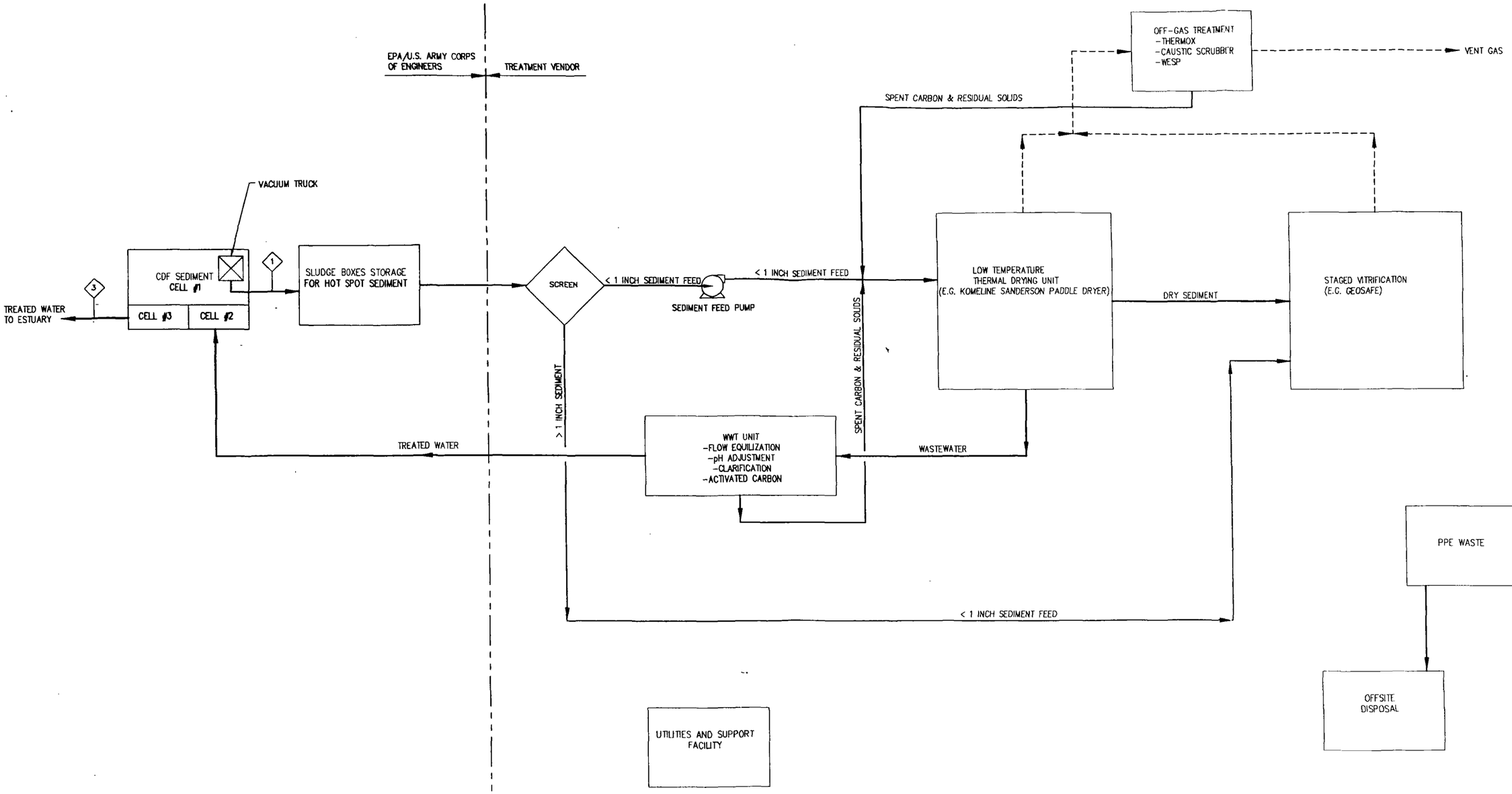
- Whether drying the sediment prior to vitrification will resolve the "fluidization" of the sediment and the associated high particulate and organic concentrations in the off-gas.
- The effectiveness of the proposed thermal dryer to dry the Hot Spot sediment to the required moisture content.
- The effectiveness of the vitrification process to destroy or incorporate PCBs into the vitrified solid material rather than desorbing them into the off-gas.
- Whether vitrification creates dioxins and furans during the process rather than treating those already present in the Hot Spot sediment.
- The size and components required for the off-gas treatment system that will be needed to effectively treat off-gas from both the thermal dryer and the vitrification process.

In developing this remedial alternative, the Geosafe process is used as representative of the vitrification processes. It is important to note that discussion of this particular technology vendor is for illustrative purposes only.

6.2.8.1 General Description

Remedial Alternative HS-4 is a removal and treatment alternative with all treatment activities occurring on the site. The overall activities include extensive design related studies, withdrawal of the Hot Spot sediments from the CDF, staging the sediments for dewatering in sealed containers, screening the sediment to remove over-sized material, drying the sediment to a moisture content of less than 10%, re-staging the dried sediment in an on-site CDF and vitrification of the material in place. Overall movement of materials from the CDF through the various treatment processes and back to the CDF is presented in Figure 6-14.

Following successful completion of the requisite pilot scale studies, the initial steps for alternative HS-4 are similar to those described for the other removal and treatment alternatives. The overall site layout for alternative HS-4, as presented in Figure 6-15, includes an area for sediment storage prior to the thermal dewatering step, an area for the thermal off-gas treatment equipment and the vitrification staging area at the eastern end of the Sawyer Street site.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 TREATED SOLIDS	3 TREATED WATER
CUBIC YARDS	15,000	8,000	---
TONS	18,000	10,000	---
MM GALLONS	---	---	160M

LEGEND

SOLID/SEMI-SOLID

VAPOR

LIQUID

MATERIAL BALANCE

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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-4
STAGED VITRIFICATION

SIZE | FIGURE 6-14 | REV

SCALE: NONE | PLOTDATE 9/25/97 | SHEET 1 OF 1

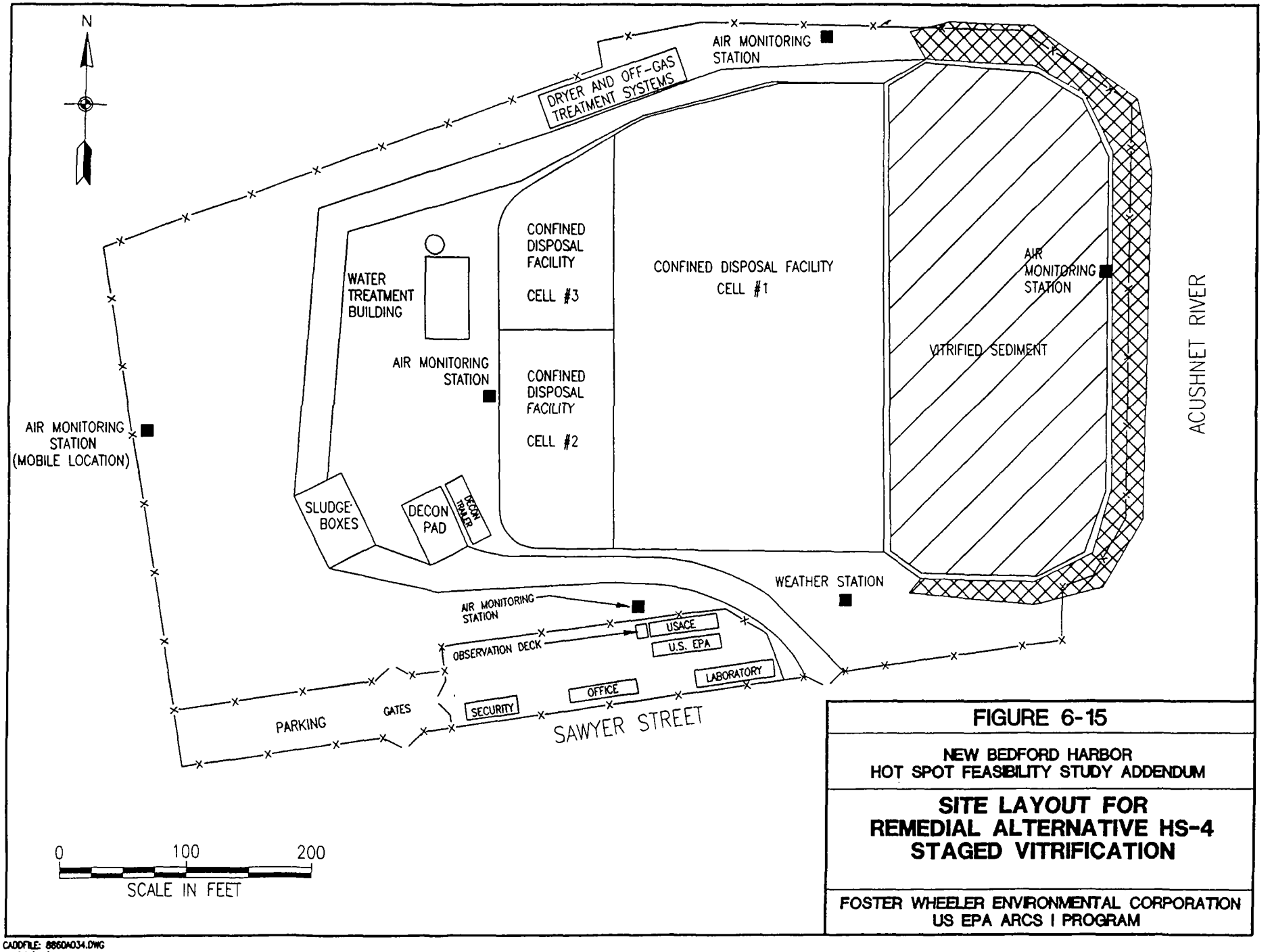


FIGURE 6-15

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-4 STAGED VITRIFICATION

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADDFILE: 8860A034.DWG
DATE:9/17/97

As with each technology, precautions would be taken at all times to minimize worker and off-site exposure to contaminated sediment. However, the dried sediment is expected to be a dry, fine, powdery material, similar in texture to the dry treated sediment residual generated during several of the pilot scale tests, yet the PCBs will still be present in this dried sediment. This material may be difficult to handle, and so it will be important to maintain some moisture in the sediment. In summary, the sediment will not be dried below 10% moisture and if it is, it will be re-wetted to facilitate materials handling. Dried sediment would be returned to the CDF using appropriate dust control measures, compacted to minimize pore space, and covered until all of the sediment is in place and the vitrification process can be started.

In addition to the dust control measures discussed above, the thermal dryer unit would require an off-gas treatment system to control organic, inorganic, and particulate emissions during the drying process. The off-gas treatment system would likely consist of a thermal oxidizer unit to destroy organic contaminants, scrubbers to remove particulate and potential acids, condensing units to remove the moisture from the off-gas stream and reduce gas flow volumes, and baghouses and/or HEPA filters for particulate removal. The off-gas system would be designed so that the same system could be used for both the thermal dryer off-gas and the vitrification process off-gas. The drying process is anticipated to take up to six months to complete.

Vitrification of the sediment would be conducted within the eastern portion of the Sawyer Street site. The melt will be conducted sequentially, across the CDF over a one and a half year period. Electrodes would be submerged into the sediment and the temperature elevated to between 1,600°C and 2,000°C to melt the sediment. The molten material would be allowed to cool resulting in an inert glass-like solid. The inert glass would be permanently fixed in the on-site CDF and would not requiring monitoring as the treated material passed TCLP leaching tests. Water generated from the drying and treatments processes would be pre-treated in a separate on-site water treatment system specifically designed for these processes. The existing water treatment facility would be used for final treatment before discharge into the harbor.

Two off-gas hoods would be used to cover the CDF during the vitrification process. The vent gas will be discharged to an off-gas treatment system for treatment prior to discharge to the atmosphere. The off-gas treatment system would be the same as for the thermal dryer off-gas, as described above. Extensive off-gas sampling and analysis would be conducted during the drying and vitrification steps to ensure emissions meet relevant regulatory criteria.

As currently configured, this alternative has an extensive site wide ambient air monitoring program for PCB and heavy metals. If the results of the design scale studies indicates the process can be implemented without the use of a thermal dryer and an extensive off-gas treatment system, the frequency of air monitoring could be reduced to some degree. The potential also exists for the dewatering method and off-gas controls to be scaled-back if the results of the design scale studies indicate that vitrification can be implemented in a safe and environmentally compliant manner without the controls described above.

6.2.8.2 Overall Protection of Human Health and the Environment

The HS-4 remedial alternative is protective of human health and the environment. The vitrification process results in a permanent, inert, solid material that is not likely to directly or indirectly adversely affect human health or the environment. The process will require engineering controls during treatment

to minimize the risk of exposure to on-site workers and off-site receptors. The actual controls, their complexity, and implementability must be determined prior to full scale remediation. However, engineering controls are expected to effectively minimize the potential risk to human health and the environment.

6.2.8.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-4. Complete listings of these respective ARARs are presented in Tables B-4-1, B-4-2 and B-4-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-4. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste management and treatment. These ARARs include PCB storage, treatment and disposal requirements under TSCA and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate

protection to health and the environment. HS-4 qualifies as an alternative disposal remedy that requires approval by the Regional Administrator, based on the requirements of TSCA.

HS-4 will require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived as "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-4 will require PCB contaminated sediments to be stored on site for approximately six years until completion of the remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does <u>not</u> meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable to the disposal of the vitrified sediments on-site containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternative may result from releases from the storage facility, discharges from vitrification, and handling/dewatering of the sediments before on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling, dewatering, and processing.

Water discharges are regulated under state and federal water quality ARARs. Water treatment will be required for the dewatering/process discharges and possibly for surface run off becoming contaminated by the stored sediments. Operation of the on-site treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. Massachusetts guidelines to be considered include ambient air limits and noise levels. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF)and air dioxin guidelines will be considered for evaluation of alternatives having air emissions. Noise levels will be minimized to the extent practicable.

6.2.8.4 Long Term Effectiveness and Permanence

The end result from the vitrification process will be a CDF full of a solid, inert, glass-like solid, similar to rock. Organic contaminants are not present in the treated material. What few contaminants (metals) remain in the treated product are thoroughly entrained in the matrix and do not leach significantly under TCLP conditions. The HS-4 remedial alternative provides a long-term permanent solution to the contamination in the Hot Spot sediment.

6.2.8.5 Reduction of Toxicity, Mobility and Volume

The HS-4 alternative effectively reduces toxicity, volume, and mobility through treatment. The toxicity of the treated residual is effectively reduced by the removal and destruction of organic contaminants and the immobilization of heavy metals within the glass matrix. Contaminants, such as metals, that are entrained in the glass like matrix are essentially immobilized and will not leach into the surrounding area. During the treatment process, the volume of the sediment is reduced by approximately 60 to 65 percent. The volume reduction is attributed primarily to water loss and also to the loss of pore space during the melting process.

6.2.8.6 Short Term Effectiveness

Of primary concern for evaluating short term effectiveness is the length of time that will be required to test and optimize the process prior to full scale implementation. Pilot scale testing may take up to three years through final testing and evaluation. Such testing will be necessary to ensure that the thermal drying process will effectively dry the sediment to meet the vitrification process requirements. In addition, it will be necessary to design and test the off-gas treatment system to treat the off-gas generated by the dryer and the vitrification process to ensure that the emissions meet regulatory criteria.

Engineering controls are commercially available that will effectively destroy organics in the off-gas and emissions can be made acceptable with the appropriate equipment. Testing will ensure that the equipment is operating at optimal conditions and is sized according to the treatment system needs.

Testing will also provide data that will determine whether the organic compounds are destroyed or otherwise immobilized in the vitrified product, or whether the organics are merely desorbed during vitrification and subsequently destroyed in the off-gas treatment system.

Should this alternative be selected, the thermal drying process will be completed prior to commencing vitrification. The drying process is expected to take approximately six months to complete. The actual vitrification process will take one and a half years resulting in an overall implementation schedule of approximately five to six years including other design and procurement activities.

The thermal drying process will produce a fine grained sediment with elevated concentrations of PCBs and other organic contaminants. This material will be returned to the CDF, compacted, covered and ultimately treated using vitrification. The material is likely to be difficult to handle and engineering controls will be implemented to reduce the potential of fugitive emissions during transportation and materials handling.

No adverse environmental impacts are anticipated while implementing alternative HS-3B.

6.2.8.7 Implementability

Overall implementability of the vitrification remedial alternative is not completely known. Several operational difficulties were identified during the pilot scale testing that require resolution prior to evaluating the implementability of the process. These operational difficulties appeared to be associated with the high moisture content and fine grained nature of the sediment and may be significantly reduced by drying the sediment prior to treatment. Equipment requirements for the thermal dryer and associated materials handling equipment cannot be determined without additional field testing.

In addition to the thermal dryer unit, an off-gas treatment system must be used to ensure that emissions from both the thermal dryer and the vitrification process meet appropriate regulatory standards. The additional testing will determine the equipment requirements for the off-gas treatment system to ensure that treatment objectives are achievable.

Depending on the results of the additional testing, equipment may be commercially available and fairly readily implemented. However, because of the varied types of equipment that will be required and the potential for unique materials handling requirements, it is possible that obtaining the required equipment could cause schedule delays or other operational difficulties. Because the sediment must be dried, placed in the CDF and compacted before the actual vitrification can begin, a significant effort will be required to coordinate testing, drying and the actual treatment activities on the site. In addition, it is expected that a significant amount of testing will be required for the off-gas systems and of the ambient air at the site during the start-up of each process. Assuming that the monitoring determines that the process is not producing unacceptable emissions, monitoring may be reduced as treatment progresses.

The potential issues associated with the formation of dioxins and furans are potentially problematic for this technology despite the effectiveness of available off-gas treatment system and must be considered in evaluating this technology.

6.2.8.8 Cost

The cost estimate for the vitrification alternative includes the cost for additional pilot study testing and the cost for full scale treatment. Treatment costs include site preparation, sediment removal from the CDF, sediment drying using a thermal dryer, sediment staging and compacting in the CDF, vitrification, dust control measures and air monitoring. Treatment costs are summarized in Table 6-10.

The total estimated cost of $48.5 million also includes costs for other indirect activities such as health an safety, legal, engineering, construction services, and profit. A contingency factor of 20 percent was also applied to the total direct and indirect costs.

6.2.8.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.8.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-10
Cost Estimate: Remedial Alternative - HS-4
Staged Vitrification

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	248,760
B. Sediment Removal From CDF	329,540
C. Dewatering	1,035,000
D. Staged Vitrification	20,686,575
E. Air Monitoring	4,672,000
TOTAL DIRECT COST (TDC)	**$26,971,875**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	1,348,594
B. Legal, Administration, Permitting (@ 10% of TDC)	2,697,188
C. Engineering (@ 10% of TDC)	2,697,188
D. Services During Construction (@ 10% of TDC)	2,697,188
E. Turnkey Contractor Fee (@ 15% of TDC)	4,045,781
TOTAL INDIRECT COST (TIC)	**$13,485,938**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$40,457,813**
CONTINGENCY (@ 20% of TDC + TIC)	8,091,563
TOTAL CAPITAL COST	**$48,549,375**
TOTAL COST - REMEDIAL ALTERNATIVE - HS-4	**$48,549,375**

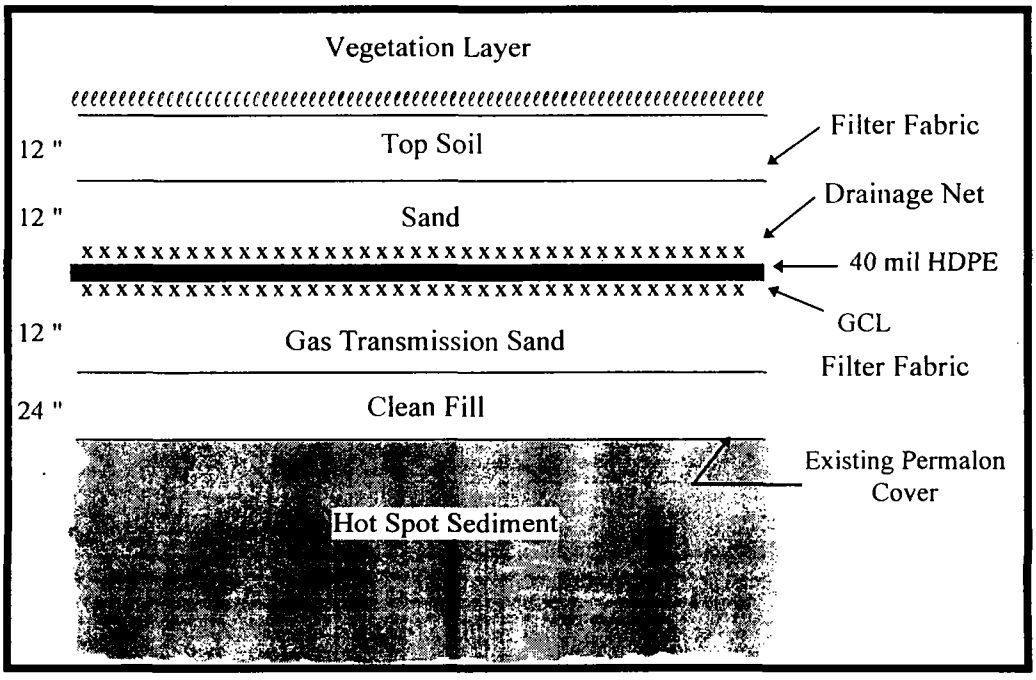
6.2.9 Alternative HS-5 In-Place Capping

This section of the FS Addendum describes Remedial Alternative HS-5 and evaluates the alternative against the detailed evaluation criteria. Alternative HS-5 involves containment of the Hot Spot sediment in its current location.

6.2.9.1 General Description

Alternative HS-5 is a containment alternative using routinely available landfill capping technology to isolate the contaminated sediments. A cross-section of the conceptual multi-layer cap is presented in Figure 6-16. The alternative would also include minimal upgrades to the existing site facility which are presented in Figure 6-17.

Figure 6-16
Conceptual Cap Design



The first step in the capping process would be placement of two feet of clean soil on top of the existing permalon cover. This material would be left for a period of six months to a year to facilitate additional settlement of the sediments. The next step involves placement of vertical wick drains throughout the sediment in the CDF to enhance the consolidation of the sediments to a point where they can support the cap. These drains expedite consolidation by removing water from the sediments through the capillary action of the vertical wicks. The wick drains would be placed on four foot centers to complete this process within a several month period.

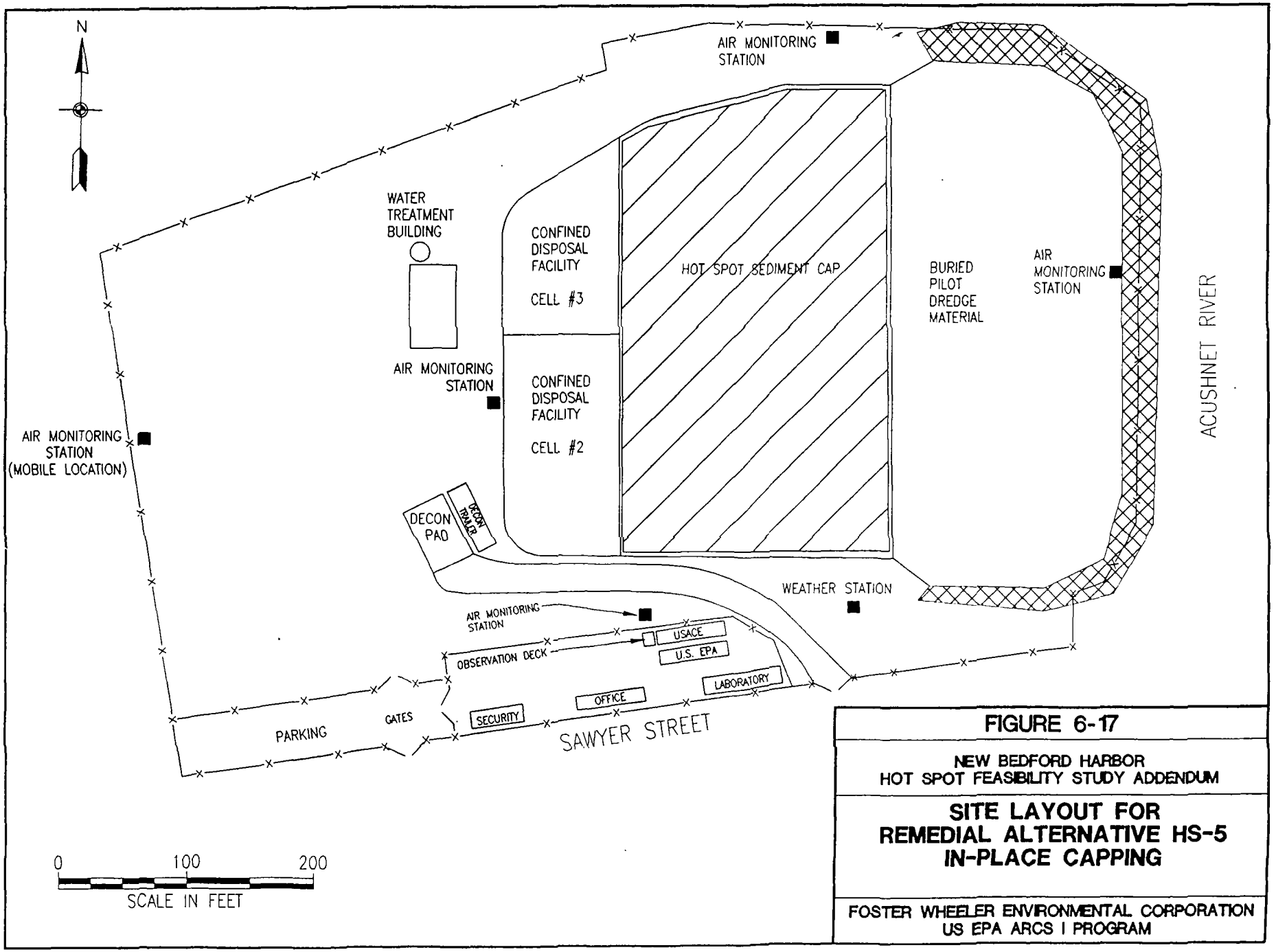


FIGURE 6-17

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-5 IN-PLACE CAPPING

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US EPA ARCS I PROGRAM

CADDFILE: 8860AD33.DWG
DATE:9/17/97

As mentioned above, the consolidation of the sediments through dewatering will allow the sediments to support the weight of a cap system. Once the sediment has sufficient shear strength to support the cap, an additional one foot thick layer of clean sand would be placed on a filter fabric layer. This sand layer would be used a gas transmission layer. The impermeable components of the cap will include a geocomposite clay layer (GCL) and a 40 mil HDPE liner material. The final components of the cap would include additional sand, top soil and a vegetative layer. The cap would also include provisions for gas collection and treatment and surface run-off controls.

6.2.9.2 Overall Protection of Human Health and the Environment

Remedial alternative HS-5 will achieve and maintain protection of human health and the environment through a combination of containment and institutional controls. Short-term effectiveness concerns are small as the hot spot sediments are not removed from the CDF. However, it may be difficult to monitor the long-term performance of the double liner system given the groundwater levels and the potential impacts of tidal fluctuations on the monitoring well network.

6.2.9.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-5. Complete listings of these respective ARARs are presented in Tables B-5-1, B-5-2 and B-5-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-5. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.*) To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste disposal and the treatment facility discharges. These ARARs include PCB disposal requirements under TSCA (40 CFR 761) and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards (310 CMR 30.00).

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. Alternative HS-5, as an alternative disposal remedy, requires approval by the Regional Administrator, based on the requirements of TSCA.

HS-5 must comply with relevant and appropriate TSCA chemical waste landfill standards, which apply to the permanent disposal of PCB contaminated dredge spoil. TSCA allows for specific requirements for the landfill ARAR to be waived upon a finding by the Regional Administrator that the facility will not present an unreasonable risk of injury to health or the environment. To use the capped CDF as a permanent disposal facility, waivers are required regarding hydrologic conditions, flood protection, and leachate collection. The facility's design that includes a multi-layer cap, gas collection and treatment, surface run-off controls, double impermeable bottom and side liners, a monitoring system for leak detection, and top-of-berm elevation two feet higher than the 100-year flood elevation should meet waiver standards for the prevention of injury to health or the environment.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does <u>not</u> meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Discharges from dewatering, monitoring, operations, and/or maintenance of the facility under alternative HS-5 will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants (federal Clean Air Act, 42 USC 7401 *et seq.*, 40 CFR Part 61 and state air standards, 301 CMR 6.00 and 7.00). Air emissions from alternative HS-5 may potentially result from releases from the CDF, including dewatering of the sediments prior to capping. Air emissions will be addressed through monitoring and proper management of the CDF disposal cell, including operation of a gas collection and treatment system.

Water discharges are regulated under state and federal water quality ARARs (federal Clean Water Act (CWA), 33 USC 1342, 40 CFR 122-125, 131 and state water standards, 314 CMR 1.00-7.00). Water treatment at the facilities on-site treatment plant will be required as part of the dewatering process and may be required if surface run-off comes in contact with the contaminated sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the CWA, Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is

proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than offset by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF) and air dioxin guidelines will be considered for evaluation of air emissions. Noise levels will be minimized to the extent practicable.

6.2.9.4 Long Term Effectiveness and Permanence

The effectiveness and permanence of alternative HS-5 would be controlled by a combination of institutional controls and isolating the Hot Spot sediment beneath a secure, impermeable cap. The sediment would also be contained by the CDF bottom double liner system originally designed and constructed to contain the sediment prior to operations.

The reliability of these controls is less for the liner than it is for the cap. This is primarily associated with the ability to monitor the cap for subsidence and/or erosion and make non-intrusive repairs on a timely basis. The liner system does not afford this same level of convenience for monitoring, detecting problems and making repairs. The difficulty in monitoring the performance of the liner is the absence of a leak detection system between the two liners. The gas collection and treatment system would also require maintenance to ensure proper operation.

Alternative HS-5 would require a five year review as the Hot Spot wastes will remain at the site. As a part of this process, extensive air monitoring would be conducted at the site to assess the effectiveness of the cap. Monitoring the effectiveness of this alternative may be somewhat hindered by the CDF's existing double liner system and the shoreline setting. It may be somewhat difficult to assess a liner failure given groundwater levels and the potential impact of tidal fluctuations on the monitoring well network. In addition, it is not currently possible to detect liquid material between the two layers of liner.

6.2.9.5 Short Term Effectiveness

The short-term effectiveness issues associated with alternative HS-5 includes protection of site workers and area residents. These would be addressed in a comprehensive health and safety plan. This document would specify the types of personnel protective equipment and monitoring equipment to ensure safe working conditions. A comprehensive ambient air monitoring program would also be conducted to ensure area residents were protected against PCB emissions.

The time to complete this alternative is on the order of two years. This would permit the overall design process to proceed in parallel as the material settles under the weight of the initial two foot thick sand layer and is further consolidated using the wick drains.

6.2.9.6 Implementability

Alternative HS-5 would be fairly implementable. The technologies of dewatering using wick drains, capping design and construction are proven effective, routinely used and readily implemented. Similarly, the ambient air monitoring program currently used at the site could be readily expanded to conduct additional testing, as necessary.

The condition of the CDF liner and the potential for leaks cannot be monitored easily given the existing CDF conditions. Similarly, should a problem be detected with the liner, repair would likely require removing the cap and sediment to make a repair.

6.2.9.7 Cost

The costs to implement alternative HS-5 include site preparation, in-place capping, the gas collection and treatment system and air monitoring. Costs for these items and the associated indirect cost items are presented in Table 6-11. The total new cost for the alternative is $10.3 million. This includes a significant component for O&M of the cap and off-gas treatment system ($1.9 million) and extensive annual monitoring for the 30 years following implementation ($4.4 million).

6.2.9.8 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.9.9 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-11
Cost Estimate: Remedial Alternative - HS-5
In-Place Capping

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	119,401
B. In-Place Capping	366,842
C. Gas Collection/Treatment	113,320
D. Air Monitoring	1,651,200
TOTAL DIRECT COST (TDC)	**$2,250,763**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	112,538
B. Legal, Administration, Permitting (@ 10% of TDC)	225,076
C. Engineering (@ 10% of TDC)	225,076
D. Services During Construction (@ 10% of TDC)	225,076
E. Turnkey Contractor Fee (@ 15% of TDC)	337,614
TOTAL INDIRECT COST (TIC)	**$1,125,382**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$3,376,145**
CONTINGENCY (@ 20% of TDC + TIC)	675,229
TOTAL CAPITAL COST	**$4,051,373**
O&M COST (Cap and Treatment Systems)	
(Present Worth @ 7% for 30 years upon completion)	**$1,861,400**
MONITORING PROGRAM (Present Worth @ 7% for 30 years)	4,433,107
TOTAL COST - REMEDIAL ALTERNATIVE - HS-5	**$10,329,668**

6.2.10 Alternative HS-6: Off-site Landfilling

This section of the FS Addendum describes Remedial Alternative HS-6 and evaluates the alternative against the detailed evaluation criteria. Alternative HS-6 involves removal of the Hot Spot sediment and disposing of this material in a permitted disposal facility. This facility would be specifically designed to meet the requirements of a secure chemical waste landfill as prescribed by TSCA regulations. Only landfills meeting the applicable compliance criteria would be considered as a potential disposal locations.

6.2.10.1 General Description

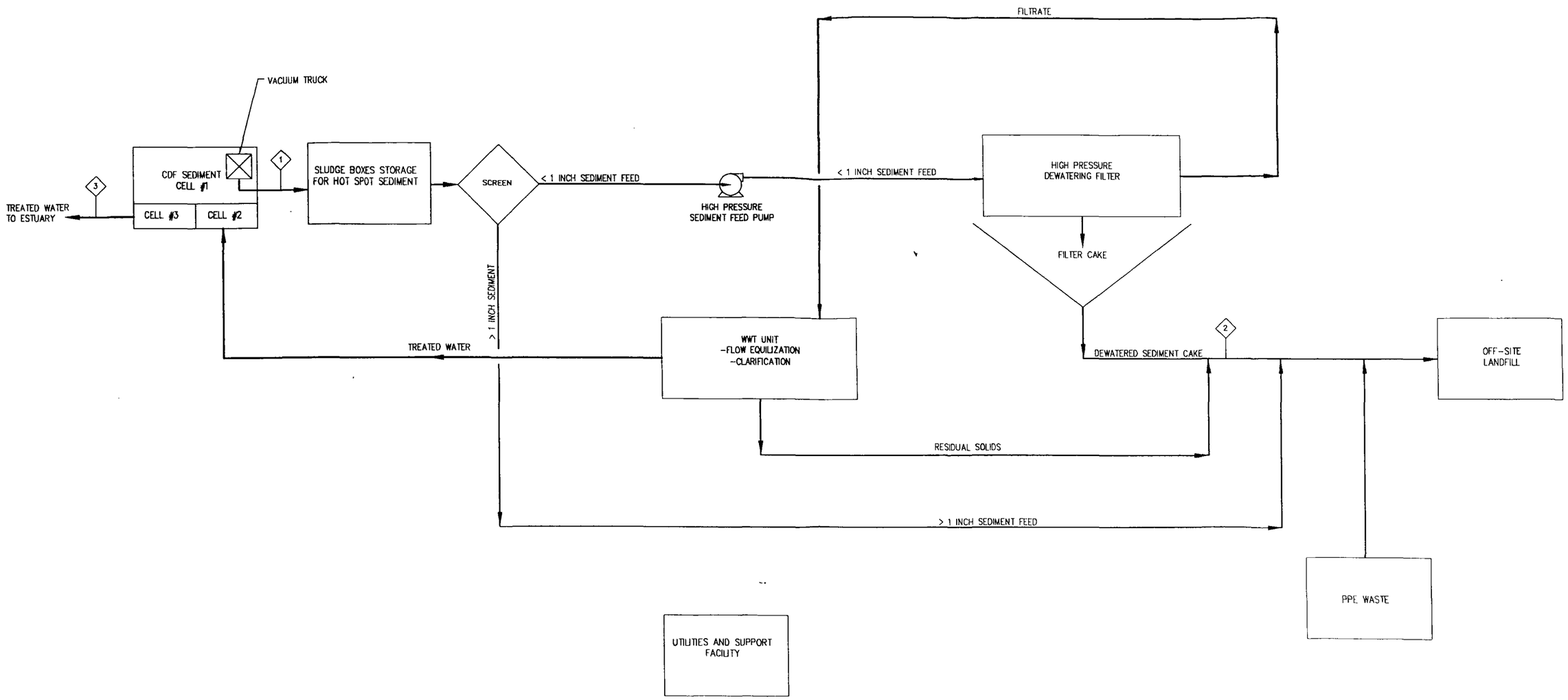
Remedial Alternative HS-6 is a removal and disposal alternative using a permitted off-site facility. The cleanup operations would include the following activities; withdrawal of the Hot Spot sediments from the CDF, staging the sediments for treatment in sealed containers, screening the sediment to remove over-sized material, dewatering the sediment with a plate and frame assembly, treating water removed from the sediments, loading the sediments for off-site shipment, transportation of the sediment, and off-site disposal in a permitted facility. Overall movement of materials at the site is presented in Figure 6-18.

The initial treatment steps for alternative HS-6 are the same as those described for other alternatives. These initial steps encompass the activities conducted from the initial upgrade of the site to accommodate the materials handling treatment operations. As with the other alternatives, the predominant feature of this initial step would be the construction of a series of treatment pads and access roads, as shown on Figure 6-19. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2.

Following dewatering and conditioning, the sediment would be loaded into 20-cubic yard, sealed roll-off containers (sludge boxes) for transportation to the permitted landfill. The dewatering process would reduce the volume of contaminated sediment from 15,000 cubic yards to approximately 11,000 cubic yards (14,500 tons). Seventeen tons of sediment would be placed in each sludge box, requiring approximately 850 trucks to complete the removal operation. Removal of the sediment from the CDF and dewatering would be the rate limiting steps. The complete operation is expected to take six months to complete. This would result in seven trucks per day operating on a five day per week basis.

6.2.10.2 Overall Protection of Human Health and the Environment

Alternative HS-6 provides protection of human health and the environment. The potential human risks associated with direct contact and inhalation will no longer be present once the sediment is removed. Potential environmental risks associated with the Hot Spot sediments are no longer present.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 DEWATERED SEDIMENT CAKE	3 TREATED WATER
CUBIC YARDS	15,000	11,000	---
TONS	18,000	14,500	---
MM GALLONS	---	---	0.8

LEGEND

- SOLID/SEMI-SOLID
- VAPOR
- LIQUID
- MATERIAL BALANCE

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NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-6
OFF-SITE LANDFILLING

SIZE | FIGURE 6-18 | REV

SCALE: NONE | PLOTDATE 9/25/97 | SHEET 1 OF 1

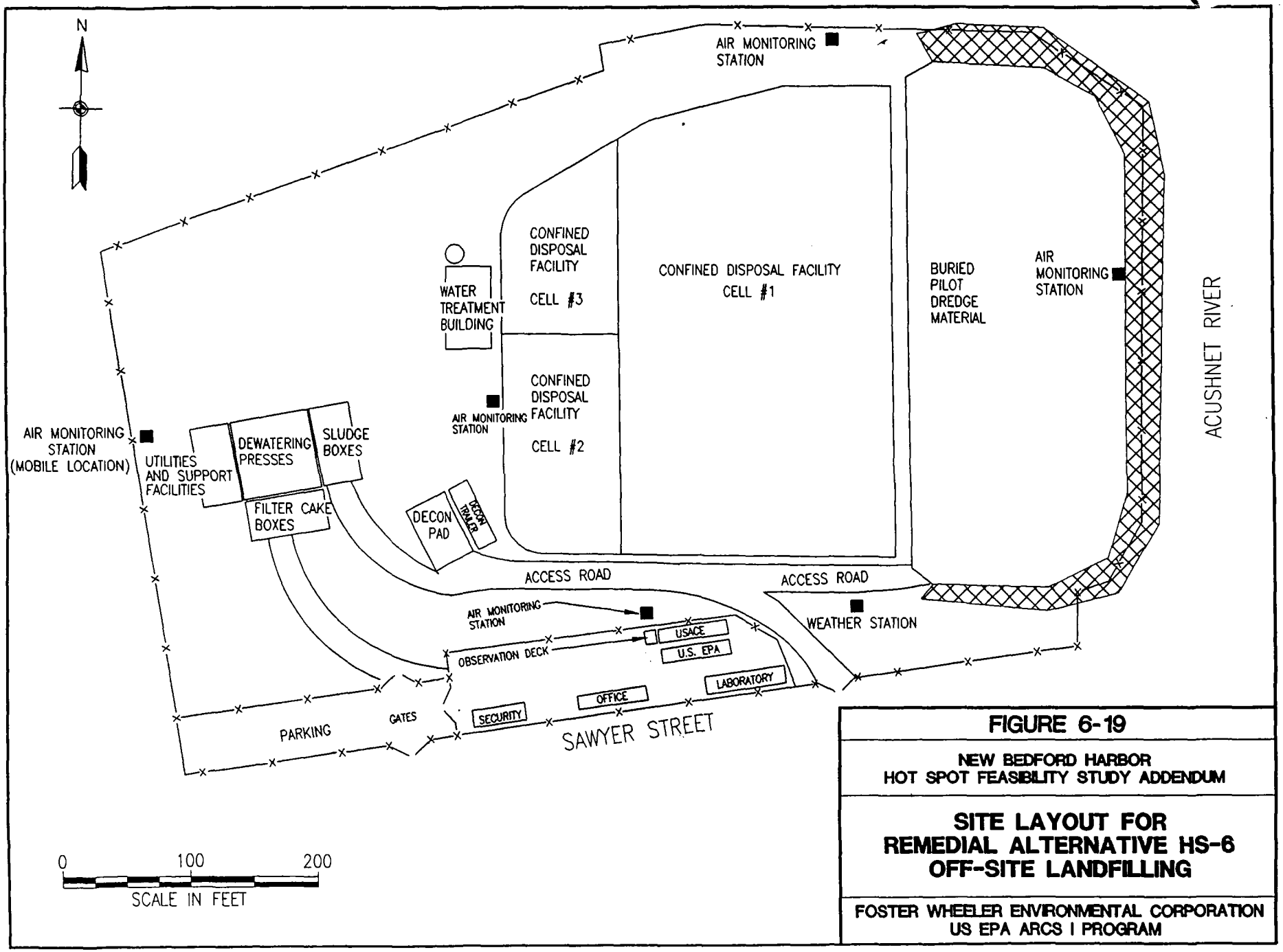

FIGURE 6-19

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-6 OFF-SITE LANDFILLING

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A031.DWG
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6.2.10.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-6. Complete listings of these respective ARARs are presented in Tables B-6-1, B-6-2 and B-6-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-6. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring of the temporary storage CDF and removal/dewatering of the sediments will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste storage and the dewatering facility discharges. These ARARs include PCB storage and disposal requirements under TSCA (40 CFR 761) and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards (310 CMR 30.00). Action-specific ARARs do not apply to the transportation and off-site disposal phases of the proposed remedy.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. HS-6 satisfies the off-site landfilling standards of TSCA.

HS-6 requires temporary storage of the PCB sediment for greater than one year before all of the PCB dredge spoil can be removed from the site. Storage of PCB dredge spoil for more than a year violates a

TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived through "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-6 will require temporary storage for approximately two years before completion of the final remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit, including standards for closure of the site upon completion of the remedy.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternative may result from releases from the storage facility and handling/dewatering of the sediments before off-site removal. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and dewatering.

Water discharges are regulated under state and federal water quality ARARs. Water treatment at the on-site treatment plant will be required for the dewatering discharges and may be required if surface run off becomes contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF) and air dioxin guidelines will be considered for evaluation of air emissions. Noise levels will be minimized to the extent practicable.

6.2.10.4 Long Term Effectiveness and Permanence

Alternative HS-6 provides long term effectiveness and permanence as the Hot Spot sediments are no longer at the site. As a result, a five year review will not be required. Again, there is no concern with the potential failure of the technical components of the remedy. In summary, there are no residual risks or concern for the adequacy and reliability of controls.

6.2.10.5 Reduction of Toxicity, Mobility and Volume

This alternative does not reduce the toxicity or mobility of the contaminants. However, the dewatering process does reduce the volume of PCB contaminated material from 15,000 cubic yards to approximately 11,000 yards. The off-site landfilling alternative does not fulfill the statutory preference for treatment as a principle element.

6.2.10.6 Short Term Effectiveness

The short term effectiveness concerns with alternative HS-6 involves protection of site workers and area residents from potential exposure to PCBs during the sediment removal and dewatering activities. These potential risks will be minimized through the use of safety plans, equipment and procedures. This will include the use of personnel protective equipment (coveralls, gloves, suits, respirators, etc.) for the workers and implementation of a comprehensive network of ambient air monitors to assess potential PCB volatilization. In addition, the vacuum truck that removes the sediment from the CDF will also be equipped with a emissions control system.

The response objectives will be achieved within a two year period including design, procurement and field implementation. Potential impacts due to construction related traffic and noise will be minimized by the five day a week operations and the low daily volume of truck traffic (seven trucks per day).

6.2.10.7 Implementability

Alternative HS-6 is implementable. The technology to complete the construction activities including removal and dewatering of the sediment are routinely available. There are currently off-site chemical waste landfills available for disposal of the Hot Spot sediment.

There would be a high level of coordination with other agencies associated with this alternative. Significant efforts would be undertaken to ensure that the selected landfill has the required permits in place and maintains an acceptable compliance record. For a waste such as the Hot Spot sediments, an independent environmental compliance audit would likely be conducted for candidate landfills prior to a selection being made.

6.2.10.8 Cost

The cost estimate for the off-site landfilling alternative includes site preparation, sediment removal from the CDF, sediment dewatering, treating water removed from the sediment, off-site transportation to and disposal at the off-site landfill and air monitoring. The transportation and disposal costs presented in Table 6-12 were developed using the average cost for two potential landfill sites. One was located in western New York State and the second location was a landfill in Alabama.

The total estimated cost of $14.8 million also includes costs for other indirect activities such as health and safety, legal, engineering, construction services and fee. A contingency factor of 20% was also applied to the total direct and indirect costs.

6.2.10.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.10.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan.

Table 6-12
Cost Estimate: Remedial Alternative - HS-6
Off-Site Landfilling

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	127,979
B. Sediment Removal From CDF	329,540
C. Dewatering	1,035,000
D. Off-Site Transportation	3,191,750
E. Off-Site Landfilling	1,865,306
F. Air Monitoring	1,651,200
TOTAL DIRECT COST (TDC)	**$8,200,775**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	410,039
B. Legal, Administration, Permitting (@ 10% of TDC)	820,078
C. Engineering (@ 10% of TDC)	820,078
D. Services During Construction (@ 10% of TDC)	820,078
E. Turnkey Contractor Fee (@ 15% of TDC)	1,230,116
TOTAL INDIRECT COST (TIC)	**$4,100,388**
SUBTOTAL COSTS	**$12,301,163**
CONTINGENCY (@ 20% of TDC + TIC)	2,460,233
TOTAL CAPITAL COST	**$14,761,395**
TOTAL COST - REMEDIAL ALTERNATIVE - HS-6	**$14,761,395**

6.2.11 Alternative HS-7: Off-site Incineration

This section of the FS Addendum describes Remedial Alternative HS-7 and evaluates the alternative against the detailed evaluation criteria. Alternative HS-7 involves removal of the Hot Spot sediment and treatment through off-site incineration at a permitted facility. This facility would be specifically designed to meet the requirements of an incinerator as prescribed by TSCA regulations. Only incinerators meeting the applicable compliance criteria would be considered as potential treatment locations.

6.2.11.1 General Description

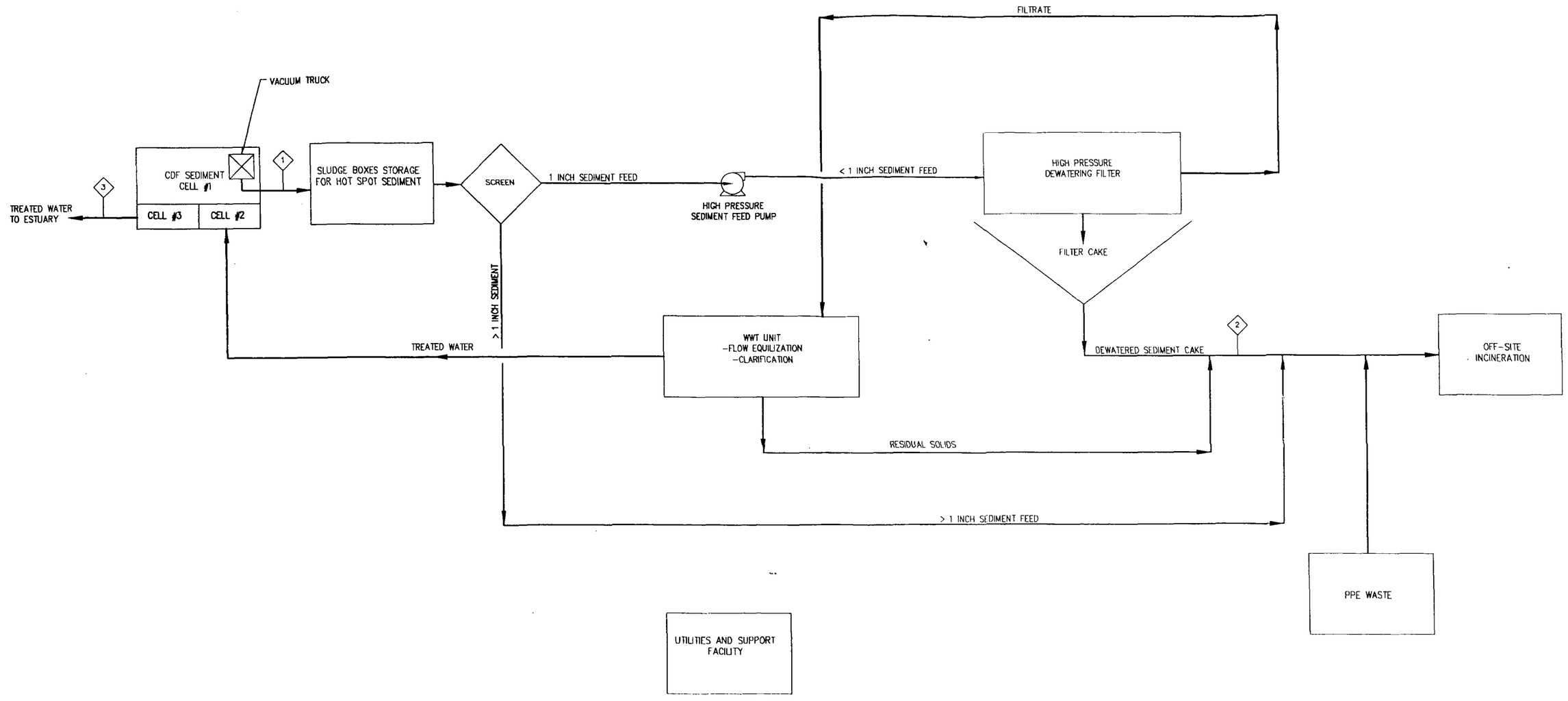
Remedial Alternative HS-7 is a removal and treatment alternative using a permitted off-site facility. The cleanup operations would include the following activities; withdrawal of the Hot Spot sediments from the CDF, staging the sediments for treatment in sealed containers, screening the sediment to remove over-sized material, dewatering the sediment with a plate and frame assembly, treating water removed from the sediment, loading the sediments for off-site shipment, and conducting treatment at a permitted off-site facility. Overall movement of materials from the CDF through the process steps is presented in Figure 6-20.

The initial treatment steps for alternative HS-7 are the same as those described for the other alternatives. These initial steps encompass the activities conducted from the initial upgrade of the site to accommodate the materials handling treatment operations. As with the other alternatives, the predominant feature of this initial step is the construction of a series of treatment pads and access roads, as shown on Figure 6-21. Additional detail on existing site conditions and other site facility requirements is discussed in Section 6.2.2.

Following dewatering and conditioning, the sediment will be loaded into 20 cubic yard, sealed roll-off containers (sludge boxes) for transportation to the off-site incineration facility. The dewatering process will reduce the volume of contaminated sediments from 15,000 cubic yards to approximately 11,000 cubic yards (14,500 tons). Seventeen tons of sediment will be placed in each sludge box, requiring approximately 850 trucks to complete the removal operation. Removal of the sediment from the CDF and dewatering will be the rate limiting steps. The complete operation is expected to take six months to complete. This will result in seven trucks per day operating on a five day per week basis.

6.2.11.2 Overall Protection of Human Health and the Environment

Alternative HS-7 would provide protection of human health and the environment. The potential human health risks associated with direct contact and inhalation would no longer be present. Similarly, the potential ecological risks would no longer be present as the sediments would have been removed from the site and treated.



OVERALL MATERIAL BALANCE	1 CDF SEDIMENT	2 DEWATERED SEDIMENT CAKE	3 TREATED WATER
CUBIC YARDS	15,000	11,000	---
TONS	18,000	14,500	---
MM GALLONS	---	---	0.8

LEGEND

SOLID/SEMI-SOLID

VAPOR

LIQUID

MATERIAL BALANCE

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DRAWN BY FPZ	DATE 6/28/97
CHECKED BY	DATE
PROJ/DES ENG	DATE
ENG APPROVAL	DATE

FOSTER WHEELER ENVIRONMENTAL CORPORATION
470 ATLANTIC AVENUE
BOSTON, MA. 02210

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

REMEDIAL ALTERNATIVE HS-7
OFF-SITE INCINERATION

SIZE | FIGURE 6-20 | REV

SCALE: NONE | PLOTDATE 9/25/97 | SHEET 1 OF 1

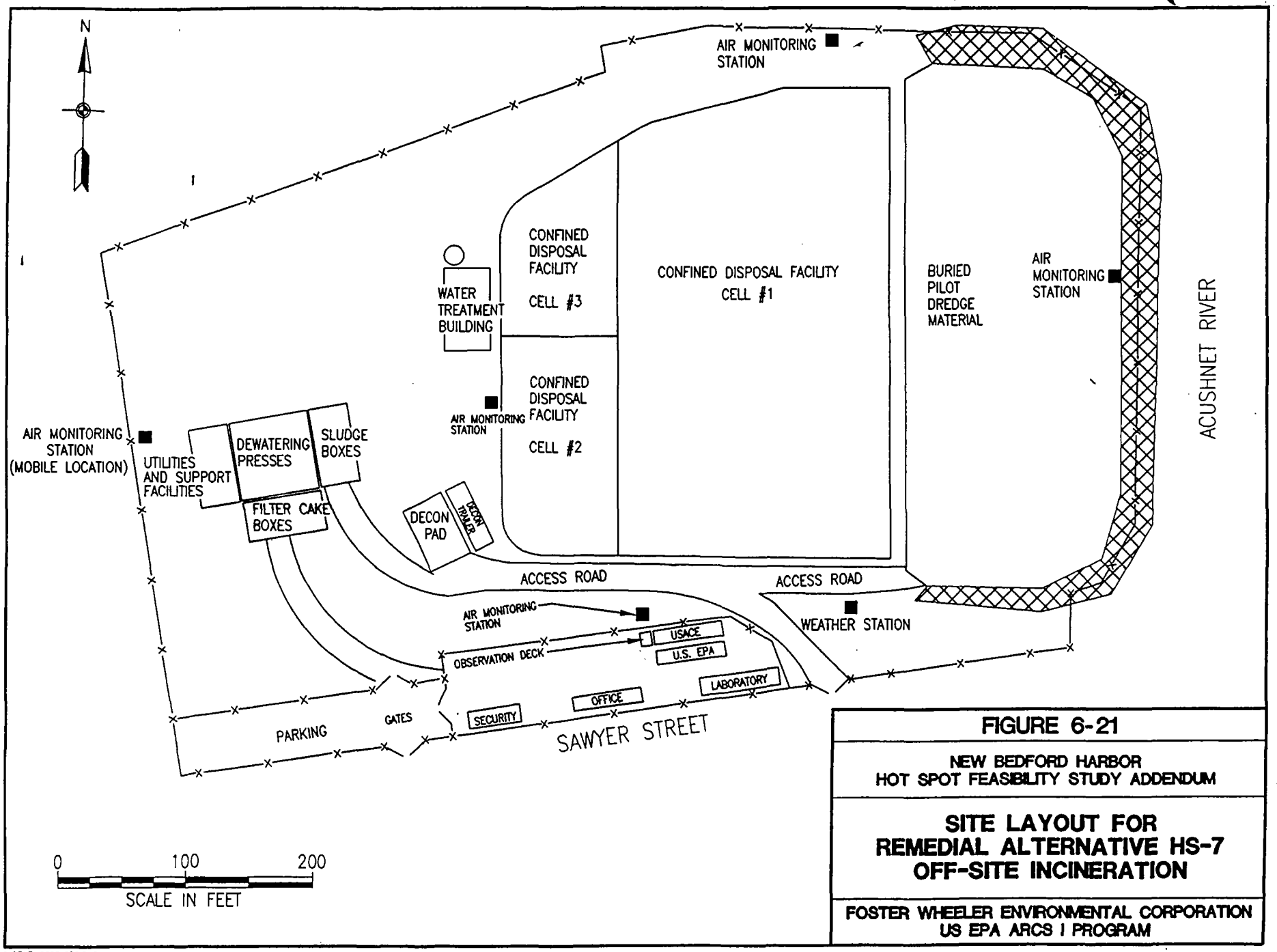


FIGURE 6-21

NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY ADDENDUM

SITE LAYOUT FOR REMEDIAL ALTERNATIVE HS-7 OFF-SITE INCINERATION

FOSTER WHEELER ENVIRONMENTAL CORPORATION
US EPA ARCS I PROGRAM

CADFILE: 8860A032.DWG
DATE: 9/17/97

6.2.11.3 Compliance with ARARs

This section discusses the chemical-specific, location-specific and action-specific ARARs for alternative HS-7. Complete listings of these respective ARARs are presented in Tables B-7-1, B-7-2 and B-7-3 of Appendix B to this document.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for alternative HS-7. Cleanup levels are based on Action-specific standards under the TSCA. Two federal guidance are cited as "To be considered" in evaluating potential carcinogenic and non-carcinogenic risks posed by contaminants at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* To implement this alternative in the coastal floodplain a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives, including operation, maintenance, and monitoring of the temporary storage CDF and removal/dewatering of the sediments will comply with all the substantive requirements of the state Location-specific ARARs. Coordination with the state will be ongoing during the planning and implementation of the remedy.

The primary action-specific ARARs are requirements regarding waste storage and the dewatering facility discharges. These ARARs include PCB storage and disposal requirements under TSCA (40 CFR 761) and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards (310 CMR 30.00). Action-specific ARARs do not apply to the transportation and off-site disposal phases of the proposed remedy.

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. HS-7 satisfies the incineration standards of TSCA.

HS-7 requires temporary storage of the PCB sediment for greater than one year before all of the PCB dredge spoil can be removed from the site. Storage of PCB dredge spoil for more than a year violates a

TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. Currently, the storage requirement is being waived through "an interim measure" under Section 121(d)(4)(A). The present waiver allows the Agency to waive the storage ARAR for an interim measure that will become part of a final remedial action at the Site. HS-7 will require temporary storage for approximately two years before completion of the final remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment (as described under Alternative HS-1, No Further Action). Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit, including standards for closure of the site upon completion of the remedy.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does not meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and discharges from monitoring, operations, and/or maintenance will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Other federal and state action-specific ARARs include air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from the proposed alternative may result from releases from the storage facility and handling/dewatering of the sediments before off-site removal. Air emissions will be addressed through monitoring, management of storage facilities, and treatment of off-gases from handling and dewatering.

Water discharges are regulated under state and federal water quality ARARs. Water treatment at the on-site treatment plant will be required for the dewatering discharges and may be required if surface run off becomes contaminated by the stored sediments. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives. The issue is the result of the degraded water quality in the Harbor, where permitting any new discharge is not possible unless the Harbor's waters reach water quality standards or until the other conditions of the regulations are met. Neither of these conditions are likely to be accomplished in a reasonable time.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

Federal PCB policies and guidance regarding PCB releases and treatment technologies for CERCLA remedial actions will be considered. The Allowable Ambient Limits and Threshold Exposure Limits will be considered for alternatives involving air emissions. Revised toxicity equivalence factors (TEF) and air dioxin guidelines will be considered for evaluation of air emissions. Noise levels will be minimized to the extent practicable.

6.2.11.4 Long Term Effectiveness and Permanence

Removal of the sediments and incineration is effective and permanent. The waste would no longer be at the site and would be treated to Destruction and Removal Efficiency (DRE) levels exceeding 99.9999%.

6.2.11.5 Reduction of Toxicity, Mobility and Volume

Alternative HS-7 reduces the volume of the PCB wastes through the initial dewatering step. The toxicity of the sediment would be significantly reduced by lowering the concentration of PCBs during incineration. The mobility of the metals may be increased through incineration and the treated solids would be tested to ensure compliance with TCLP requirements.

6.2.11.6 Short Term Effectiveness

The short term effectiveness concerns with alternative HS-7 involve protection of site workers and area residents from potential exposure to PCBs during the sediment removal and dewatering activities. These potential risks would be minimized through the use of safety plans, equipment and procedures. These would include the use of personnel protective equipment (coveralls, gloves, suits, respirators, etc.) for the workers and implementation of a comprehensive network of ambient air monitors to assess potential PCB volatilization. In addition, the vacuum truck that removes the sediment from the CDF would also be equipped with an emissions control system.

The time to complete the remedial actions under alternative HS-7 is on the order of two years. This includes the time necessary for design, procurement and field implementation. Potential impacts due to construction related traffic and noise would be minimized by the five day a week operations and the low daily volume of truck traffic (seven trucks per day).

6.2.11.7 Implementability

Alternative HS-7 is implementable as the required construction services are locally available and there are permitted incineration facilities available to treat the Hot Spot sediment. However, one of these facilities recently announced that it would no longer be accepting waste and as a result, there is some concern as to whether there will be an incineration facility available to accept this waste in the future. Given this situation, it may be prudent to have a back-up approach available for treatment and/or disposal of the sediments.

This alternative would likely require a significant amount of coordination between federal, state and local officials.

6.2.11.8 Cost

The costs for alternative HS-7 include the following activities: site preparation, sediment removal from the CDF, dewatering, treating water removed from the sediment, off-site transportation, off-site incineration and air monitoring. Estimated costs for this alternative are summarized in Table 6-13. The representative incineration facility chosen for typical costing reasons is located in Texas.

The total alternative cost of $37.7 million presented in Table 6-13 also includes a number of indirect costs and a 20% contingency.

6.2.11.9 State Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the state on the Proposed Plan.

6.2.11.10 Community Acceptance

This criterion will be evaluated by EPA within the ROD based on input received from the community on the Proposed Plan

Table 6-13
Cost Estimate: Remedial Alternative - HS-7
Off-Site Incineration

ACTIVITY	COST ($)
DIRECT COSTS	
A. Site Preparation	127,979
B. Sediment Removal From CDF	329,540
C. Dewatering	1,035,000
D. Off-Site Transportation	5,604,300
E. Off-Site Incineration	12,195,120
F. Air Monitoring	1,651,200
TOTAL DIRECT COST (TDC)	**$20,943,139**
INDIRECT COSTS	
A. Health & Safety (@ 5% of TDC) Level D Protection	1,047,157
B. Legal, Administration, Permitting (@ 10% of TDC)	2,094,314
C. Engineering (@ 10% of TDC)	2,094,314
D. Services During Construction (@ 10% of TDC)	2,094,314
E. Turnkey Contractor Fee (@ 15% of TDC)	3,141,471
TOTAL INDIRECT COST (TIC)	**$10,471,570**
SUBTOTAL DIRECT AND INDIRECT COSTS	**$31,414,709**
CONTINGENCY (@ 20% of TDC + TIC)	6,282,942
TOTAL CAPITAL COST	**$37,697,650**
TOTAL COST - REMEDIAL ALTERNATIVE - HS-7	**$37,697,650**

6.3 Comparison of Remedial Alternatives

In this section, the eleven remedial alternatives presented in Section 6.2 are compared with each other. Comparisons are presented in a qualitative manner and attempt to identify substantive differences between the alternatives. As required under the NCP, the following criteria form the basis for the comparative analysis:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Short Term Effectiveness
- Long Term Effectiveness
- Reduction of Toxicity, Mobility and Volume
- Implementability
- Cost

6.3.1 Overall Protection of Human Health and the Environment

The no further action alternative (HS-1) will provide limited long-term protection of human health and the environment, due, primarily, to the limitations of the existing cover system over the hot spot sediments. The existing cover system consists of a maintained water layer over a relatively thin plastic cover to minimize air emissions of PCBs. While the integrity of the water layer and cover can be effectively maintained in the short-term, wind and sun damage will cause long-term maintenance problems and the long-term integrity of the cover system will be difficult to ensure.

The primary difference in long-term protectiveness between the on-site treatment alternatives (HS-2A, HS-2B, HS-2C, HS-3A, HS-3B, HS-3C, HS-4) and the on-site non-treatment alternatives (HS-1 and HS-5), is the magnitude of residual risk and the reliance on long-term controls to minimize the risks. However, the on-site treatment alternatives present some short-term risks and implementability challenges. All of the on-site treatment alternatives involve removing the sediments from the CDF and handling them prior to treatment. The removal and handling activities could generate PCB emissions. The use of reagents and process equipment that are quite hazardous in nature, pose potential risks to on-site workers and nearby residents. These potential risks can be greatly minimized through compliance with appropriate procedures and controls For on-site treatment alternatives HS-2A and HS-3A there are also potential short-term risks with the treatment residuals from the solid phase destruction process. For on-site treatment alternatives which involve thermal desorption (HS-3A, HS-3B and HS-3C), the potential exists for emissions of particulates, metals such as lead, and the possibility for creating and emitting dioxins and furans. The emissions would be controlled using available off-gas control technology. The short-term risks and implementability challenges are lower for the two on-site treatment alternatives (HS-2C and HS-3C) which involve off-site incineration of the contaminated treatment residuals from either solvent extraction or thermal desorption.

For the two off-site alternatives (HS-6 and HS-7) potential short-term risks to human health and the environment occur in the handling and dewatering of the contaminated sediments, prior to off-site shipment.

6.3.2 Compliance with ARARs

All of the alternatives comply with ARARs, although waivers will be required for a number of provisions pertaining to the implementation of each alternative.

There are no "applicable" or "relevant and appropriate" federal or state chemical-specific ARARs for the proposed remedies at the site.

Location-specific ARARs pertain to the site's location within a coastal floodplain, adjacent to the Harbor. Federal ARARs are Executive Order 11988 - Floodplain Management (40 CFR Part 6, Appendix A), the Fish and Wildlife Coordination Act (16 USC Part 661 *et seq.*, 40 CFR 6.302) and the Coastal Zone Management Act (16 USC Parts 1451 *et seq.* For every alternative a determination must be made that no practicable alternative exists outside the floodplain. Under such circumstances the potential harm must be minimized and action taken to restore and preserve natural and beneficial values. The Fish and Wildlife Coordination Act requires that the U.S. Fish and Wildlife Service be consulted regarding preventing and mitigating any potential losses to fish and wildlife resources in regards to all of the alternatives.

State ARARs regulate coastal zone management (301 CMR 21.0), waterways (regarding flowed and filled tidelands)(310 CMR 9.00), and wetlands protection (131 MGL 40, 310 CMR 10.00). The state wetlands protection statute identifies the following protected resource areas that occur on or adjacent to the site: Land Subject to Coastal Storm Flowage, Land Under Ocean, Designated Port Area, Coastal Beaches (including tidal flats), Coastal Bank (including a 100-foot buffer zone inland from the edge of the bank), and Land Containing Shellfish.

All actives pertaining to the alternatives, including operation, maintenance, and monitoring of the temporary storage CDF and removal/dewatering of the sediments will comply with all the substantive requirements of the state Location-specific ARARs.

The primary action-specific ARARs pertaining to each alternative are requirements regarding waste management and treatment of discharges. These ARARs include PCB disposal requirements under TSCA (40 CFR 761) and identification and regulation of characteristic hazardous waste under Massachusetts Hazardous Waste Management standards (310 CMR 30.00).

TSCA requires that any PCB contaminated dredge spoil with a concentration of 50 ppm or greater be disposed of either in an approved incinerator, an approved chemical waste landfill, or by using a disposal method to be approved by the Regional Administrator. Approval must be based on a finding that, based on technical, environmental, and economic considerations, disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternative disposal method will provide adequate protection to health and the environment. Four of the alternatives (Solvent Extraction and Off-Site Incineration, HS-2C; Thermal Desorption and Off-Site Incineration, HS-3C; Off-Site Landfilling, HS-6, and Off-Site Incineration, HS-7) satisfy one of the first two approved disposal methods. The other seven proposed remedies (involving either in-place permanent disposal (HS-1 and HS-5) or on-site treatment (HS-2A and B, HS-3A and B, and 4)) entail alternative disposal remedies that require approval by the Regional Administrator, based on the requirements of TSCA.

The two proposed in-place disposal remedies (No Further Action, HS-1 and In-Place Capping, HS-5) must comply with relevant and appropriate TSCA chemical waste landfill standards, which apply to the permanent disposal of PCB contaminated dredge spoil (40 CFR 761.75). TSCA allows for specific requirements for the landfill ARAR to be waived upon a finding by the Regional Administrator that the facility will not present an unreasonable risk of injury to health or the environment. To use the present CDF facility as a permanent disposal facility under either alternative, waivers are required regarding hydrologic conditions, flood protection, and leachate collection. Under both HS-1 and HS-5, the facility design includes double impermeable bottom and side liners, a monitoring system for leak detection, and top-of-berm elevation two feet higher than the 100-year flood elevation that should meet waiver standards for the prevention of injury to health or the environment. HS-5 provides further protection in that it also includes a multi-layer cap, gas collection and treatment and surface run-off controls.

The remaining nine remedies (HS-2A, B, and C; 3A, B, and C; 4, 6 and 7) would involving either the removal of contamination off-site or some form of on-site treatment. All require temporary storage of the PCB sediment for greater than one year. Storage of PCB dredge spoil for more than a year violates a TSCA storage requirement. This ARAR needs to be waived under Section 121(d)(4)(C) of CERCLA due to the technical impracticality, based on engineering constraints, involved in removing and/or treating the PCB material in less than a year. The nine removal or on-site treatment alternatives will require storage periods estimated between two to five years before completion of the final remedy. In the interim, the PCB dredge spoil will remain stored within the existing CDF in a manner that is protective of health and the environment. Storage of the PCB dredge spoil will comply with the remaining TSCA storage ARARs that do not involve the one-year storage limit, including closure of the temporary storage cell.

Massachusetts Hazardous Waste ARAR's apply to all non-PCB contaminants that meet characteristic hazardous waste standards. Recent toxicity characteristic leaching procedure (TCLP) data on the dredged sediment samples show the sediment does <u>not</u> meet the definition of a RCRA characteristic waste. Toxicity characteristic (TC) constituent concentrations are below TC regulatory limits for hazardous waste. Sediments, process wastes, and/or discharges from monitoring, operations, and/or maintenance of all of the alternatives will be tested for hazardous constituents. Any characteristic wastes identified will be stored, treated, and/or disposed of in compliance with state hazardous waste requirements.

Massachusetts Solid Waste ARARs are applicable for all alternatives that involve the disposal of treated sediments (Alternatives HS-2A, 2B and 2C; HS-3A, 3B, and 3C; and 4), containing less the 50 ppm of PCBs. These requirements include cover systems, surface and groundwater protection, monitoring, and post-closure measures.

Every alternative will comply with federal and state action-specific ARARs governing air quality and air pollution requirements, which preclude the release of PCBs and other contaminants. Air emissions from every proposed alternatives may result from releases from the storage facility, discharges from extraction and treatment technologies, and/or handling/dewatering of the sediments before off-site removal or on-site processing. Air emissions will be addressed through monitoring, management of storage facilities, and/or treatment of off-gases from handling, dewatering, and processing.

Every alternative will likely produce at least some water discharges regulated under state and federal water quality ARARs. Contaminated discharges will require treatment at the facility's on-site water

treatment plant. Water treatment may be required because of surface run off becoming contaminated by the stored sediments or from dewatering and/or process discharges. Operation of the water treatment plant requires a waiver of a provision of the National Pollutant Discharge Elimination System requirements of the federal Clean Water Act (CWA), Section 402. The provision prohibits new discharges into waters (including New Bedford Harbor) that do not meet applicable water quality criteria, unless certain conditions are met (40 CFR 122.4(i)). It is proposed that a protectiveness waiver under Section 121(d)(4)(B) of CERCLA be used for this ARAR since compliance would essentially prevent the cleanup of this Site and result in greater risk to human health and the environment than other alternatives.

Furthermore, since New Bedford Harbor water quality is so degraded as to preclude diluting any proposed discharge, Section 402 of the CWA requires that discharges from all of the alternatives meet ambient water quality criteria (WQC) at the discharge point. Except for copper, it is expected that the treatment facility can attain compliance with WQC during the remedial activities. Consistent with Section 303 of the CWA and its Total Maximum Daily Load (TMDL) approach, it is proposed that discharge limits for the water treatment plant be implemented that are below current background levels of copper, but above WQC. This approach allows for attainment of ambient WQC throughout the waterbody in a phased or step-wise approach. The copper that will be discharged from the treatment plant will be more than off set by the permanent removal of copper contaminated sediments from the Harbor.

6.3.3 Long Term Effectiveness

The long-term effectiveness and permanence criterion addresses the remaining risks after the site has been remediated along with the degree of certainty that the alternative will prove successful. The two off-site alternatives, off-site landfilling and off-site incineration, alternatives HS-6 and HS-7, respectively, provide the highest degree of long term effectiveness and permanence as the Hot Spot sediments are no longer present. The adequacy and reliability of controls does not apply to these two off-site alternatives. Alternative HS-4 provides a high degree of long term effectiveness and permanence as the residual contaminants, primarily the metals are immobilized in the vitrified product.

The sediment would remain untreated at the site under the no further action alternative (HS-1) and the in-place capping alternative (HS-5) and as such, both have a significant amount of residual risk associated with them. However, the risks for no further action (HS-1) are higher as the ability to contact the sediment still exists and the potential for PCB emissions are much higher. In addition, the controls under the in-place capping alternative (HS-5) are more reliable than under the no further action alternative.

The remaining alternatives are on-site treatment approaches that would treat the sediment to PCB concentrations of less than 50 ppm. Each of these treatment alternatives use separation as the first step (solvent extraction or thermal desorption) and then treat the highly concentrated oil material through a number of potential treatment processes. As such, the treatment residual associated with the three solvent-extraction alternatives (HS-2A, 2B and 2C) are equivalent to the risks posed by the solids resulting from the thermal desorption alternatives (HS-3A, 3B and 3C).

The magnitude of risk associated with the treatment residuals from the gas phase chemical destruction (HS-2B and HS-3B) are not considered as there will be no residuals left at the site. The residuals associated with the solid phase destruction components of alternatives HS-2A and HS-3A are of some uncertainty due

to the potentially high caustic characteristics of the treated residuals. While the residual material from the process is expected to have PCB levels below 5 ppm, the results of the pilot study testing indicated these wastes may still pose some risk due to elevated pH and reactivity. If the residues cannot be safely stored on-site, further treatment or off-site disposal will be required.

The treated solid residuals from the on-site treatment processes would be disposed of in an on-site CDF designed to effectively manage sediments contaminated with much higher PCB concentrations. As such, these facilities would provide an appropriate method to manage the residual risks associated with these treated solids. It is also important to note that these solids would retain most of the heavy metals as these separation processes are primarily targeted at organic type contaminants such as PCBs. These solids were tested for the leachability of the metals and passed the TCLP leaching test. As a result no additional treatment such as solidification would be required.

The degree of certainty that the proposed alternatives will prove successful is not known. The treatability studies showed that each treatment alternative tested (the HS-2 and HS-3 alternatives and HS-4) needed additional testing or evaluation to determine whether the alternatives would work at full-scale operation. The no further action alternative (HS-1) would require continued monitoring and maintenance to its cap system (designed originally as a temporary cover) in order to provide long-term protectiveness. In-Place Capping (HS-5) has the potential for successful containment of the contaminants. However, the alternative relies on the stability of the existing CDF and the ability to install a permanent cap over the site. Under the current design of the CDF it would be extremely difficult to repair/replace the facility in the event of remedy failure. Off-site landfilling or incineration (HS-6 and HS-7) have a high potential to succeed. However, to implement either alternative it will be necessary to evaluate the record of the receiving facility to determine that the contaminants will either be landfilled or incinerated properly and in accordance with all regulations.

6.3.4 Reduction in Toxicity and Mobility Volume

All of the treatment alternatives (HS-2A, HS-2B, HS-2C, HS-3A, HS-3B, HS-3C, HS-4 and HS-7) provide for significant reductions in toxicity and volume for the contaminants. Typical volume reductions of PCB contaminated material for both on-site separation processes (solvent extraction and thermal desorption) are on the order of 97%. Overall PCB treatment efficiencies are expected to be on the order of 99%. The overall highest treatment efficiency is associated with off-site incineration (HS-7) which typically operates in the 99.9999% DRE range. While the Eco Logic reactor alone did reach this range, the maximum efficiency of the overall treatment scheme (separation and destruction) is limited by the desorption efficiency of 99%.

The only treatment alternative that reduced the mobility of the contaminants, particularly, the inorganic contaminants was vitrification (HS-4). In fact, the mobility of the metals in the treated solids generally increased for alternatives that used thermal desorption as the initial separation step (HS-3A, HS-3B and HS-3C). Despite this increase in mobility, the treated solids passed TCLP testing and therefore, no additional treatment would be required prior to disposal in an on-site CDF.

There will be some reduction in the overall volume of contaminated sediment with no further action (HS-1) in-place capping (HS-5) and off-site landfilling (HS-6). However, the volume reductions are not expected to be significant (HS-1, 5% to 10% reduction; HS-5, 10% to 20% reduction; and HS-6, 20% to 30% reduction).

6.3.5 Short Term Effectiveness

The short-term effectiveness refers to the effect of the alternative on human health and the environment during implementation. In addition, this criterion considers the time until the remedial action is complete. All of the on-site treatment alternatives with the exception of vitrification (HS-4) could be completed in four to five years. The vitrification alternative would likely be on the order of six years, provided the results of design scale testing were straight forward and did not require significant time to finalize the implementation approach. The two off-site alternatives (HS-6 and HS-7) would require approximately two years to complete. On-site alternative HS-5, in place capping, would also require approximately two years to complete. The no further action alternative (HS-1) by definition is already complete.

The potential risks to site workers and nearby residents under the various treatment alternatives are significant. All of the techniques use process equipment and reagents that are hazardous in nature. These different hazards include flammable materials, electricity, heat, open flames, numerous chemicals, etc. Therefore, detailed safety plans and procedures will be required. Alternative HS-2B (solvent extraction and gas phase chemical reduction) may present the highest level of short term risk given the limited space available at the site and the quantities of hazardous materials at the site. Also, alternatives that use two treatment technologies at the site together (HS-2A, HS-2B, HS-3A, HS-3B and HS-4) inherently have more short-term risks. These risks may not necessarily be additive, in some cases they may be synergistically related. The alternatives which employ only one technology at the site, solvent extraction and off-site incineration (HS-2C) and thermal desorption and off-site incineration (HS-3C) pose less short-term risks.

The risks to site workers due to the potentially hazardous nature of the process residuals from the solid phase dechlorination process (HS-2A and HS-3A) must also be considered. The reactivity and high pH of this material encountered during the pilot scale treatability studies could pose significant risks.

For the on-site treatment alternatives which include thermal desorption as a treatment step (HS-3A, HS-3B and HS-3C), there is the potential to volatilize metals such as lead. The possibility also exists for the creation and emission of dioxins and furans. These compounds will be controlled using available off-gas control technologies.

Protection of site workers and the community under the two off-site alternatives (HS-6 and HS-7) would be ensured through air monitoring as the only on-site activities would be sediment removal and dewatering. Efforts would also be made to ease the potential impact of truck traffic with the residential character of the area neighborhoods.

6.3.6 Implementability

The implementability of an alternative includes the technical and administrative feasibility of implementing the alternative, as well as the availability of the technology. The two off-site alternatives (HS-6 and HS-7), in-place capping (HS-5), and no further action (HS-1) are readily implementable. However, the condition of the liner over the long-term and the potential for leaks cannot be monitored easily given the groundwater levels and the potential impacts of tidal fluctuations on a monitoring well network. The remaining alternatives all employ one or more innovative treatment technologies. Inherent in these technologies are performance risks. These include both safety risks related to the operating-chemicals and/or parameters and the potential that the technology may not work at full-scale as marketed. The information from the treatability studies helps to understand and minimize these risks.

The solvent extraction alternatives (HS-2A, 2B and 2C) use the same approach for separation of the PCBs from the sediments. These systems have been thoroughly tested at the bench and pilot scale with Hot Spot type sediment, yet the full-scale applications implemented to date have been on lower levels of PCB contamination. Notwithstanding this, the full-scale units are constructed with unit process equipment that is routinely available in the marketplace and has a significant operating history. The implementability of the three PCB destruction approaches combined with solvent extraction increase moving from HS-2A to HS-2C. The destruction component of HS-2A (solid phase chemical destruction) is still somewhat in the developmental stage as full-scale units for commercial application are currently being constructed. Relative to the Hot Spot sediment, the technology also has some materials handling difficulties to work through. Alternative HS-2B involves gas phase chemical destruction which has been used at full-scale on highly concentrated PCB wastes. However, the technology has not been used with solvent extraction as a first step and so, initial efforts may be required to work through any compatibility issues. Off-site incineration is readily implementable, although there is some potential concern that the availability of commercial incinerators may become an issue in the future.

Another common theme for the solvent extraction alternatives is the percentage of capital cost allocated to the project compared to the other treatment approaches. This greatly influences the overall cost of these alternatives. This, in combination with the potential lack of full-scale commercial processes other than the one tested during the treatability studies could greatly impact the competitiveness of the bidding process for the alternatives. Also, issues such as government ownership of the treatment equipment would have to be evaluated in such a case.

The separation step in the thermal desorption alternatives (HS-3A, 3B and 3C) is generally available. It should be noted that there is a significant difference in the commercial availability of the thermal desorption used as a representative process in alternative HS-2B. The unit used in alternative HS-2B (the Eco Logic TRM) would have to go through additional process development and testing based on the observations made during the treatability study. It could take up to 18 months and significant capital to work through these issues before treatment could begin. Implementability for the PCB destruction components of the thermal desorption alternatives (HS-3A, 3B and 3C) is similar to the solvent extraction alternatives with the exception of alternative HS-3B. The thermal desorption and chemical destruction components of HS-3B have been used together and compatibility should not present a problem. However, the implementability of alternative HS-3B as a whole will likely be constrained by the thermal desorption step. In addition, the issue of competitive bidding also exists for alternative HS-3B.

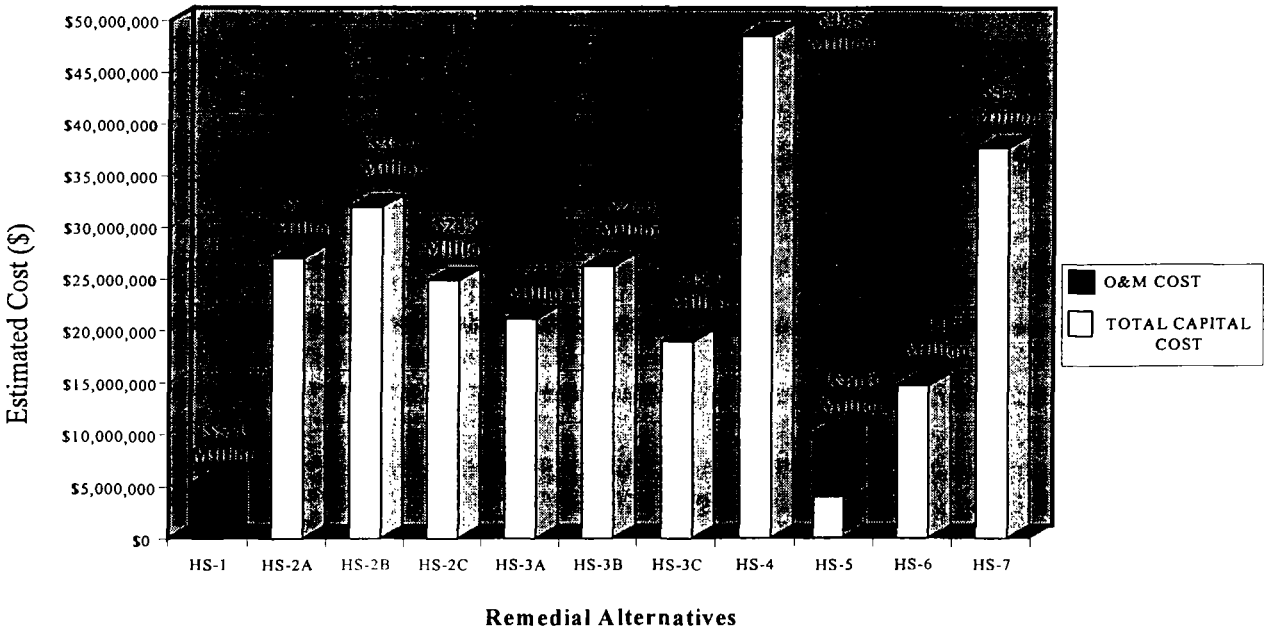
The vitrification alternative (HS-4) has significant implementability issues that require a comprehensive design scale study to address. This study will add two years and over $3 million to the overall cost of the remedial alternatives.

6.3.7 Cost

The cost estimates prepared for each of the 11 remedial alternative were developed on the basis of capital costs which include both direct costs and indirect costs. The direct capital costs were developed through a combination of vendor estimates resulting from the treatability study program, other vendor quotes, actual costs from the USACE's work at the site over the past ten years, and engineering judgment and experience. The indirect capital costs were developed using typical Feasibility Study indirect elements, including health and safety, legal and permitting, engineering, construction services, and profit. The total cost for the alternatives also included 20% for contingency. Operation and Maintenance (O&M) costs were included for the alternatives that maintain the sediment in its current location (HS-1 and HS-5).

The costs range from $5.4 million to $48.6 million. The cost for the non-removal alternatives were on the low end the range, no further action, HS-1 at $5.4 million and HS-5, in-place capping at $10.3 million. The removal and treatment alternatives ranged from $19.0 million to $48.6 million. The off-site non-treatment alternative, off-site landfilling, HS-6, was estimated at $14.8 million. The clear trends in the costs are demonstrated in Figure 6-22. In summary, treatment is more expensive than non-treatment approaches, and the monitoring cost component for the non-removal alternatives plays a large role in the total cost for the alternative.

Figure 6-22
Remedial Alternative Cost Estimate Summary



The treatment costs for most of the on-site treatment technologies (HS-2A, HS-2B, HS-2C, HS-3A, HS-3B, HS-3C, and HS-4) range from approximately $20 million to $30 million. The exception being vitrification, HS-4, at $48.5 million. The accuracy range for Feasibility Studies is typically plus 50%, minus 30%. Given the range and the average cost for on-site treatment, there is not a tremendous difference in cost between the six non-vitrification treatment alternatives that could be implemented at the site. As a result, factors such as implementability and short-term effectiveness may play a larger role in comparing the on-site treatment alternatives against one another.

6.3.8 Summary of Detailed Analysis

Evaluation of the eleven remedial alternatives, using the detailed criteria is summarized in Table 6-14. This table facilitates a comparison of the eleven alternatives with the evaluation criteria and relative to one another.

Table 6-14
Summary of Detailed Analysis of Remedial Alternatives

Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-1: No Further Action	This alternative provides limited protection of human health and the environment. Limited long-term protection is primarily due to the longevity of the existing cover.	This alternative complies with Federal and State ARARs, with a waiver of the prohibition against new discharges into degraded waters regulation under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)). In addition, the federal Toxic Substances Control Act (TSCA) requires a finding by the Regional Administration that it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that the alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Requires a waiver of relevant and appropriate TSCA Chemical Waste Landfill Standards (40 CFR 761.75) regarding hydrologic conditions, flood protection, and leachate collection. The waiver may be invoked upon a finding by the Regional Administrator that the operation of the facility will not present an unreasonable risk of injury to health or the environment. Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable (40 CFR Part 6, Appendix A).	This alternative provides limited long-term effectiveness.	None, as no treatment occurs.	Workers conducting monitoring would require appropriate health and safety equipment.	Readily implementable Difficult to monitor effectiveness of existing double liner system.	$5.4 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

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Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-2A: Solvent Extraction and Solid Phase Chemical Destruction	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Requires a finding by the Regional Administration that, under TSCA, it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through a combination of treatment using solvent extraction and solid phase chemical destruction. There will be minimal risks following treatment and disposal of the sediments in an on-site CDF. The on-site CDF will provide appropriate and reliable control of the treatment residuals.	Volume of PCB wastes reduced by 97% through solvent extraction. Toxicity reduced by over 99% through solid phase chemical destruction. Destruction of PCBs is irreversible. Treated residuals pass TCLP testing. Satisfies preference for treatment.	Short-term risks with the two processes will require significant controls to protect site workers and the community. Remedial actions may take 5 years to complete if implementability issues do not arise. No adverse environmental impacts are anticipated while implementing HS-2A.	Technologies remain to be proven at full scale for Hot Spot sediment and as a result, performance risks exist. Solid phase chemical destruction has materials handling issues with the treatment residuals which may impact implementability. Limited sources for the technologies could limit competitiveness of the bidding process for both technologies.	$27.1 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

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Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-2B: Solvent Extraction and Gas Phase Chemical Destruction	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Requires a finding by the Regional Administration that, under TSCA, it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through a combination of treatments using solvent extraction and gas phase chemical destruction. There will be minimal risks following treatment and disposal of the sediments in an on-site CDF. The on-site CDF will provide appropriate and reliable control of the treatment residuals.	Volume of PCB wastes reduced by 97% through solvent extraction. Toxicity reduced by over 99% through gas phase chemical destruction. Destruction of PCBs is irreversible. Treated residuals pass TCLP testing. Satisfies preference for treatment.	Short-term risks with the two processes will require significant controls to protect site workers and the community. The limited site area may preclude safe application of these technologies due to risks to site workers and the community. Remedial actions may take 5 years to complete if implementability issues do not arise No adverse environmental impacts are anticipated while implementing HS-2B.	Technologies remain to be proven at full scale for Hot Spot sediment, and as a result performance risks exist. These two technologies have yet to work together. Limited sources for the two technologies could limit competitiveness of the bidding process for both technologies.	$31.9 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.
-2C: Solvent Extraction and Off-site Incineration	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through a combination of solvent extraction and off-site incineration at an approved TSCA facility. There will be minimal risks following treatment and disposal of the sediments in an on-site CDF. The on-site CDF will provide appropriate and reliable control of the treatment residuals.	Volume of PCB wastes reduced by 97% through solvent extraction. Toxicity reduced by over 99% through off-site incineration at an approved TSCA facility. Destruction of PCBs is irreversible. Treated residuals pass TCLP testing. Satisfies preference for treatment.	Short-term risks associated with solvent extraction will require controls to protect site workers and the community. Remedial actions may take 4 to 5 years to complete if implementability issues do not arise. No adverse environmental impacts are anticipated while implementing alternative HS-2C.	Solvent Extraction remains unproven at full scale for the Hot Spot sediments and as a result, some performance risks exist. Limited sources for solvent extraction could limit the competitiveness of the bidding process for this technology. The availability of off-site facilities on a national basis is limited and will have to be monitored.	$24.9 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

Table 6-14
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Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-3A: Thermal Desorption and Solid Phase Chemical Destruction	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Requires a finding by the Regional Administration that, under TSCA, it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through a combination of thermal desorption and solid phase chemical destruction. There will be minimal risks following treatment and disposal of the sediments in an on-site CDF. The on-site CDF will provide appropriate and reliable control of the treatment residuals.	Volume of PCB wastes reduced by 97% through thermal desorption. Toxicity reduced by over 99% through solid phase chemical destruction. Destruction of PCBs is irreversible. Treated residuals pass TCLP testing. Satisfies preference for treatment.	Short-term risks with the two processes will require significant controls to protect site workers and the community. Remedial actions may take 5 years to complete if implementability issues do not arise. Thermal desorption may create dioxins and furans, and/or volatile metals emissions through the course of thermal separation that will require off-gas treatment. Protection of the community during site activities will be achieved through emission control technology and ambient air monitoring. No adverse environmental impacts are anticipated while implementing HS-3A.	These technologies remain unproven at full scale for the Hot Spot sediment and as a result, some performance risks exist. Limited sources for solid phase chemical destruction could limit the competitiveness of this technology in the bidding process.	$21.2 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

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Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-3B: Thermal Desorption and Gas Phase Chemical Destruction	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Requires a finding by the Regional Administration that, under TSCA, it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through a combination of thermal desorption and gas phase chemical destruction. There will be minimal risks following treatment and disposal of the sediments in an on-site CDF. The on-site CDF will provide appropriate and reliable control of the treatment residuals.	Volume of PCB wastes reduced by 97% through thermal desorption. Toxicity reduced by over 99% through gas phase chemical destruction. Treatment of PCBs is irreversible. Treated residuals pass TCLP testing. Satisfies preference for treatment.	Short-term risks with the two processes will require significant controls to protect site workers and the community. Remedial actions may take 5 years to complete if implementability issues do not arise. Thermal desorption may create dioxins and furans, and/or volatile metals emissions through the course of thermal separation that will require off-gas treatment. Protection of the community during site activities will be achieved through emission control technology and ambient air monitoring. No adverse environmental impacts are anticipated while implementing HS-3B.	The combination of these technologies remains unproven at full scale for the Hot Spot sediment. The materials handling difficulties experienced by the thermal desorption unit used during the pilot scale treatability studies may be indicative of problems that would exist during full-scale implementation. Limited sources for the combination of these technologies may limit the competition of the technologies in the bidding process.	$26.3 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

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Summary of Detailed Analysis of Remedial Alternatives

Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-3C: Thermal Desorption and Off-site Incineration	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness, through a combination of thermal desorption and off-site incineration at an approved TSCA facility. There will be minimal risks following treatment and disposal of the sediments in an on-site CDF. The on-site CDF will provide appropriate and reliable control of the treatment residuals.	Volume of PCB wastes reduced by 97% through thermal desorption. Toxicity reduced by over 99% through off-site incineration at an approved TSCA facility. Treatment of PCBs is irreversible. Treated residuals pass TCLP testing. Satisfies preference for treatment.	Short-term risks for site workers will be addressed through H&S plans, procedures and equipment. Thermal treatment may create dioxins and furans and/or volatile metals emissions through the course of treatment that will require off-gas treatment. Remedial actions may take 4 to 5 years to complete if implementability issues do not arise. Protection of the community during site activities will be achieved through emission control technology and ambient air monitoring. No adverse environmental impacts are anticipated while implementing HS-3C.	Thermal Desorption remains unproven at full scale for treating the Hot Spot sediment and as a result, some performance risks exist. The availability of off-site incineration facilities on a national basis is limited and will have to be monitored.	$19.0 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

Table 6-14
Summary of Detailed Analysis of Remedial Alternatives

Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-4: Staged Vitrification	This alternative provides protection of human health and the environment. Protection achieved through permanent destruction of PCBs and disposal of treatment residuals in an on-site CDF.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Requires a finding by the Regional Administration that, under TSCA, it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through destruction of the organic contaminants and encapsulation of the inorganic contaminants in a glass-like matrix. There will be minimal residual risk as the vitrification process is a highly effective treatment process. Only limited controls will be required to manage the treatment residuals.	The process is permanent, irreversible and satisfies the preference for treatment. The process reduces the overall volume of sediment by over 50% and significally destroys the PCBs and immobilizes the heavy metals. Treated residuals pass TCLP testing.	The remedial actions will take 5 to 6 years to complete if the results of the design scale testing are positive and no problems occur during implementation. Thermal treatment may create dioxins and furans and/or volatile metals emissions through the course of treatment that will require off-gas treatment. Protection of the community during site activities will be achieved through emission control technology and ambient air monitoring. No adverse environmental impacts are anticipated while implementing HS-4.	The technology must be tested at the pilot scale during design phase of projection. Many of the goods and services are available, the complicating factor is the difficult wet sediment matrix. The risk of performance failure is high until the design scale testing can prove otherwise.	$48.5 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.
HS-5: In-Place Capping	Protection of human health and the environment is provided through the combination of an impermeable cap and liner.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Requires a finding by the Regional Administration that, under TSCA, it is not reasonable or appropriate to dispose of the PCB contaminated dredge spoil in either an incinerator or a chemical waste landfill, and that alternative disposal method will protect health and the environment (40 CFR 761.60.(a)(5). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	This alternative provides long-term effectiveness through containment of the Hot Spot sediments and institutional controls. The in-place cap provides for long term effectiveness. The protection of the cap is a function of the long-term integrity of the new cap and existing liner systems.	No reduction of toxicity and mobility. Volume of sediment will be reduced by 10% to 20% through dewatering.	The remedial actions can be completed in 2 years. Short-term risks to site workers will be low but will be controlled through H&S plans, procedures and equipment. No adverse environmental impacts are anticipated while implementing HS-5.	Alternative can be readily implemented. If the cap fails, it may be expensive to repair. If the liner fails, the entire contents of the CDF may have to be emptied to facilitate repair.	$10.3 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

Table 6-14
Summary of Detailed Analysis of Remedial Alternatives

Remedial Alternative	Overall Protection of Human and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity and Volume Through Treatment	Short-Term Effectiveness	Implementibility	Cost	State Acceptance	Community Acceptance
HS-6: Off-site Landfilling	This alternative provides protection of human health and environment. Protection is achieved through containment at a permitted off-site facility.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	Provides a high degree of long-term protection as there are no wastes remaining at the site. Relies on the controls of a permitted off-site landfill to provide long-term protection.	No reduction in mobility or toxicity. Slight volume reduction 20% to 30% through dewatering.	Protection of site workers and the community during the sediment removal and dewatering activities will be through H&S plans, procedures, equipment and ambient air monitoring. The remedial actions will be completed within 2 years. Potential impacts of truck traffic will be addressed through appropriate routing and timing of truck traffic. No adverse environmental impacts are anticipated while implementing HS-6.	Alternative is readily implementable. Significant coordinate with Federal, State and local official and the community will likely be required.	$14.8 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.
HS-7: Off-site Incineration	This alternative provides protection of human health and the environment through destruction of the PCBs at an off-site incineration facility.	This alternative complies with Federal and State ARARs, with waivers of: a) the prohibition against new discharges into degraded waters under Section 402 of the federal Clean Water Act (40 CFR 122.4(i)) and b) the one year PCB storage limitation regulation in the federal Toxic Substances Control Act (TSCA)(40 CFR 761.65(a)). Since the remedy is located within the 100-year coastal floodplain of New Bedford Harbor, Executive Order 11988 (Protection of Floodplains) requires a determination that federal actions involving floodplains have the least adverse effects on the environment compared to other alternatives and that mitigation be carried out to the extent practicable.	Provides a high degree of long-term protection as there are no wastes remaining at the site. The PCBs are destroyed in a permanent irreversible manner.	Toxicity and volume are significantly reduced through incineration. Destruction of PCBs is irreversible. Satisfies preference for treatment.	The remedial actions will be completed within 2 years. Protection of site workers and the community during the sediment removal and dewatering activities will be through H&S plans, procedures, equipment and ambient air monitoring. Potential impacts of truck traffic will be addressed through appropriate routing and timing of truck traffic. No adverse environmental impacts are anticipated while implementing HS-7.	Alternative is readily implementable. Significant coordinate with Federal, State and local official and the community will likely be required. The availability of off-site incineration facilities on a national basis is limited and will have to be evaluated.	$37.7 Million	This criterion will be evaluated by EPA within the ROD based on input from the state on the Proposed Plan.	This criterion will be evaluated by EPA within the ROD based on input from the community on the Proposed Plan.

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7. REFERENCES

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APPENDIX A

ARCS I WORK ASSIGNMENT NUMBER 030-1L43
EPA CONTRACT NUMBER 68-W9-0034
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TECHNICAL MEMORANDUM
BENCH SCALE
SOLIDIFICATION/STABILIZATION TESTING
HOT SPOT SEDIMENTS
NEW BEDFORD HARBOR
NEW BEDFORD, MASSACHUSETTS

NOTICE

THE INFORMATION IN THIS DOCUMENT HAS BEEN FUNDED BY THE UNITED STATED ENVIRONMENTAL PROTECTION AGENCY (EPA) UNDER ARCS I CONTRACT NO. 68-W9-0034 TO FOSTER WHEELER ENVIRONMENTAL CORPORATION (FOSTER WHEELER). THIS DOCUMENT IS A DRAFT AND HAS NOT BEEN FORMALLY RELEASED BY EITHER FOSTER WHEELER OR THE EPA. AS A DRAFT, THIS DOCUMENT SHOULD NOT BE CITED OR QUOTED, AND IS BEING CIRCULATED FOR COMMENT ONLY.

******* DRAFT FINAL *******

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1. INTRODUCTION

This Technical Memorandum has been prepared as part of Work Assignment No. 030-1L43 under ARCS I Contract No. 68-W9-0034 between Foster Wheeler Environmental Corporation (Foster Wheeler Environmental) and the U.S. Environmental Protection Agency (EPA).

The document is divided into four major sections: 1.0 Introduction; 2.0 Bench Scale Treatability Testing; 3.0 Results; and 4.0 Conclusions. Attachments A through G include CDF sampling locations, field notes, MSDSs and analytical data for the treatability study testing.

1.1 Bench Scale Treatability Study Objectives

In support of the project goal of finding a viable and safe non-incineration treatment technology to destroy or treat the toxic constituents (primarily PCBs and metals) of the Hot Spot sediment, while working to maximize community involvement, the specific bench scale treatability study test objectives included the following:

- Develop a waste profile for the Hot Spot sediments.
- Evaluate and quantify the effectiveness of stabilization/solidification (S/S) technologies to immobilize the PCBs and heavy metals present in the contaminated material.
- Quantify the disposition of materials to support a mass balance evaluation.
- Produce data of sufficient quality such that a risk assessment of treatment residuals, if required, can be conducted for the S/S processes.
- Evaluate the viability of S/S processes to be scaled-up to full scale operations including the overall development time-frame and estimated full scale treatment costs.
- Characterize the operational hazards associated with full scale implementation of the S/S processes.
- Evaluate the S/S process performance against the nine detailed evaluation criteria contained in the National Contingency Plan (NCP), including the ability of S/S to reduce the toxicity, mobility, and volume of the hazardous constituents.

1.2 General Technical Approach

Foster Wheeler Environmental conducted the bench scale treatability testing of three solidification/stabilization admixtures to determine their effectiveness in immobilizing the PCBs and heavy metals present in the New Bedford Harbor Hot Spot sediments. The engineering and field execution aspects of the treatability study included the following activities:

- Conducting bench scale testing of the three S/S admixtures utilizing S/S reagents provided by two subcontractors. In addition to the S/S subcontracts, Foster Wheeler Environmental also conducted an S/S evaluation using commercially available Portland Cement and absorbent clay as admixtures.

- Implementing the bench scale treatability studies as well as the sampling and analytical testing in accordance with the site-specific Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPjP).

- Compilation of the physical/chemical data gathered during the bench scale studies.

2. BENCH SCALE TREATABILITY TESTING

The steps taken to evaluate solidification/stabilization as a treatment process are discussed in this section. These steps include characterizing the Hot Spot sediment and the admixtures, mixing the admixtures with sediment, and subsequent testing of the resulting solidified product. These steps are discussed in more detail below.

2.1 Untreated Hot Spot Sediments

The sediment utilized in the bench scale treatability studies was taken from the Confined Disposal Facility (CDF) at a location expected to have a relatively high PCB concentration. Sediment was removed from Station 1+60 South as shown on the Figure included in Attachment A. The selection of this location was based on the analytical data for the core samples taken from the CDF by the Army Corps of Engineers (USACE) in June 1995. These USACE sampling locations and analytical results are also included in Attachment A. The USACE results for this area averaged approximately 13,000 ppm PCB.

Sediment for the bench scale treatability study was manually removed from five locations in the CDF (see Attachment A) on November 20, 1995. Sediment was placed in a wheelbarrow for mixing. The sediment was thoroughly mixed, sampled in duplicate for PCBs (24 hour fast turnaround), and then transferred to 5-gallon plastic buckets. PCB results for the samples collected from the wheelbarrow are included in Attachment B. These sample results averaged approximately 12,000 ppm. This PCB concentration was determined to be appropriate for the bench scale testing. Subsequently, a sample was collected from each of the five buckets that were to be used for the testing. Results for the five buckets ranged from 4,800 ppm to 18,800 and averaged approximately 10,000 ppm (Attachment B).

2.2 Solidification/Stabilization Reagents

The following seven (7) admixtures from Foster Wheeler Environmental, MARCOR Environmental and World Environmental were utilized during the bench scale treatability study.

Foster Wheeler	MARCOR	World
Portland Cement	HWT-27	LPC II
Absorbent Clay		Clarion SM399 Zoneco - P1 OT - P2

A brief description of each reagent is provided below. The chemical analysis results for each are included in Attachment C. Material Safety Data Sheets (MSDSs) for the reagents are provided in Attachment D.

Portland Cement: Type II Portland cement purchased from a local hardware store in New Bedford, Massachusetts was utilized for the bench scale treatability study.

Absorbent Clay: Absorbent clay (Oil - Dry) commonly used to address oil spills associated with automobile maintenance was purchased from an automotive supply shop for use in the bench scale study.

HWT-27: HWT-27 is a sintered material, very similar to Portland cement in both color and texture. It is produced by heating a mixture of substances such as limestone and shale to a high temperature (greater than 1,200^{o}C). The substances manufactured are essentially calcium silicates contained in a crystalline mass not separable into the individual components.

LPC II: LPC II is a custom blended agent used to stabilize, solidify, and fixate a variety of non-hazardous and hazardous wastes. The material is a light gray powder which has a chemical makeup that is very similar to Portland cement (15% SiO_2 and 68% CaO).

Clarion SM-399: Clarion SM-399 is specifically designed for dewatering and stabilization of wastes that contain large amounts of organic compounds. It is made up of a complex of montmorillonite clay and quaternary ammonium compound.

Zoneco - P1: Zoneco - P1 is a mixture of organic and amino acids and other organic compounds. The chemical analysis for the P1 material is included in Attachment D.

OT - P2: OT - P2 is a white, milky liquid containing 40% active alkoxysilane emulsified in water. OT - P2 is designed to deposit a reactive hydrophobic silane treatment to inorganic substrates. Alkoxysilanes react readily with inorganic materials like glass, mica, talc or wollastonic to form a durable treatment. Due to the highly organic nature of alkyl silane treatment, they improve the compatibility of inorganic material in organic resins, both thermoplastic and thermoset.

2.3 Bench Scale Testing Procedures

On November 30 and December 4, 1995, bench scale treatability tests were conducted on the Hot Spot sediments using S/S reagents supplied by Foster Wheeler Environmental, MARCOR and World. Each S/S reagent(s) was added, mixed and cured in accordance with the instructions provided by the vendor. The following sections provide the specific mixing procedures utilized for each admixture. Worksheets for each batch are included in Attachment E.

Each group of reagents was mixed in three proportions (batches) to determine whether the proportion of reagents had an effect on the results. Samples from each batch were analyzed for TCLP using both EPA Method 1311 and the steel cage method. The difference in the two methods is described in Section 3.0 below. Each mixture was analyzed in triplicate to provide an indication of the variability within the batch. In addition, each mixture was analyzed for compressive strength.

2.3.1 Foster Wheeler Environmental

Foster Wheeler Environmental utilized a stabilization/solidification admixture consisting of Portland cement and an absorbent clay. Each reagent was added to the sediment in the following proportions:

Batch	Sediment	Portland Cement	Absorbent Clay
#1	3,000 g	600 g (20 %)	0 g
#2	3,000 g	600 g (20%)	75 g (2.5%)
#3	3,000 g	750 g (25%)	75 g (2.5%)

Utilizing the Hobart mixer to create a homogenous mix to ensure encapsulation the following procedure was followed:

Mixing and Curing Procedure

1. Weighed out 3,000 grams of sediment from Bucket # 11 and placed material in mixing bowl.

2. The sediment was mixed for 1 minute to ensure that the 3,000 gram batch was uniform.

3. After the initial 1 minute mix and while the sediment was still being mixed, the Portland cement was added. The Portland cement was slowly added (approximately 30 seconds) and then the material was mixed for an additional 2 minutes to ensure uniform mixing.

4. For Batches #2 and #3, the adsorbent clay (Oil Dry) was added after the Portland cement and allowed to mix for 30 seconds prior to staring the final 2 minutes of mixing.

5. The total mixing times for each batch were as follows:

Batch	Sediment	Portland Cement	Adsorbent Clay	Mix	Total
#1	1 min	30 sec	--	2 min	3.5 min
#2	1 min	30 sec	30 sec	2 min	4 min
#3	1 min	30 sec	30 sec	2 min	4 min

6. During the mixing of each batch, the sides of the mixing bowl were scraped to ensure uniform mixing of the reagents.

7. At the end of the final 2 minutes of mixing the mixer was turned off and the following containers were filled for each batch:

Container	TCLP - Standard	TCLP Block	Compressive Strength
4 oz. Tall, Wide Mouth Glass jars	3	3	0
2" x 4" Plastic Cylinder Molds	0	0	3

8. In addition to the above samples, two (2) additional 4 oz tall wide mouth jars were filled for each batch. These samples were held for potential future tests.

9. The glass jars were sealed and the 2"x 4" cylinders capped, and then all the samples were placed in Ziploc bags and cured for 30 days.

2.3.2 MARCOR Environmental

Sediment was used from bucket #13 for the MARCOR tests. The MARCOR Environmental stabilization/solidification admixture was added to the sediment in a slurry form at mix ratios of 12.5%, 17.5% and 25% (by weight).

Utilizing the Hobart mixer to create a homogenous mix to ensure encapsulation the following procedure was followed:

Mixing and Curing Procedure

1. Prepared the HWT-27 slurry by mixing 2 lbs of dry reagent with 2.2 lbs of tap water. The HWT-27 and water were mixed in a glass bowl with a stainless steel wire wisp until uniform.

2. Weighed out 2,500 grams of sediment from Bucket #13 (1,500 grams for Batch #3) and placed it in the mixer's mixing bowl.

3. The sediment was mixed for I minute to ensure that the material was uniform prior to adding the solidification/stabilization reagent.

4. After the initial 1 minute mix and while the sediment was still being mixed, the HWT-27 slurry was added. The slurry was slowly added (approximately 10 seconds) and then the material was mixed for an additional 2 minutes to ensure uniform mixing.

5. During the mixing of each batch, the sides of the mixing bowl were scraped to ensure complete mixing of the reagent.

6. The total mixing time for each batch was 1 minute for the sediment, 10 seconds for the addition of the HWT-27 slurry and an additional 2 minutes of total mixing for a total of 3.167 minutes.

7. At the end of the final 2 minutes of mixing the mixer was turned off and the following containers were filled for each batch:

Container	TCLP - Standard	TCLP - Block	Compressive Strength
4 oz. Tall, Wide Mouth Glass jars	3	3	0
2" x 4" Plastic Cylinder Molds	0	0	3

8. In addition to the above samples, two (2) additional 4 oz tall wide mouth jars were filled for each batch. These samples were held for potential future tests.

9. All the samples were air cured for approximately 30 days prior to physical and chemical testing.

2.3.3 World Environmental

Three stabilization/solidification mixtures were recommended by World Environmental for the bench scale testing:

Batch #1	Batch #2	Batch #3
18% (by weight) LPC II 2% Clarion SM-399 2% Zoneco - P1	18% LPC II 2% Clarion SM399 2% OT - P2	15% LPC II 2% Clarion SM399 2% Zoneco - P1

Utilizing the Hobart mixer to create a homogenous mix to ensure encapsulation the following procedure was followed:

Mixing and Curing Procedure

1. Weighed out 2,000 grams of sediment from Bucket # 15 in mixing bowl of mixer.

2. The sediment was mixed for 1 minute to ensure that the 2,000 gram batch was uniform.

3. After the initial I minute mix and while the sediment was still being mixed, the reagents were added sequentially as indicated below. Each reagent was allowed to be thoroughly mixed prior to added the next.

Batch	Sediment	LPC II	SM399	P1	P2
#1	2,000 g	360 g (18%)	40 g (2%)	40 g (2%)	0 g
#2	2,000 g	360 g (18%)	40 g (2%)	0 g	40 g (2%)
#3	2,000 g	300 g (15%)	40 g (2%)	20 g (1%)	0 g

4. After the final reagent was added and allowed to be mixed, the material was mixed for an additional two (2) minutes. The total mixing times for each batch were as follows:

Sediment	LPC II	SM 399	P1/P2	Mix	Total
1 min	1 min	30 sec	30 sec	2 min	5 min

5. During the mixing of each batch, the sides of the mixing bowl were scraped to ensure uniform mixing of the reagents.

6. At the end of the final 2 minute mix, the mixer was turned off and the following containers were filled for each batch:

Container	TCLP - Standard	TCLP - Block	Compressive Strength
4 oz. Tall, Wide Mouth Glass jars	3	3	0
2" x 4" Plastic Cylinder Molds	0	0	3

7. In addition to the above mentioned samples, two (2) additional 4 oz. glass jars were filled for each batch. These samples were held for potential additional testing.

8. All the samples were allowed to air cure for approximately 30 days prior to physical and chemical testing.

2.4 Bulking Factor Test Procedures

December 13, 1995 bulking factor tests were conducted with the stabilization/solidification reagents utilized in the Bench Scale Treatability Studies for the Hot Spot sediments. The highest reagent ratio utilized during the Bench Scale Treatability Studies was used for the bulking factor tests. Using sediment from Bucket #14 (10,500 ppm PCBs, moisture content of 40%), the following procedures were used:

1. Using three (3) one liter plastic beakers (each weighing 142 g), 475 ml of sediment was added to each beaker resulting in the following weights:

   Beaker #1 (Foster Wheeler) - 622 g of sediment
   Beaker #2 (MARCOR) - 610 g of sediment
   Beaker #3 (World) - 646 g of sediment

2. The following reagent additions were made to each respective beaker and mixed with a plastic spoon:

Beaker #1:	2.5%	Oil Dry	=	15 g
	25%	Portland Cement	=	156 g
Beaker #2:	25%	HWT-27 slurry	=	153 g
Beaker #3:	18%	LPC II	=	116 g
	2%	SM-399	=	13 g
	2%	P1	=	13 g

Note: The MARCOR HWT-27 slurry was mixed according to the Field Operations Plan (1 lb HWT-27 per 1.1 lbs water).

3. After mixing, the spoon and sides of the beaker were scraped and the mixture made level using the bottom of a plastic cup. The following weights and volumes were recorded after mixing and leveling:

Beaker #1:	Weight	=	787 g
	Volume	=	525 ml
Beaker #2:	Weight	=	758 g
	Volume	=	575 ml
Beaker #3:	Weight	=	780 g
	Volume	=	550 ml

After mixing the mixtures were allowed to air cure within the fume hood.

Thirty-four (34) days after mixing on January 16, 1996, the beakers were re-weighed and the following weights and volumes were recorded:

Beaker #1:	Weight	=	778 g	
	Volume	=	525 ml	
Beaker #2:	Weight	=	702 g	
	Volume	=	500 ml	(also lost approximately 1/8" from sides of beaker)
Beaker #3:	Weight	=	768 g	
	Volume	=	525 ml	

3. RESULTS

The result of the testing conducted during the bench scale treatability study are presented in the following sections. These include mixing and curing, bulking factor tests, chemical analysis, and unconfined compressive strength.

3.1 Chemical Analysis

Samples were collected of untreated sediment, stabilization/solidification (S/S) admixtures, make-up water, and the stabilized material. Sediment samples were analyzed for PCBs, TCL semivolatiles (SVOCs), TAL metals and TPH to characterize the material prior to treatment. The samples were also analyzed for particle size and moisture content to determine bulking ratios and treatment handling requirements. Both the reagents and make-up water were also analyzed for PCBs, SVOCs, and metals to ensure that these mixes were not contributing additional contamination to the sediment. Analytical results for these analyses are included in Attachment C. Results from these analyses indicate that the reagents do not contribute significant concentrations to the TCLP analyses.

To evaluate the overall effectiveness of stabilization/solidification, the feed sediment and treated material were analyzed using the TCLP leaching procedure, EPA Method 1311. Treated (solidified) material was also leached using the steel cage procedure included in Attachment F. The steel cage procedure suspends the solidified material intact in the leachate solution, whereas the 1311 method requires that the sample be pulverized to pass through a 9.5 mm sieve before leaching. Both methods use an acidic leaching solution intended to simulate the natural leaching that would occur in a landfill situation.

The cage method may be useful for two reasons. The first being that it may give a more accurate indication of how material may behave when stored in solidified form. The second use for the steel cage data is that the amount of disintegration of the solid under the steel cage conditions may correlate with freeze/thaw degradation of the solidified product.

The TCLP leachates from both the conventional 1311 and steel cage methods were analyzed for PCBs, TCL SVOCs, and TAL metals. The analytical results for the TCLP analyses are summarized and discussed below. The complete set of laboratory results is included on the tables in Attachment G.

TCLP (Method 1311) results for selected analytes are reported on Table 1 and are discussed below. Results from the routine TCLP (1311) leaching procedure, where the sample is pulverized first, were chosen for this summary discussion. This routine leaching procedure was expected to be a more conservative measure than the steel cage, as the samples were physically pulverized prior to leaching. In fact, results from the steel cage leaching were not significantly different from the routine leaching results, with the exception of some metals results which suggest contamination from the cage material (Attachment G). Therefore, the routine TCLP (Method 1311) results were selected for this evaluation. The complete data set is included as Attachment G.

Table 1
Summary of TCLP (EPA Method 1311) Results
(Results are the average of three replicate samples)

Analyte	TCLP Regulatory Limit	Untreated Sediment Average	MARCOR M1	MARCOR M2	MARCOR M3	FOSTER WHEELER FW1	FOSTER WHEELER FW2	FOSTER WHEELER FW3	WORLD W1	WORLD W2	WORLD W3
PCBs											
Aroclor-1242	NC	11	47	35	42	27	33	38	40	24	29
Aroclor-1254	NC	0.22	1.6	3.0	4.0	--	--	7.3	2.8	0.8	1.2
Total PCBs	NC	11	49	38	46	27	33	45	43	25	30
SVOCs											
Phenol	NC	2	1	2.7	4.3	4.7	3.3	3.0	1.3	3.0	1.3
1,3-Dichlorobenzene	NC	40.25	32	20	22	48	47	36	21	20	28
1,4-Dichlorobenzene	7,500	102.5	127	82	94	173	153	88	92	97	122
1,2-Dichlorobenzene	NC	1.25	0.33	--	1.0	3.0	1.7	4.7	--	--	--
N-Nitroso-di-n-propylamine	NC	0.75	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	NC	13.25	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	NC	3.75	3.7	2.3	4.3	4.3	4.0	4.0	3.3	3.7	3.7
4-Chloro-3-methylphenol	NC	1.75	--	--	--	--	--	--	--	--	--
Acenaphthene	NC	1.25	--	--	--	--	--	--	--	--	--
4-Nitrophenol	NC	2	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	130	0.75	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	NC	2.25	12	17	15	2.7	3.7	--	1.0	1.0	1.0
Pyrene	NC	2.25	--	--	--	--	--	--	--	--	--
METALS											
Arsenic	5,000	54.1	18.3	6.7	8.5	3.0	3.4	3.0	3.4	3.8	10.7
Barium	100,000	618	564	669	534	1,217	1,207	1,760	429	382	328
Cadmium	1,000	147	131	133	34.6	0.20	0.20	0.20	0.20	0.20	0.20
Chromium	5,000	226	207	158	59.2	18.6	20.6	14.5	14.4	13.7	13.9
Copper	NC	161	706	798	688	731	726	820	1,353	1,340	1,497
Lead	5,000	1,630	964	393	67.2	1.8	3.6	6.0	2.9	2.0	7.4
Mercury	200	0.20	0.20	2.6	1.1	0.20	0.20	0.20	0.20	0.20	0.20
Selenium	1,000	12.6	17.1	26.0	19.9	16.9	15.3	10.6	14.9	10.2	10.9
Silver	5,000	0.70	0.70	2.2	1.8	0.70	0.70	0.70	0.70	0.70	0.70
Zinc	NC	18,050	18,307	20,933	10,235	12.7	17.0	60.8	14.2	8.9	16.4

Results are reported in units of ug/L

NC = no criteria
-- = not detected

3.1.1 TCLP PCBs

TCLP PCB data for the raw sediment and solidified materials are summarized in Table 1. No regulatory standard for this analysis is available, therefore, the data are used comparatively only. Untreated raw sediment PCB results were 11 ug/L (ppb) in the TCLP leachate solution. This is consistent with the results for the pilot study feed material, where the TCLP results for sediment with approximately 2,300 ppm PCBs gave a TCLP result of 15 ppb and sediment with an average PCB concentration of 5,700 ppm gave an average TCLP result of 27 ppb. Based on these ratios of TCLP results to untreated sediment results, and the assumption that the relationship is linear, maximum sediment concentrations of 200,000 ppm would give a maximum TCLP PCB result of approximately 1.1 ppm (mg/L). In summary, the high concentrations of PCBs in the sediment are not readily leachable using the TCLP process, presumably because the high concentration of oil and other organics in the sediment preferentially retain the PCBs rather than allowing them to dissolve in the acidic TCLP leachate solution.

TCLP PCB results for the solidified materials were higher than for the initial raw sediment for each group of stabilization materials. Average TCLP PCB results for stabilized material ranged from 25 to 49 ppb, double to greater than quadruple those found for the untreated sediment. Although the reason for the greater leachability in the treated material cannot be determined based on the limited available data, one possible reason is that the solidification process absorbs some of the oily, organic fraction of sediment making the PCBs more mobile in the aqueous phase. Based on these results, stabilization/ solidification is not an effective method of treating the PCBs in the Hot Spot sediment.

3.1.2 TCLP Metals

Results for TCLP metals in untreated and stabilized sediment are provided in Table 1. None of the TCLP metals results for untreated raw Hot Spot sediment approached the respective TCLP regulatory criteria. This is consistent with the pilot study feed material data. The metal of greatest concern from a TCLP perspective was lead with a TCLP concentration of 1,630 ppb detected during this bench scale study. Lead has a regulatory criteria of 5,000 ppb. TCLP lead results from the pilot study materials ranged from 470 ppb to 940 ppb, significantly less than the criteria.

Other metals of concern in the Hot Spot sediment included arsenic, cadmium, chromium, copper, and zinc. Solidification/stabilization does reduce the TCLP concentration of most of the metals of concern. Both the World Environmental and the Foster Wheeler Portland cement mixtures effectively reduced the TCLP concentrations of arsenic, cadmium, chromium, lead, and zinc. All three S/S mixtures resulted in an increased concentration of copper in the leachate solution, although the results from World Environmental were the highest. Copper is not included on the RCRA list of metals and has no associated regulatory criteria. Because the laboratory does not typically include copper in the TCLP analysis, the results for this analyte may be biased high due to laboratory error. Should copper become a TCLP analyte of concern in the future, additional testing should be conducted prior to drawing conclusions regarding the TCLP results for this analyte.

The Foster Wheeler prepared mixture of Portland cement appears to be at least as or more effective at treating metals than the Marcor or World mixtures.

In summary, the solidification/stabilization process reduces the concentration of TCLP metals in the Hot Spot sediment. The raw, untreated Hot Spot sediment did not exceed criteria for TCLP metals. Therefore, in its current state in the CDF, Hot Spot sediment requires no further treatment for metals contamination. Although the results from the pilot scale tests indicate that treated product from the three tested technologies studies will not exceed TCLP criteria, it is possible that one of treatment technologies ultimately selected to treat the PCB contamination may provide a treated sediment material with increased mobility of metals. In the event that treated sediments require additional treatment for metals, it appears that solidification/stabilization is a possible treatment technology for future consideration.

3.1.3 TCLP Semivolatiles

TCLP results for selected semivolatiles in untreated and solidified sediment are provided in Table 1. The compounds presented in the table were detected in the leachate for the untreated sediment. Other semivolatile compounds were analyzed for but were not detected in the untreated sediment leachate and therefore, were not considered further. Similar to the TCLP PCB results, solidification/stabilization does not appear to appreciably reduce the concentration of semivolatiles in the TCLP leachate.

Semivolatile concentrations in the Hot Spot sediment are somewhat inconsequential in comparison with the elevated levels of PCBs. They were considered in this evaluation in order to provide a complete review of the solidification stabilization process. TCLP semivolatile results for the untreated sediment do not approach the TCLP regulatory limit for semivolatiles and it is reasonable to presume that treated sediment resulting from a process that removes PCBs is not likely to exceed TCLP criteria for semivolatiles.

3.2 Unconfined Compressive Strength

In addition to the TCLP leaching procedures, the compressive strength of the treated material was also determined. The unconfined compressive strength data for each S/S admixture is provided in Table 2. Of the three admixtures tested, Portland cement provided the highest compressive strength and MARCOR provided the lowest compressive strength. The average compressive strengths for Foster Wheeler, MARCOR and World was 221 psi, 58 psi and 162 psi, respectively.

Table 2
Compressive Strength Data
Bench Scale Treatability Study

Mixture	SAMPLE No.	COMPRESSIVE STRENGTH (psi)	AVERAGE (psi)
Foster Wheeler Environmental Mix 1: 20% Portland Cement	EA1 EA2 EA3	210 205 190	200
Foster Wheeler Environmental Mix 2: 20% Portland Cement 2.5% Oil Dry	EB1 EB2 EB3	210 170 210	195
Foster Wheeler Environmental Mix 3: 25% Portland Cement 2.5% Oil Dry	EC1 EC2 EC3	255 270 285	270
MARCOR Environmental Mix 1: 12.5% HWT-25 Slurry	MA1 MA2 MA3	55 35 50	45
MARCOR Environmental Mix 2: 17.5% HWT-25 Slurry	MB1 MB2 MB3	45 50 60	50
MARCOR Environmental Mix 3: 25% HWT-25 Slurry	MC1 MC2 MC3	80 75 90	80
World Environmental Mix 1: 18% LPC II 2% SM399 2% P1	WA1 WA2 WA3	185 200 210	200
World Environmental Mix 2: 18% LPC II 2% SM399 2% P2	WB1 WB2 WB3	110 185 75	125
World Environmental Mix3: 15% LPC II 2% SM399 1% P1	WC1 WC2 WC3	130 170 180	160

3.3 Mixing and Curing

All three admixtures mixed relatively easily with the Hot Spot sediments. The addition of Portland Cement and World's reagents produced a slightly pasty mixture which could present some material handling difficulties at full scale. Since MARCOR's reagent was added in a slurry form, the resultant mixture was more fluid than the other two mixtures and may be slightly easier to handle on a full scale.

After approximately one week of air curing, samples containing Portland cement and the World reagents had set up to a relatively hard material. However, the MARCOR samples were still soft and pliable. By the end of the 30 day curing period all the samples appeared dry and solid.

3.4 Bulking Factor Test

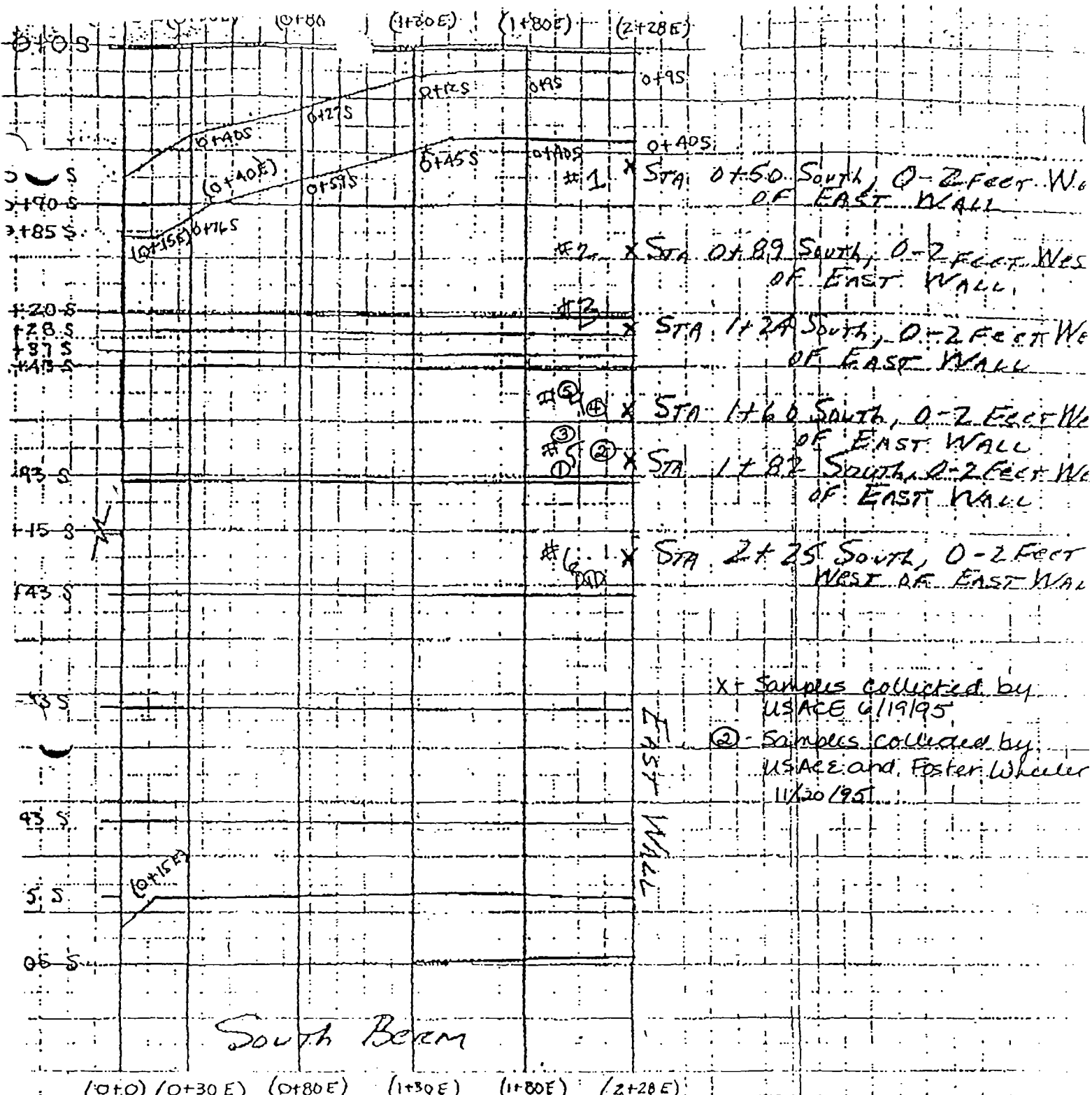
Based on the results of the bulking factor study, the MARCOR reagent provided the largest percentage decrease in weight (7.4 %) and volume (13 %). The least amount of reduction was observed in the samples prepared with Foster Wheeler Environmental's reagents, 1.14% and 0 % for weight and volume, respectively. The sediment treated with the World Environmental reagents had weight and volume decreases of 1.5 % and 4.5 %, respectively.

4. CONCLUSIONS

Based on the data collected from the bench scale treatability study, it does not appear that stabilization/solidification is a viable treatment method for the Hot Spot sediments. At the mix ratios tested, the admixtures did not significantly lower the leachability of the PCBs and, in most cases, increased the leachability. A high reagent to sediment ratio may decrease the leachability of the PCBs, however, the treatment cost would also increase as well as the volume of material which must ultimately be disposed.

Solidification/stabilization may be an appropriate treatment technology to consider for heavy metals contamination. Available data indicate that TCLP metals concentrations are not likely to be of concern in untreated sediment or in the treated material resulting from one of the PCB removal processes (i.e., solvent or thermal desorption). However, should heavy metals be of concern at a later date, solidification/stabilization appears to be a viable treatment option for further consideration.

Attachment A
Drawing of CDF Sampling Locations
and U.S.A.C.E. 6/95 Sample Results



DWG: CDF #7

Scale: 1" = 60'

Date: 6/19/95

Attachment A
Core Samples from CDF #1 Taken by USACE
6/19/95

Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Range	Mean	Std. Dev.
Total PCB	492	763	3,005	14,412	10,924	7,405	492 - 14,412	6,167	5,719
Oil & Grease	780	980	14,000	30,000	34,000	22,000	780 - 34,000	16,960	14,225
TOC (%)	0.01	0.12	7.9	15.5	8	7.8	<0.01 - 16	7	6
Cadmium	0.3	0.4	10	17	22	14	0.3 - 22	11	9
Copper	50	55	520	980	980	690	50 - 980	546	421
Chromium	7.2	8.3	220	340	420	280	7 - 420	213	172
Lead	36	38	440	710	680	490	36 - 710	399	299
% Moisture	15.1	17.8	48.5	139.6	145.2	137.9	15 - 145	84	63
% Solids	85.7	85.4	39	36.5	36.1	40.1	36 - 85	54	25
SpecificGravity	2.7	2.61	2.58	2.42	2.48	2.49	2.42 - 2.70	2.55	0.1

Attachment B
Summary of Bench Scale
Feed Sediment Data

Attachment B
Preliminary and Feed Sediment Data (mg/kg)

Target Analyte	Wheelbarrow Sample #1	Wheelbarrow Sample #2	Bucket #11	Bucket #12	Bucket #13	Bucket # 14	Bucket #14 (Dup)	Bucket #15
Arocolor - 1016	ND	ND	ND	ND	ND	ND	ND	ND
Arocolor - 1221	ND	ND	ND	ND	ND	ND	ND	ND
Arocolor - 1232	ND	ND	ND	ND	ND	ND	ND	ND
Arocolor - 1242	8,184	5,700	7,000	3,400	7,200	7,200	3,800	13,000
Arocolor - 1248	ND	ND	ND	ND	ND	ND	ND	ND
Arocolor - 1254	5,500	4,300	3,400	1,400	3,200	3,300	1,700	5,800
Arocolor - 1260	ND	ND	ND	ND	ND	ND	ND	ND
Total PCB	13,684	10,000	10,400	4,800	10,400	10,500	5,500	18,800
% Solids	38	41	42	43	43	43	42	43

Attachment C
Laboratory Results For
S/S Reagents

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN74 B# 11

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122931

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122931R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 55 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.3

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	22000	U
111-44-4	bis(2-Chloroethyl)Ether	22000	U
95-57-8	2-Chlorophenol	22000	U
541-73-1	1,3-Dichlorobenzene	22000	J
106-46-7	1,4-Dichlorobenzene	83000	
95-50-1	1,2-Dichlorobenzene	22000	U
95-48-7	2-Methylphenol	22000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	22000	U
106-44-5	4-Methylphenol	22000	U
621-64-7	N-Nitroso-Di-n-Propylamine	22000	U
67-72-1	Hexachloroethane	22000	U
98-95-3	Nitrobenzene	22000	U
78-59-1	Isophorone	22000	U
88-75-5	2-Nitrophenol	22000	U
105-67-9	2,4-Dimethylphenol	22000	U
111-91-1	bis(2-Chloroethoxy)Methane	22000	U
120-83-2	2,4-Dichlorophenol	22000	U
120-82-1	1,2,4-Trichlorobenzene	6700	J
91-20-3	Naphthalene	22000	U
106-47-8	4-Chloroaniline	22000	U
87-68-3	Hexachlorobutadiene	22000	U
59-50-7	4-Chloro-3-Methylphenol	22000	U
91-57-6	2-Methylnaphthalene	22000	U
77-47-4	Hexachlorocyclopentadiene	22000	U
88-06-2	2,4,6-Trichlorophenol	22000	U
95-95-4	2,4,5-Trichlorophenol	56000	U
91-58-7	2-Chloronaphthalene	22000	U
88-74-4	2-Nitroaniline	56000	U
131-11-3	Dimethylphthalate	22000	U
208-96-8	Acenaphthylene	22000	U
606-20-2	2,6-Dinitrotoluene	22000	U
99-09-2	3-Nitroaniline	56000	U
83-32-9	Acenaphthene	22000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN74

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122931

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122931R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 55 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.3

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	56000	U
100-02-7	4-Nitrophenol	56000	U
132-64-9	Dibenzofuran	22000	U
121-14-2	2,4-Dinitrotoluene	22000	U
84-66-2	Diethylphthalate	22000	U
7005-72-3	4-Chlorophenyl-phenylether	22000	U
86-73-7	Fluorene	22000	U
100-01-6	4-Nitroaniline	56000	U
534-52-1	4,6-Dinitro-2-methylphenol	56000	U
86-30-6	N-Nitrosodiphenylamine (1)	22000	U
101-55-3	4-Bromophenyl-phenylether	22000	U
118-74-1	Hexachlorobenzene	22000	U
87-86-5	Pentachlorophenol	56000	U
85-01-8	Phenanthrene	12000	JX
120-12-7	Anthracene	22000	U
86-74-8	Carbazole	22000	U
84-74-2	Di-n-Butylphthalate	22000	U
206-44-0	Fluoranthene	18000	JX
129-00-0	Pyrene	18000	J
85-68-7	Butylbenzylphthalate	22000	U
91-94-1	3,3'-Dichlorobenzidine	22000	U
56-55-3	Benzo(a)Anthracene	8400	J
218-01-9	Chrysene	22000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	14000	J
117-84-0	Di-n-Octyl Phthalate	22000	U
205-99-2	Benzo(b)Fluoranthene	7800	JX
207-08-9	Benzo(k)Fluoranthene	8200	JX
50-32-8	Benzo(a)Pyrene	7000	J
193-39-5	Indeno(1,2,3-cd)Pyrene	7000	J
53-70-3	Dibenz(a,h)Anthracene	22000	U
191-24-2	Benzo(g,h,i)Perylene	22000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN74

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122931

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122931R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 55 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.3

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN PCB	17.17	110000	J
2.	UNKNOWN PCB	18.00	100000	J
3.	UNKNOWN PCB	18.13	170000	J
4.	UNKNOWN PCB	19.10	240000	J
5.	UNKNOWN PCB	19.50	140000	J
6.	UNKNOWN PCB	19.88	91000	J
7.	UNKNOWN PCB	20.07	240000	J
8.	UNKNOWN PCB	20.30	120000	J
9.	UNKNOWN PCB	20.47	80000	J
10.	UNKNOWN PCB	20.80	180000	J
11.	UNKNOWN PCB	20.90	150000	J
12.	UNKNOWN PCB	21.23	110000	J
13.	UNKNOWN PCB	22.03	80000	J
14.	UNKNOWN PCB	22.13	290000	J
15.	UNKNOWN PCB	22.45	84000	J
16.	UNKNOWN PCB	22.57	220000	J
17.	UNKNOWN PCB	22.68	160000	J
18.	UNKNOWN PCB	23.32	200000	J
19.	UNKNOWN PCB	23.82	140000	J
20.	UNKNOWN PCB	24.23	84000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN74
Bucket #11

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122931

Sample wt/vol: 30.0 (g/mL) G Lab File ID: S122931R

% Moisture: 55 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 500

GPC Cleanup: (Y/N) Y pH: 7.3 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1900	U
319-85-7	beta-BHC	1900	U
319-86-8	delta-BHC	1900	U
58-89-9	gamma-BHC (Lindane)	1900	U
76-44-8	Heptachlor	1900	U
309-00-2	Aldrin	1900	U
1024-57-3	Heptachlor epoxide	1900	U
959-98-8	Endosulfan I	1900	U
60-57-1	Dieldrin	3700	U
72-55-9	4,4'-DDE	3700	U
72-20-8	Endrin	3700	U
33213-65-9	Endosulfan II	3700	U
72-54-8	4,4'-DDD	3700	U
1031-07-8	Endosulfan sulfate	3700	U
50-29-3	4,4'-DDT	3700	U
72-43-5	Methoxychlor	19000	U
53494-70-5	Endrin ketone	3700	U
7421-36-3	Endrin aldehyde	3700	U
5103-71-9	alpha-Chlordane	1900	U
5103-74-2	gamma-Chlordane	1900	U
8001-35-2	Toxaphene	190000	U
12674-11-2	Aroclor-1016	37000	U
11104-28-2	Aroclor-1221	74000	U
11141-16-5	Aroclor-1232	37000	U
53469-21-9	Aroclor-1242	5000000	EC
12672-29-6	Aroclor-1248	37000	U
11097-69-1	Aroclor-1254	2200000	EC
11096-82-5	Aroclor-1260	37000	U

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN74DL

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122931DL

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 55 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 5000

GPC Cleanup: (Y/N) Y pH: 7.3 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	19000	U
319-85-7	beta-BHC	19000	U
319-86-8	delta-BHC	19000	U
58-89-9	gamma-BHC (Lindane)	19000	U
76-44-8	Heptachlor	19000	U
309-00-2	Aldrin	19000	U
1024-57-3	Heptachlor epoxide	19000	U
959-98-8	Endosulfan I	19000	U
60-57-1	Dieldrin	37000	U
72-55-9	4,4'-DDE	37000	U
72-20-8	Endrin	37000	U
33213-65-9	Endosulfan II	37000	U
72-54-8	4,4'-DDD	37000	U
1031-07-8	Endosulfan sulfate	37000	U
50-29-3	4,4'-DDT	37000	U
72-43-5	Methoxychlor	190000	U
53494-70-5	Endrin ketone	37000	U
7421-36-3	Endrin aldehyde	37000	U
5103-71-9	alpha-Chlordane	19000	U
5103-74-2	gamma-Chlordane	19000	U
8001-35-2	Toxaphene	1900000	U
12674-11-2	Aroclor-1016	370000	U
11104-28-2	Aroclor-1221	740000	U
11141-16-5	Aroclor-1232	370000	U
53469-21-9	Aroclor-1242	7500000	D
12672-29-6	Aroclor-1248	370000	U
11097-69-1	Aroclor-1254	3200000	D
11096-82-5	Aroclor-1260	370000	U

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1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAJQ20 B#1 #

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280252

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: _43.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	13600		E	P
7440-36-0	Antimony	0.90	U	N	P
7440-38-2	Arsenic	11.5			P
7440-39-3	Barium	169		E	P
7440-41-7	Beryllium	0.60	B		P
7440-43-9	Cadmium	14.1		N	P
7440-70-2	Calcium	5350			P
7440-47-3	Chromium	315		E	P
7440-48-4	Cobalt	7.1	B	E	P
7440-50-8	Copper	822			P
7439-89-6	Iron	22300		E	P
7439-92-1	Lead	584			P
7439-95-4	Magnesium	6480		E	P
7439-96-5	Manganese	195		E	P
7439-97-6	Mercury	1.5			CV
7440-02-0	Nickel	54.7		E	P
7440-09-7	Potassium	2540		E	P
7782-49-2	Selenium	1.9	B		P
7440-22-4	Silver	2.6	B		P
7440-23-5	Sodium	11100			P
7440-28-0	Thallium	1.2	U		P
7440-62-2	Vanadium	44.7		E	P
7440-66-6	Zinc	1910			P
	Cyanide				NR

Color Before: BROWN Clarity Before: _____ Texture: MEDIUM

Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN75 B#11 Dup

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122932

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122932

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	22000	U
111-44-4	bis(2-Chloroethyl)Ether	22000	U
95-57-8	2-Chlorophenol	22000	U
541-73-1	1,3-Dichlorobenzene	25000	
106-46-7	1,4-Dichlorobenzene	94000	
95-50-1	1,2-Dichlorobenzene	22000	U
95-48-7	2-Methylphenol	22000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	22000	U
106-44-5	4-Methylphenol	22000	U
621-64-7	N-Nitroso-Di-n-Propylamine	22000	U
67-72-1	Hexachloroethane	22000	U
98-95-3	Nitrobenzene	22000	U
78-59-1	Isophorone	22000	U
88-75-5	2-Nitrophenol	22000	U
105-67-9	2,4-Dimethylphenol	22000	U
111-91-1	bis(2-Chloroethoxy)Methane	22000	U
120-83-2	2,4-Dichlorophenol	22000	U
120-82-1	1,2,4-Trichlorobenzene	7800	J
91-20-3	Naphthalene	22000	U
106-47-8	4-Chloroaniline	22000	U
87-68-3	Hexachlorobutadiene	22000	U
59-50-7	4-Chloro-3-Methylphenol	22000	U
91-57-6	2-Methylnaphthalene	22000	U
77-47-4	Hexachlorocyclopentadiene	22000	U
88-06-2	2,4,6-Trichlorophenol	22000	U
95-95-4	2,4,5-Trichlorophenol	54000	U
91-58-7	2-Chloronaphthalene	22000	U
88-74-4	2-Nitroaniline	54000	U
131-11-3	Dimethylphthalate	22000	U
208-96-8	Acenaphthylene	22000	U
606-20-2	2,6-Dinitrotoluene	22000	U
99-09-2	3-Nitroaniline	54000	U
83-32-9	Acenaphthene	22000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN75

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122932

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122932

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	54000	U
100-02-7	4-Nitrophenol	54000	U
132-64-9	Dibenzofuran	22000	U
121-14-2	2,4-Dinitrotoluene	22000	U
84-66-2	Diethylphthalate	22000	U
7005-72-3	4-Chlorophenyl-phenylether	22000	U
86-73-7	Fluorene	22000	U
100-01-6	4-Nitroaniline	54000	U
534-52-1	4,6-Dinitro-2-methylphenol	54000	U
86-30-6	N-Nitrosodiphenylamine (1)	22000	U
101-55-3	4-Bromophenyl-phenylether	22000	U
118-74-1	Hexachlorobenzene	22000	U
87-86-5	Pentachlorophenol	54000	U
85-01-8	Phenanthrene	22000	U
120-12-7	Anthracene	22000	U
86-74-8	Carbazole	22000	U
84-74-2	Di-n-Butylphthalate	22000	U
206-44-0	Fluoranthene	12000	JX
129-00-0	Pyrene	12000	J
85-68-7	Butylbenzylphthalate	22000	U
91-94-1	3,3'-Dichlorobenzidine	22000	U
56-55-3	Benzo(a)Anthracene	22000	U
218-01-9	Chrysene	22000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	21000	J
117-84-0	Di-n-Octyl Phthalate	22000	U
205-99-2	Benzo(b)Fluoranthene	22000	U
207-08-9	Benzo(k)Fluoranthene	22000	U
50-32-8	Benzo(a)Pyrene	22000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	22000	U
53-70-3	Dibenz(a,h)Anthracene	22000	U
191-24-2	Benzo(g,h,i)Perylene	22000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN75

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122932

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122932

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.1

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN PCB	17.18	100000	J
2.	UNKNOWN PCB	18.02	91000	J
3.	UNKNOWN PCB	18.15	160000	J
4.	UNKNOWN PCB	19.10	200000	J
5.	UNKNOWN PCB	19.52	130000	J
6.	UNKNOWN PCB	19.90	87000	J
7.	UNKNOWN PCB	20.08	210000	J
8.	UNKNOWN PCB	20.32	110000	J
9.	UNKNOWN PCB	20.48	72000	J
10.	UNKNOWN PCB	20.83	150000	J
11.	UNKNOWN PCB	20.90	120000	J
12.	UNKNOWN PCB	21.25	100000	J
13.	UNKNOWN PCB	22.05	120000	J
14.	UNKNOWN PCB	22.15	300000	J
15.	UNKNOWN PCB	22.47	100000	J
16.	UNKNOWN PCB	22.58	280000	J
17.	UNKNOWN PCB	22.70	150000	J
18.	UNKNOWN PCB	23.33	220000	J
19.	UNKNOWN PCB	23.83	160000	J
20.	UNKNOWN PCB	24.23	98000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN75

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122932

Sample wt/vol: 30.0 (g/mL) G Lab File ID: S122932

% Moisture: 54 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 500

GPC Cleanup: (Y/N) Y pH: 7.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1800	U
319-85-7	beta-BHC	1800	U
319-86-8	delta-BHC	1800	U
58-89-9	gamma-BHC (Lindane)	1800	U
76-44-8	Heptachlor	1800	U
309-00-2	Aldrin	1800	U
1024-57-3	Heptachlor epoxide	1800	U
959-98-8	Endosulfan I	1800	U
60-57-1	Dieldrin	3600	U
72-55-9	4,4'-DDE	3600	U
72-20-8	Endrin	3600	U
33213-65-9	Endosulfan II	3600	U
72-54-8	4,4'-DDD	3600	U
1031-07-8	Endosulfan sulfate	3600	U
50-29-3	4,4'-DDT	3600	U
72-43-5	Methoxychlor	18000	U
53494-70-5	Endrin ketone	3600	U
7421-36-3	Endrin aldehyde	3600	U
5103-71-9	alpha-Chlordane	1800	U
5103-74-2	gamma-Chlordane	1800	U
8001-35-2	Toxaphene	180000	U
12674-11-2	Aroclor-1016	36000	U
11104-28-2	Aroclor-1221	73000	U
11141-16-5	Aroclor-1232	36000	U
53469-21-9	Aroclor-1242	5100000	EC
12672-29-6	Aroclor-1248	36000	U
11097-69-1	Aroclor-1254	2100000	EC
11096-82-5	Aroclor-1260	36000	U

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN75DL

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122932DL

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 54 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 5000

GPC Cleanup: (Y/N) Y pH: 7.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	18000	U
319-85-7	beta-BHC	18000	U
319-86-8	delta-BHC	18000	U
58-89-9	gamma-BHC (Lindane)	18000	U
76-44-8	Heptachlor	18000	U
309-00-2	Aldrin	18000	U
1024-57-3	Heptachlor epoxide	18000	U
959-98-8	Endosulfan I	18000	U
60-57-1	Dieldrin	36000	U
72-55-9	4,4'-DDE	36000	U
72-20-8	Endrin	36000	U
33213-65-9	Endosulfan II	36000	U
72-54-8	4,4'-DDD	36000	U
1031-07-8	Endosulfan sulfate	36000	U
50-29-3	4,4'-DDT	36000	U
72-43-5	Methoxychlor	180000	U
53494-70-5	Endrin ketone	36000	U
7421-36-3	Endrin aldehyde	36000	U
5103-71-9	alpha-Chlordane	18000	U
5103-74-2	gamma-Chlordane	18000	U
8001-35-2	Toxaphene	1800000	U
12674-11-2	Aroclor-1016	360000	U
11104-28-2	Aroclor-1221	730000	U
11141-16-5	Aroclor-1232	360000	U
53469-21-9	Aroclor-1242	7700000	D
12672-29-6	Aroclor-1248	360000	U
11097-69-1	Aroclor-1254	5100000	D
11096-82-5	Aroclor-1260	360000	U

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1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAJQ21

B7 DUP

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280253

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: _45.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	11300		E	P
7440-36-0	Antimony_	0.98	U	N	P
7440-38-2	Arsenic__	10.7			P
7440-39-3	Barium___	135		E	P
7440-41-7	Beryllium	0.49	B		P
7440-43-9	Cadmium__	12.7		N	P
7440-70-2	Calcium__	4580			P
7440-47-3	Chromium_	287		E	P
7440-48-4	Cobalt___	6.2	B	E	P
7440-50-8	Copper___	745			P
7439-89-6	Iron_____	19400		E	P
7439-92-1	Lead_____	531			P
7439-95-4	Magnesium	5960		E	P
7439-96-5	Manganese	160		E	P
7439-97-6	Mercury__	1.1			CV
7440-02-0	Nickel___	50.7		E	P
7440-09-7	Potassium	2210	B	E	P
7782-49-2	Selenium_	2.3			P
7440-22-4	Silver___	2.8	B		P
7440-23-5	Sodium___	10900			P
7440-28-0	Thallium_	1.3	U		P
7440-62-2	Vanadium_	37.9		E	P
7440-66-6	Zinc_____	1660			P
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: _____ Texture: MEDIUM

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN76 M-1

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122933

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122933

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 6 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/27/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 12.9

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	11000	U
111-44-4	bis(2-Chloroethyl)Ether	11000	U
95-57-8	2-Chlorophenol	11000	U
541-73-1	1,3-Dichlorobenzene	11000	U
106-46-7	1,4-Dichlorobenzene	11000	U
95-50-1	1,2-Dichlorobenzene	11000	U
95-48-7	2-Methylphenol	11000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	11000	U
106-44-5	4-Methylphenol	11000	U
621-64-7	N-Nitroso-Di-n-Propylamine	11000	U
67-72-1	Hexachloroethane	11000	U
98-95-3	Nitrobenzene	11000	U
78-59-1	Isophorone	11000	U
88-75-5	2-Nitrophenol	11000	U
105-67-9	2,4-Dimethylphenol	11000	U
111-91-1	bis(2-Chloroethoxy)Methane	11000	U
120-83-2	2,4-Dichlorophenol	11000	U
120-82-1	1,2,4-Trichlorobenzene	11000	U
91-20-3	Naphthalene	11000	U
106-47-8	4-Chloroaniline	11000	U
87-68-3	Hexachlorobutadiene	11000	U
59-50-7	4-Chloro-3-Methylphenol	11000	U
91-57-6	2-Methylnaphthalene	11000	U
77-47-4	Hexachlorocyclopentadiene	11000	U
88-06-2	2,4,6-Trichlorophenol	11000	U
95-95-4	2,4,5-Trichlorophenol	27000	U
91-58-7	2-Chloronaphthalene	11000	U
88-74-4	2-Nitroaniline	27000	U
131-11-3	Dimethylphthalate	11000	U
208-96-8	Acenaphthylene	11000	U
606-20-2	2,6-Dinitrotoluene	11000	U
99-09-2	3-Nitroaniline	27000	U
83-32-9	Acenaphthene	11000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN76

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122933

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122933

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 6 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/27/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 12.9

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	27000	U
100-02-7	4-Nitrophenol	27000	U
132-64-9	Dibenzofuran	11000	U
121-14-2	2,4-Dinitrotoluene	11000	U
84-66-2	Diethylphthalate	11000	U
7005-72-3	4-Chlorophenyl-phenylether	11000	U
86-73-7	Fluorene	11000	U
100-01-6	4-Nitroaniline	27000	U
534-52-1	4,6-Dinitro-2-methylphenol	27000	U
86-30-6	N-Nitrosodiphenylamine (1)	11000	U
101-55-3	4-Bromophenyl-phenylether	11000	U
118-74-1	Hexachlorobenzene	11000	U
87-86-5	Pentachlorophenol	27000	U
85-01-8	Phenanthrene	11000	U
120-12-7	Anthracene	11000	U
86-74-8	Carbazole	11000	U
84-74-2	Di-n-Butylphthalate	11000	U
206-44-0	Fluoranthene	11000	U
129-00-0	Pyrene	11000	U
85-68-7	Butylbenzylphthalate	11000	U
91-94-1	3,3'-Dichlorobenzidine	11000	U
56-55-3	Benzo(a)Anthracene	11000	U
218-01-9	Chrysene	11000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	11000	U
117-84-0	Di-n-Octyl Phthalate	11000	U
205-99-2	Benzo(b)Fluoranthene	11000	U
207-08-9	Benzo(k)Fluoranthene	11000	U
50-32-8	Benzo(a)Pyrene	11000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	11000	U
53-70-3	Dibenz(a,h)Anthracene	11000	U
191-24-2	Benzo(g,h,i)Perylene	11000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN76

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122933

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122933

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 6 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/27/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 12.9

Number TICs found: 18

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1. 100-52-7	BENZALDEHYDE (ACN)(DOT)	7.53	3200	JN
2. 937-61-1	BENZENE, (PROPOXYMETHYL)-	10.03	5300	JN
3. 3012-37-1	THIOCYANIC ACID, PHENYLMETHY	13.62	5300	JN
4.	UNKNOWN HYDROCARBON	16.65	2100	J
5.	UNKNOWN HYDROCARBON	17.82	16000	J
6.	UNKNOWN HYDROCARBON	18.93	8500	J
7.	UNKNOWN	20.08	2100	J
8.	UNKNOWN	21.28	2100	J
9.	UNKNOWN	22.07	4300	J
10.	UNKNOWN	22.12	6400	J
11.	UNKNOWN	24.67	4300	J
12.	UNKNOWN	27.50	9600	J
13.	UNKNOWN	27.98	6400	J
14.	UNKNOWN	28.07	2100	J
15.	UNKNOWN	31.17	3200	J
16.	UNKNOWN	31.77	3200	J
17.	UNKNOWN	34.30	16000	J
18.	UNKNOWN	35.32	3200	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN76

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122933

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 6 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) Y pH: 12.9 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1.8	U
319-85-7	beta-BHC	1.8	U
319-86-8	delta-BHC	1.8	U
58-89-9	gamma-BHC (Lindane)	1.8	U
76-44-8	Heptachlor	1.8	U
309-00-2	Aldrin	1.8	U
1024-57-3	Heptachlor epoxide	1.8	U
959-98-8	Endosulfan I	1.8	U
60-57-1	Dieldrin	3.5	U
72-55-9	4,4'-DDE	3.5	U
72-20-8	Endrin	3.5	U
33213-65-9	Endosulfan II	3.5	U
72-54-8	4,4'-DDD	3.5	U
1031-07-8	Endosulfan sulfate	3.5	U
50-29-3	4,4'-DDT	3.5	U
72-43-5	Methoxychlor	18	U
53494-70-5	Endrin ketone	3.5	U
7421-36-3	Endrin aldehyde	3.5	U
5103-71-9	alpha-Chlordane	1.8	U
5103-74-2	gamma-Chlordane	1.8	U
8001-35-2	Toxaphene	180	U
12674-11-2	Aroclor-1016	35	U
11104-28-2	Aroclor-1221	71	U
11141-16-5	Aroclor-1232	35	U
53469-21-9	Aroclor-1242	35	U
12672-29-6	Aroclor-1248	35	U
11097-69-1	Aroclor-1254	35	U
11096-82-5	Aroclor-1260	35	U

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INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAJQ60 m-1

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280256

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: _99.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	25300		E	P
7440-36-0	Antimony	0.94	B	N	P
7440-38-2	Arsenic	4.5			P
7440-39-3	Barium	233		E	P
7440-41-7	Beryllium	3.5			P
7440-43-9	Cadmium	0.06	U	N	P
7440-70-2	Calcium	340000			P
7440-47-3	Chromium	55.8		E	P
7440-48-4	Cobalt	14.6		E	P
7440-50-8	Copper	23.6			P
7439-89-6	Iron	14600		E	P
7439-92-1	Lead	5.9			P
7439-95-4	Magnesium	35700		E	P
7439-96-5	Manganese	12200		E	P
7439-97-6	Mercury	0.03	U		CV
7440-02-0	Nickel	24.3		E	P
7440-09-7	Potassium	5350		E	P
7782-49-2	Selenium	3.8			P
7440-22-4	Silver	0.15	U		P
7440-23-5	Sodium	6790			P
7440-28-0	Thallium	0.57	U		P
7440-62-2	Vanadium	33.4		E	P
7440-66-6	Zinc	26.6			P
	Cyanide				NR

Color Before: GRAY Clarity Before: _____ Texture: FINE

Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN77 ESI-PC

Portland Cement

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122934

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122934

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 0 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.2

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	10000	U
111-44-4	bis(2-Chloroethyl)Ether	10000	U
95-57-8	2-Chlorophenol	10000	U
541-73-1	1,3-Dichlorobenzene	10000	U
106-46-7	1,4-Dichlorobenzene	10000	U
95-50-1	1,2-Dichlorobenzene	10000	U
95-48-7	2-Methylphenol	10000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	10000	U
106-44-5	4-Methylphenol	10000	U
621-64-7	N-Nitroso-Di-n-Propylamine	10000	U
67-72-1	Hexachloroethane	10000	U
98-95-3	Nitrobenzene	10000	U
78-59-1	Isophorone	10000	U
88-75-5	2-Nitrophenol	10000	U
105-67-9	2,4-Dimethylphenol	10000	U
111-91-1	bis(2-Chloroethoxy)Methane	10000	U
120-83-2	2,4-Dichlorophenol	10000	U
120-82-1	1,2,4-Trichlorobenzene	10000	U
91-20-3	Naphthalene	10000	U
106-47-8	4-Chloroaniline	10000	U
87-68-3	Hexachlorobutadiene	10000	U
59-50-7	4-Chloro-3-Methylphenol	10000	U
91-57-6	2-Methylnaphthalene	10000	U
77-47-4	Hexachlorocyclopentadiene	10000	U
88-06-2	2,4,6-Trichlorophenol	10000	U
95-95-4	2,4,5-Trichlorophenol	25000	U
91-58-7	2-Chloronaphthalene	10000	U
88-74-4	2-Nitroaniline	25000	U
131-11-3	Dimethylphthalate	10000	U
208-96-8	Acenaphthylene	10000	U
606-20-2	2,6-Dinitrotoluene	10000	U
99-09-2	3-Nitroaniline	25000	U
83-32-9	Acenaphthene	10000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN77

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122934

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122934

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 0 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.2

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	25000	U
100-02-7	4-Nitrophenol	25000	U
132-64-9	Dibenzofuran	10000	U
121-14-2	2,4-Dinitrotoluene	10000	U
84-66-2	Diethylphthalate	10000	U
7005-72-3	4-Chlorophenyl-phenylether	10000	U
86-73-7	Fluorene	10000	U
100-01-6	4-Nitroaniline	25000	U
534-52-1	4,6-Dinitro-2-methylphenol	25000	U
86-30-6	N-Nitrosodiphenylamine (1)	10000	U
101-55-3	4-Bromophenyl-phenylether	10000	U
118-74-1	Hexachlorobenzene	10000	U
87-86-5	Pentachlorophenol	25000	U
85-01-8	Phenanthrene	10000	U
120-12-7	Anthracene	10000	U
86-74-8	Carbazole	10000	U
84-74-2	Di-n-Butylphthalate	10000	U
206-44-0	Fluoranthene	10000	U
129-00-0	Pyrene	10000	U
85-68-7	Butylbenzylphthalate	10000	U
91-94-1	3,3'-Dichlorobenzidine	10000	U
56-55-3	Benzo(a)Anthracene	10000	U
218-01-9	Chrysene	10000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	10000	U
117-84-0	Di-n-Octyl Phthalate	10000	U
205-99-2	Benzo(b)Fluoranthene	10000	U
207-08-9	Benzo(k)Fluoranthene	10000	U
50-32-8	Benzo(a)Pyrene	10000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	10000	U
53-70-3	Dibenz(a,h)Anthracene	10000	U
191-24-2	Benzo(g,h,i)Perylene	10000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN77

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122934

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122934

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 0 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.2

Number TICs found: 1

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	34.23	2000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN77

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122934

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 0 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) Y pH: 13.2 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1.7	U
319-85-7	beta-BHC	1.7	U
319-86-8	delta-BHC	1.7	U
58-89-9	gamma-BHC (Lindane)	1.7	U
76-44-8	Heptachlor	1.7	U
309-00-2	Aldrin	1.7	U
1024-57-3	Heptachlor epoxide	1.7	U
959-98-8	Endosulfan I	1.7	U
60-57-1	Dieldrin	3.3	U
72-55-9	4,4'-DDE	3.3	U
72-20-8	Endrin	3.3	U
33213-65-9	Endosulfan II	3.3	U
72-54-8	4,4'-DDD	3.3	U
1031-07-8	Endosulfan sulfate	3.3	U
50-29-3	4,4'-DDT	3.3	U
72-43-5	Methoxychlor	17	U
53494-70-5	Endrin ketone	3.3	U
7421-36-3	Endrin aldehyde	3.3	U
5103-71-9	alpha-Chlordane	1.7	U
5103-74-2	gamma-Chlordane	1.7	U
8001-35-2	Toxaphene	170	U
12674-11-2	Aroclor-1016	33	U
11104-28-2	Aroclor-1221	67	U
11141-16-5	Aroclor-1232	33	U
53469-21-9	Aroclor-1242	33	U
12672-29-6	Aroclor-1248	33	U
11097-69-1	Aroclor-1254	33	U
11096-82-5	Aroclor-1260	33	U

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1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW87

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280249

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: 100.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	19500		E	P
7440-36-0	Antimony	1.3	B	N	P
7440-38-2	Arsenic	4.0			P
7440-39-3	Barium	548		E	P
7440-41-7	Beryllium	0.68	B		P
7440-43-9	Cadmium	0.06	U	N	P
7440-70-2	Calcium	447000			P
7440-47-3	Chromium	55.2		E	P
7440-48-4	Cobalt	11.9		E	P
7440-50-8	Copper	11.3			P
7439-89-6	Iron	24500		E	P
7439-92-1	Lead	5.3			P
7439-95-4	Magnesium	10200		E	P
7439-96-5	Manganese	312		E	P
7439-97-6	Mercury	0.04	U		CV
7440-02-0	Nickel	15.4		E	P
7440-09-7	Potassium	9030		E	P
7782-49-2	Selenium	0.69	U		P
7440-22-4	Silver	0.15	U		P
7440-23-5	Sodium	759	B		P
7440-28-0	Thallium	2.9			P
7440-62-2	Vanadium	134		E	P
7440-66-6	Zinc	40.0			P
	Cyanide				NR

Color Before: GRAY Clarity Before: _____ Texture: FINE

Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN78 ES1 OD

Oil Dry

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122935

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122935

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 5 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	11000	U
111-44-4	bis(2-Chloroethyl)Ether	11000	U
95-57-8	2-Chlorophenol	11000	U
541-73-1	1,3-Dichlorobenzene	11000	U
106-46-7	1,4-Dichlorobenzene	11000	U
95-50-1	1,2-Dichlorobenzene	11000	U
95-48-7	2-Methylphenol	11000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	11000	U
106-44-5	4-Methylphenol	11000	U
621-64-7	N-Nitroso-Di-n-Propylamine	11000	U
67-72-1	Hexachloroethane	11000	U
98-95-3	Nitrobenzene	11000	U
78-59-1	Isophorone	11000	U
88-75-5	2-Nitrophenol	11000	U
105-67-9	2,4-Dimethylphenol	11000	U
111-91-1	bis(2-Chloroethoxy)Methane	11000	U
120-83-2	2,4-Dichlorophenol	11000	U
120-82-1	1,2,4-Trichlorobenzene	11000	U
91-20-3	Naphthalene	11000	U
106-47-8	4-Chloroaniline	11000	U
87-68-3	Hexachlorobutadiene	11000	U
59-50-7	4-Chloro-3-Methylphenol	11000	U
91-57-6	2-Methylnaphthalene	11000	U
77-47-4	Hexachlorocyclopentadiene	11000	U
88-06-2	2,4,6-Trichlorophenol	11000	U
95-95-4	2,4,5-Trichlorophenol	26000	U
91-58-7	2-Chloronaphthalene	11000	U
88-74-4	2-Nitroaniline	26000	U
131-11-3	Dimethylphthalate	11000	U
208-96-8	Acenaphthylene	11000	U
606-20-2	2,6-Dinitrotoluene	11000	U
99-09-2	3-Nitroaniline	26000	U
83-32-9	Acenaphthene	11000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN78

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122935

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122935

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 5 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	26000	U
100-02-7	4-Nitrophenol	26000	U
132-64-9	Dibenzofuran	11000	U
121-14-2	2,4-Dinitrotoluene	11000	U
84-66-2	Diethylphthalate	11000	U
7005-72-3	4-Chlorophenyl-phenylether	11000	U
86-73-7	Fluorene	11000	U
100-01-6	4-Nitroaniline	26000	U
534-52-1	4,6-Dinitro-2-methylphenol	26000	U
86-30-6	N-Nitrosodiphenylamine (1)	11000	U
101-55-3	4-Bromophenyl-phenylether	11000	U
118-74-1	Hexachlorobenzene	11000	U
87-86-5	Pentachlorophenol	26000	U
85-01-8	Phenanthrene	11000	U
120-12-7	Anthracene	11000	U
86-74-8	Carbazole	11000	U
84-74-2	Di-n-Butylphthalate	11000	U
206-44-0	Fluoranthene	11000	U
129-00-0	Pyrene	11000	U
85-68-7	Butylbenzylphthalate	11000	U
91-94-1	3,3'-Dichlorobenzidine	11000	U
56-55-3	Benzo(a)Anthracene	11000	U
218-01-9	Chrysene	11000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	11000	U
117-84-0	Di-n-Octyl Phthalate	11000	U
205-99-2	Benzo(b)Fluoranthene	11000	U
207-08-9	Benzo(k)Fluoranthene	11000	U
50-32-8	Benzo(a)Pyrene	11000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	11000	U
53-70-3	Dibenz(a,h)Anthracene	11000	U
191-24-2	Benzo(g,h,i)Perylene	11000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN78

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122935

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122935

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 5 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 7.1

Number TICs found: 3

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	26.47	3200	J
2.	UNKNOWN	26.55	3200	J
3.	UNKNOWN	33.32	3200	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN78

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122935

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 5 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) Y pH: 7.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1.8	U
319-85-7	beta-BHC	1.8	U
319-86-8	delta-BHC	1.8	U
58-89-9	gamma-BHC (Lindane)	1.8	U
76-44-8	Heptachlor	1.8	U
309-00-2	Aldrin	1.8	U
1024-57-3	Heptachlor epoxide	1.8	U
959-98-8	Endosulfan I	1.8	U
60-57-1	Dieldrin	3.5	U
72-55-9	4,4'-DDE	3.5	U
72-20-8	Endrin	3.5	U
33213-65-9	Endosulfan II	3.5	U
72-54-8	4,4'-DDD	3.5	U
1031-07-8	Endosulfan sulfate	3.5	U
50-29-3	4,4'-DDT	3.5	U
72-43-5	Methoxychlor	18	U
53494-70-5	Endrin ketone	3.5	U
7421-36-3	Endrin aldehyde	3.5	U
5103-71-9	alpha-Chlordane	1.8	U
5103-74-2	gamma-Chlordane	1.8	U
8001-35-2	Toxaphene	180	U
12674-11-2	Aroclor-1016	35	U
11104-28-2	Aroclor-1221	71	U
11141-16-5	Aroclor-1232	35	U
53469-21-9	Aroclor-1242	35	U
12672-29-6	Aroclor-1248	35	U
11097-69-1	Aroclor-1254	35	U
11096-82-5	Aroclor-1260	35	U

U.S. EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW88

ES1 OD

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280250

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: _95.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	14500		E	P
7440-36-0	Antimony	0.43	U	N	P
7440-38-2	Arsenic	1.7	B		P
7440-39-3	Barium	93.4		E	P
7440-41-7	Beryllium	4.3			P
7440-43-9	Cadmium	0.59	B	N	P
7440-70-2	Calcium	17500			P
7440-47-3	Chromium	46.7		E	P
7440-48-4	Cobalt	20.1		E	P
7440-50-8	Copper	4.4	B		P
7439-89-6	Iron	14100		E	P
7439-92-1	Lead	7.4			P
7439-95-4	Magnesium	16100		E	P
7439-96-5	Manganese	187		E	P
7439-97-6	Mercury	0.05	U		CV
7440-02-0	Nickel	20.4		E	P
7440-09-7	Potassium	2330		E	P
7782-49-2	Selenium	0.73	U		P
7440-22-4	Silver	0.16	U		P
7440-23-5	Sodium	196	B		P
7440-28-0	Thallium	0.61	B		P
7440-62-2	Vanadium	47.1		E	P
7440-66-6	Zinc	46.3			P
	Cyanide				NR

Color Before: GRAY Clarity Before: _____ Texture: COARSE

Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN79 LDC II

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122936X

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 4 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.4

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	10000	U
111-44-4	bis(2-Chloroethyl)Ether	10000	U
95-57-8	2-Chlorophenol	10000	U
541-73-1	1,3-Dichlorobenzene	10000	U
106-46-7	1,4-Dichlorobenzene	10000	U
95-50-1	1,2-Dichlorobenzene	10000	U
95-48-7	2-Methylphenol	10000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	10000	U
106-44-5	4-Methylphenol	10000	U
621-64-7	N-Nitroso-Di-n-Propylamine	10000	U
67-72-1	Hexachloroethane	10000	U
98-95-3	Nitrobenzene	10000	U
78-59-1	Isophorone	10000	U
88-75-5	2-Nitrophenol	10000	U
105-67-9	2,4-Dimethylphenol	10000	U
111-91-1	bis(2-Chloroethoxy)Methane	10000	U
120-83-2	2,4-Dichlorophenol	10000	U
120-82-1	1,2,4-Trichlorobenzene	10000	U
91-20-3	Naphthalene	10000	U
106-47-8	4-Chloroaniline	10000	U
87-68-3	Hexachlorobutadiene	10000	U
59-50-7	4-Chloro-3-Methylphenol	10000	U
91-57-6	2-Methylnaphthalene	10000	U
77-47-4	Hexachlorocyclopentadiene	10000	U
88-06-2	2,4,6-Trichlorophenol	10000	U
95-95-4	2,4,5-Trichlorophenol	26000	U
91-58-7	2-Chloronaphthalene	10000	U
88-74-4	2-Nitroaniline	26000	U
131-11-3	Dimethylphthalate	10000	U
208-96-8	Acenaphthylene	10000	U
606-20-2	2,6-Dinitrotoluene	10000	U
99-09-2	3-Nitroaniline	26000	U
83-32-9	Acenaphthene	10000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN79

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122936X

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 4 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.4

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	26000	U
100-02-7	4-Nitrophenol	26000	U
132-64-9	Dibenzofuran	10000	U
121-14-2	2,4-Dinitrotoluene	10000	U
84-66-2	Diethylphthalate	10000	U
7005-72-3	4-Chlorophenyl-phenylether	10000	U
86-73-7	Fluorene	10000	U
100-01-6	4-Nitroaniline	26000	U
534-52-1	4,6-Dinitro-2-methylphenol	26000	U
86-30-6	N-Nitrosodiphenylamine (1)	10000	U
101-55-3	4-Bromophenyl-phenylether	10000	U
118-74-1	Hexachlorobenzene	10000	U
87-86-5	Pentachlorophenol	26000	U
85-01-8	Phenanthrene	10000	U
120-12-7	Anthracene	10000	U
86-74-8	Carbazole	10000	U
84-74-2	Di-n-Butylphthalate	10000	U
206-44-0	Fluoranthene	10000	U
129-00-0	Pyrene	42000	
85-68-7	Butylbenzylphthalate	10000	U
91-94-1	3,3'-Dichlorobenzidine	10000	U
56-55-3	Benzo(a)Anthracene	10000	U
218-01-9	Chrysene	10000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	10000	U
117-84-0	Di-n-Octyl Phthalate	10000	U
205-99-2	Benzo(b)Fluoranthene	10000	U
207-08-9	Benzo(k)Fluoranthene	10000	U
50-32-8	Benzo(a)Pyrene	37000	
193-39-5	Indeno(1,2,3-cd)Pyrene	14000	
53-70-3	Dibenz(a,h)Anthracene	10000	U
191-24-2	Benzo(g,h,i)Perylene	66000	

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN79

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122936X

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 4 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.4

Number TICs found: 8

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	26.40	2100	J
2.	UNKNOWN	26.47	5200	J
3.	UNKNOWN	26.77	2100	J
4.	UNKNOWN	28.03	3100	J
5.	UNKNOWN PAH	29.40	49000	J
6.	UNKNOWN PAH	29.82	24000	J
7.	UNKNOWN PAH	34.53	3100	J
8.	UNKNOWN PAH	35.67	7300	J

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN79RE

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122936R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 4 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.4

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	10000	U
111-44-4	bis(2-Chloroethyl)Ether	10000	U
95-57-8	2-Chlorophenol	10000	U
541-73-1	1,3-Dichlorobenzene	10000	U
106-46-7	1,4-Dichlorobenzene	10000	U
95-50-1	1,2-Dichlorobenzene	10000	U
95-48-7	2-Methylphenol	10000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	10000	U
106-44-5	4-Methylphenol	10000	U
621-64-7	N-Nitroso-Di-n-Propylamine	10000	U
67-72-1	Hexachloroethane	10000	U
98-95-3	Nitrobenzene	10000	U
78-59-1	Isophorone	10000	U
88-75-5	2-Nitrophenol	10000	U
105-67-9	2,4-Dimethylphenol	10000	U
111-91-1	bis(2-Chloroethoxy)Methane	10000	U
120-83-2	2,4-Dichlorophenol	10000	U
120-82-1	1,2,4-Trichlorobenzene	10000	U
91-20-3	Naphthalene	10000	U
106-47-8	4-Chloroaniline	10000	U
87-68-3	Hexachlorobutadiene	10000	U
59-50-7	4-Chloro-3-Methylphenol	10000	U
91-57-6	2-Methylnaphthalene	10000	U
77-47-4	Hexachlorocyclopentadiene	10000	U
88-06-2	2,4,6-Trichlorophenol	10000	U
95-95-4	2,4,5-Trichlorophenol	26000	U
91-58-7	2-Chloronaphthalene	10000	U
88-74-4	2-Nitroaniline	26000	U
131-11-3	Dimethylphthalate	10000	U
208-96-8	Acenaphthylene	10000	U
606-20-2	2,6-Dinitrotoluene	10000	U
99-09-2	3-Nitroaniline	26000	U
83-32-9	Acenaphthene	10000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN79RE

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122936R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 4 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.4

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	26000	U
100-02-7	4-Nitrophenol	26000	U
132-64-9	Dibenzofuran	10000	U
121-14-2	2,4-Dinitrotoluene	10000	U
84-66-2	Diethylphthalate	10000	U
7005-72-3	4-Chlorophenyl-phenylether	10000	U
86-73-7	Fluorene	10000	U
100-01-6	4-Nitroaniline	26000	U
534-52-1	4,6-Dinitro-2-methylphenol	26000	U
86-30-6	N-Nitrosodiphenylamine (1)	10000	U
101-55-3	4-Bromophenyl-phenylether	10000	U
118-74-1	Hexachlorobenzene	10000	U
87-86-5	Pentachlorophenol	26000	U
85-01-8	Phenanthrene	10000	U
120-12-7	Anthracene	10000	U
86-74-8	Carbazole	10000	U
84-74-2	Di-n-Butylphthalate	10000	U
206-44-0	Fluoranthene	10000	U
129-00-0	Pyrene	10000	U
85-68-7	Butylbenzylphthalate	10000	U
91-94-1	3,3'-Dichlorobenzidine	10000	U
56-55-3	Benzo(a)Anthracene	10000	U
218-01-9	Chrysene	10000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	10000	U
117-84-0	Di-n-Octyl Phthalate	10000	U
205-99-2	Benzo(b)Fluoranthene	10000	U
207-08-9	Benzo(k)Fluoranthene	10000	U
50-32-8	Benzo(a)Pyrene	10000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	10000	U
53-70-3	Dibenz(a,h)Anthracene	10000	U
191-24-2	Benzo(g,h,i)Perylene	10000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN79RE

( ) Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122936R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 4 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 13.4

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN79

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122936

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 4 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) Y pH: 13.4 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1.8	U
319-85-7	beta-BHC	1.8	U
319-86-8	delta-BHC	1.8	U
58-89-9	gamma-BHC (Lindane)	1.8	U
76-44-8	Heptachlor	1.8	U
309-00-2	Aldrin	1.8	U
1024-57-3	Heptachlor epoxide	1.8	U
959-98-8	Endosulfan I	1.8	U
60-57-1	Dieldrin	3.4	U
72-55-9	4,4'-DDE	3.4	U
72-20-8	Endrin	3.4	U
33213-65-9	Endosulfan II	3.4	U
72-54-8	4,4'-DDD	3.4	U
1031-07-8	Endosulfan sulfate	3.4	U
50-29-3	4,4'-DDT	3.4	U
72-43-5	Methoxychlor	18	U
53494-70-5	Endrin ketone	3.4	U
7421-36-3	Endrin aldehyde	3.4	U
5103-71-9	alpha-Chlordane	1.8	U
5103-74-2	gamma-Chlordane	1.8	U
8001-35-2	Toxaphene	180	U
12674-11-2	Aroclor-1016	34	U
11104-28-2	Aroclor-1221	70	U
11141-16-5	Aroclor-1232	34	U
53469-21-9	Aroclor-1242	34	U
12672-29-6	Aroclor-1248	34	U
11097-69-1	Aroclor-1254	34	U
11096-82-5	Aroclor-1260	34	U

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1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW89

LPC II

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280251

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: _99.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	12300		E	P
7440-36-0	Antimony	0.48	B	N	P
7440-38-2	Arsenic	5.2			P
7440-39-3	Barium	130		E	P
7440-41-7	Beryllium	0.42	B		P
7440-43-9	Cadmium	0.06	U	N	P
7440-70-2	Calcium	483000			P
7440-47-3	Chromium	21.0		E	P
7440-48-4	Cobalt	3.1	B	E	P
7440-50-8	Copper	8.4			P
7439-89-6	Iron	10500		E	P
7439-92-1	Lead	4.0			P
7439-95-4	Magnesium	5930		E	P
7439-96-5	Manganese	209		E	P
7439-97-6	Mercury	0.05	U		CV
7440-02-0	Nickel	6.5	B	E	P
7440-09-7	Potassium	3370		E	P
7782-49-2	Selenium	0.73	U		P
7440-22-4	Silver	0.16	U		P
7440-23-5	Sodium	1560			P
7440-28-0	Thallium	0.85	B		P
7440-62-2	Vanadium	34.5		E	P
7440-66-6	Zinc	46.4			P
	Cyanide				NR

Color Before: GRAY Clarity Before: _____ Texture: FINE

Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN80

5m399

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122937

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122937

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 6 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) Y pH: 8.6

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	53000	U
111-44-4	bis(2-Chloroethyl)Ether	53000	U
95-57-8	2-Chlorophenol	53000	U
541-73-1	1,3-Dichlorobenzene	53000	U
106-46-7	1,4-Dichlorobenzene	53000	U
95-50-1	1,2-Dichlorobenzene	53000	U
95-48-7	2-Methylphenol	53000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	53000	U
106-44-5	4-Methylphenol	53000	U
621-64-7	N-Nitroso-Di-n-Propylamine	53000	U
67-72-1	Hexachloroethane	53000	U
98-95-3	Nitrobenzene	53000	U
78-59-1	Isophorone	53000	U
88-75-5	2-Nitrophenol	53000	U
105-67-9	2,4-Dimethylphenol	53000	U
111-91-1	bis(2-Chloroethoxy)Methane	53000	U
120-83-2	2,4-Dichlorophenol	53000	U
120-82-1	1,2,4-Trichlorobenzene	53000	U
91-20-3	Naphthalene	53000	U
106-47-8	4-Chloroaniline	53000	U
87-68-3	Hexachlorobutadiene	53000	U
59-50-7	4-Chloro-3-Methylphenol	53000	U
91-57-6	2-Methylnaphthalene	53000	U
77-47-4	Hexachlorocyclopentadiene	53000	U
88-06-2	2,4,6-Trichlorophenol	53000	U
95-95-4	2,4,5-Trichlorophenol	130000	U
91-58-7	2-Chloronaphthalene	53000	U
88-74-4	2-Nitroaniline	130000	U
131-11-3	Dimethylphthalate	53000	U
208-96-8	Acenaphthylene	53000	U
606-20-2	2,6-Dinitrotoluene	53000	U
99-09-2	3-Nitroaniline	130000	U
83-32-9	Acenaphthene	53000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN80

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122937

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122937

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 6 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) Y pH: 8.6

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	130000	U
100-02-7	4-Nitrophenol	130000	U
132-64-9	Dibenzofuran	53000	U
121-14-2	2,4-Dinitrotoluene	53000	U
84-66-2	Diethylphthalate	53000	U
7005-72-3	4-Chlorophenyl-phenylether	53000	U
86-73-7	Fluorene	53000	U
100-01-6	4-Nitroaniline	130000	U
534-52-1	4,6-Dinitro-2-methylphenol	130000	U
86-30-6	N-Nitrosodiphenylamine (1)	53000	U
101-55-3	4-Bromophenyl-phenylether	53000	U
118-74-1	Hexachlorobenzene	53000	U
87-86-5	Pentachlorophenol	130000	U
85-01-8	Phenanthrene	53000	U
120-12-7	Anthracene	53000	U
86-74-8	Carbazole	53000	U
84-74-2	Di-n-Butylphthalate	53000	U
206-44-0	Fluoranthene	53000	U
129-00-0	Pyrene	90000	
85-68-7	Butylbenzylphthalate	53000	U
91-94-1	3,3'-Dichlorobenzidine	53000	U
56-55-3	Benzo(a)Anthracene	53000	U
218-01-9	Chrysene	53000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	53000	U
117-84-0	Di-n-Octyl Phthalate	53000	U
205-99-2	Benzo(b)Fluoranthene	53000	U
207-08-9	Benzo(k)Fluoranthene	53000	U
50-32-8	Benzo(a)Pyrene	77000	
193-39-5	Indeno(1,2,3-cd)Pyrene	23000	J
53-70-3	Dibenz(a,h)Anthracene	53000	U
191-24-2	Benzo(g,h,i)Perylene	56000	

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN80

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122937

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122937

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 6 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/28/95

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) Y pH: 8.6

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN HYDROCARBON	15.40	100000	J
2.	UNKNOWN	16.55	21000	J
3.	UNKNOWN HYDROCARBON	16.63	80000	J
4.	UNKNOWN HYDROCARBON	17.80	260000	J
5.	UNKNOWN	18.83	53000	J
6.	UNKNOWN HYDROCARBON	18.90	96000	J
7.	UNKNOWN	19.15	110000	J
8.	UNKNOWN	19.83	170000	J
9.	UNKNOWN HYDROCARBON	19.97	74000	J
10.	UNKNOWN	20.97	27000	J
11.	UNKNOWN	21.27	210000	J
12.	UNKNOWN	21.88	380000	J
13.	UNKNOWN	22.03	37000	J
14.	UNKNOWN	22.23	32000	J
15.	UNKNOWN	22.82	43000	J
16.	UNKNOWN HYDROCARBON	23.77	27000	J
17.	UNKNOWN	24.65	80000	J
18.	UNKNOWN HYDROCARBON	26.27	27000	J
19.	UNKNOWN	28.03	27000	J
20.	UNKNOWN PAH	29.37	80000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN80

sm399

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122937

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 6 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) Y pH: 8.6 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1.8	U
319-85-7	beta-BHC	1.8	U
319-86-8	delta-BHC	1.8	U
58-89-9	gamma-BHC (Lindane)	1.8	U
76-44-8	Heptachlor	1.8	U
309-00-2	Aldrin	1.8	U
1024-57-3	Heptachlor epoxide	1.8	U
959-98-8	Endosulfan I	1.8	U
60-57-1	Dieldrin	3.5	U
72-55-9	4,4'-DDE	3.5	U
72-20-8	Endrin	3.5	U
33213-65-9	Endosulfan II	3.5	U
72-54-8	4,4'-DDD	3.5	U
1031-07-8	Endosulfan sulfate	3.5	U
50-29-3	4,4'-DDT	3.5	U
72-43-5	Methoxychlor	18	U
53494-70-5	Endrin ketone	3.5	U
7421-36-3	Endrin aldehyde	3.5	U
5103-71-9	alpha-Chlordane	1.8	U
5103-74-2	gamma-Chlordane	1.8	U
8001-35-2	Toxaphene	180	U
12674-11-2	Aroclor-1016	35	U
11104-28-2	Aroclor-1221	71	U
11141-16-5	Aroclor-1232	35	U
53469-21-9	Aroclor-1242	41	P
12672-29-6	Aroclor-1248	35	U
11097-69-1	Aroclor-1254	25	J
11096-82-5	Aroclor-1260	35	U

U.S. EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW78

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063
Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78
Matrix (soil/water): SOIL_ Lab Sample ID: 280243
Level (low/med): LOW__ Date Received: 12/01/95
% Solids: _94.4

SM399

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	4900		E	P
7440-36-0	Antimony	0.44	U	N	P
7440-38-2	Arsenic	4.4			P
7440-39-3	Barium	46.2		E	P
7440-41-7	Beryllium	1.1			P
7440-43-9	Cadmium	0.06	U	N	P
7440-70-2	Calcium	6900			P
7440-47-3	Chromium	0.52	B	E	P
7440-48-4	Cobalt	0.50	B	E	P
7440-50-8	Copper	2.0	B		P
7439-89-6	Iron	3840		E	P
7439-92-1	Lead	29.0			P
7439-95-4	Magnesium	2460		E	P
7439-96-5	Manganese	137		E	P
7439-97-6	Mercury	0.06	U		CV
7440-02-0	Nickel	3.5	B	E	P
7440-09-7	Potassium	695	B	E	P
7782-49-2	Selenium	0.73	U		P
7440-22-4	Silver	0.16	U		P
7440-23-5	Sodium	7680			P
7440-28-0	Thallium	0.59	U		P
7440-62-2	Vanadium	1.0	B	E	P
7440-66-6	Zinc	55.0			P
	Cyanide				NR

Color Before: GRAY_____ Clarity Before: _____ Texture: FINE__
Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN81 PI

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

no metals data would not digest

Matrix: (soil/water) WATER Lab Sample ID: 95122938

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122938

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 10.0

GPC Cleanup: (Y/N) N pH: 12.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
108-95-2	Phenol	93	J
111-44-4	bis(2-Chloroethyl)Ether	100	U
95-57-8	2-Chlorophenol	100	U
541-73-1	1,3-Dichlorobenzene	100	U
106-46-7	1,4-Dichlorobenzene	100	U
95-50-1	1,2-Dichlorobenzene	100	U
95-48-7	2-Methylphenol	100	U
108-60-1	2,2'-oxybis(1-Chloropropane)	100	U
106-44-5	4-Methylphenol	42	J
621-64-7	N-Nitroso-Di-n-Propylamine	100	U
67-72-1	Hexachloroethane	100	U
98-95-3	Nitrobenzene	100	U
78-59-1	Isophorone	100	U
88-75-5	2-Nitrophenol	100	U
105-67-9	2,4-Dimethylphenol	100	U
111-91-1	bis(2-Chloroethoxy)Methane	100	U
120-83-2	2,4-Dichlorophenol	100	U
120-82-1	1,2,4-Trichlorobenzene	100	U
91-20-3	Naphthalene	100	U
106-47-8	4-Chloroaniline	100	U
87-68-3	Hexachlorobutadiene	100	U
59-50-7	4-Chloro-3-Methylphenol	100	U
91-57-6	2-Methylnaphthalene	100	U
77-47-4	Hexachlorocyclopentadiene	100	U
88-06-2	2,4,6-Trichlorophenol	100	U
95-95-4	2,4,5-Trichlorophenol	250	U
91-58-7	2-Chloronaphthalene	100	U
88-74-4	2-Nitroaniline	250	U
131-11-3	Dimethylphthalate	100	U
208-96-8	Acenaphthylene	100	U
606-20-2	2,6-Dinitrotoluene	100	U
99-09-2	3-Nitroaniline	250	U
83-32-9	Acenaphthene	100	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN81

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122938

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122938

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 10.0

GPC Cleanup: (Y/N) N pH: 12.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
51-28-5	2,4-Dinitrophenol	250	U
100-02-7	4-Nitrophenol	250	U
132-64-9	Dibenzofuran	100	U
121-14-2	2,4-Dinitrotoluene	100	U
84-66-2	Diethylphthalate	100	U
7005-72-3	4-Chlorophenyl-phenylether	100	U
86-73-7	Fluorene	100	U
100-01-6	4-Nitroaniline	250	U
534-52-1	4,6-Dinitro-2-methylphenol	250	U
86-30-6	N-Nitrosodiphenylamine (1)	100	U
101-55-3	4-Bromophenyl-phenylether	100	U
118-74-1	Hexachlorobenzene	100	U
87-86-5	Pentachlorophenol	250	U
85-01-8	Phenanthrene	100	U
120-12-7	Anthracene	100	U
86-74-8	Carbazole	100	U
84-74-2	Di-n-Butylphthalate	100	U
206-44-0	Fluoranthene	100	U
129-00-0	Pyrene	100	U
85-68-7	Butylbenzylphthalate	100	U
91-94-1	3,3'-Dichlorobenzidine	100	U
56-55-3	Benzo(a)Anthracene	100	U
218-01-9	Chrysene	100	U
117-81-7	bis(2-Ethylhexyl)Phthalate	100	U
117-84-0	Di-n-Octyl Phthalate	100	U
205-99-2	Benzo(b)Fluoranthene	100	U
207-08-9	Benzo(k)Fluoranthene	100	U
50-32-8	Benzo(a)Pyrene	100	U
193-39-5	Indeno(1,2,3-cd)Pyrene	100	U
53-70-3	Dibenz(a,h)Anthracene	100	U
191-24-2	Benzo(g,h,i)Perylene	100	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN81

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122938

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122938

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 10.0

GPC Cleanup: (Y/N) N pH: 12.0

Number TICs found: 18

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	21368-68-3	BICYCLO[2.2.1]HEPTAN-2-ONE	10.33	50	JN
2.	507-70-0	BORNEOL	10.65	40	JN
3.	536-60-7	BENZENEMETHANOL, 4-(1-METHYL	10.83	50	JN
4.		UNKNOWN	10.98	130	J
5.		UNKNOWN	13.17	120	J
6.		UNKNOWN	13.95	40	J
7.		UNKNOWN	14.52	80	J
8.		UNKNOWN	18.22	210	J
9.		UNKNOWN	19.17	70	J
10.		UNKNOWN	20.20	30	J
11.		UNKNOWN	21.77	80	J
12.		UNKNOWN	22.43	80	J
13.		UNKNOWN	23.40	140	J
14.		UNKNOWN	23.90	320	J
15.		UNKNOWN	24.32	550	J
16.		UNKNOWN	24.80	700	J
17.	1740-19-8	1-PHENANTHRENECARBOXYLIC ACI	25.13	750	JN
18.		UNKNOWN	26.38	270	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN81

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122938

Sample wt/vol: 1000 (g/mL) ML Lab File ID:

% Moisture: decanted: (Y/N) Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 12/04/95

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 01/05/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) N pH: 12.0 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
319-84-6	alpha-BHC	0.050	U
319-85-7	beta-BHC	0.050	U
319-86-8	delta-BHC	0.050	U
58-89-9	gamma-BHC (Lindane)	0.050	U
76-44-8	Heptachlor	0.050	U
309-00-2	Aldrin	0.050	U
1024-57-3	Heptachlor epoxide	0.050	U
959-98-8	Endosulfan I	0.050	U
60-57-1	Dieldrin	0.10	U
72-55-9	4,4'-DDE	0.10	U
72-20-8	Endrin	0.10	U
33213-65-9	Endosulfan II	0.10	U
72-54-8	4,4'-DDD	0.10	U
1031-07-8	Endosulfan sulfate	0.10	U
50-29-3	4,4'-DDT	0.10	U
72-43-5	Methoxychlor	0.50	U
53494-70-5	Endrin ketone	0.10	U
7421-36-3	Endrin aldehyde	0.10	U
5103-71-9	alpha-Chlordane	0.050	U
5103-74-2	gamma-Chlordane	0.050	U
8001-35-2	Toxaphene	5.0	U
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	2.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN82 PII

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122939

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122939

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 50000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 50.0

GPC Cleanup: (Y/N) N pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
108-95-2	Phenol	25000	U
111-44-4	bis(2-Chloroethyl)Ether	25000	U
95-57-8	2-Chlorophenol	25000	U
541-73-1	1,3-Dichlorobenzene	25000	U
106-46-7	1,4-Dichlorobenzene	25000	U
95-50-1	1,2-Dichlorobenzene	25000	U
95-48-7	2-Methylphenol	25000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	25000	U
106-44-5	4-Methylphenol	25000	U
621-64-7	N-Nitroso-Di-n-Propylamine	25000	U
67-72-1	Hexachloroethane	25000	U
98-95-3	Nitrobenzene	25000	U
78-59-1	Isophorone	25000	U
88-75-5	2-Nitrophenol	25000	U
105-67-9	2,4-Dimethylphenol	25000	U
111-91-1	bis(2-Chloroethoxy)Methane	25000	U
120-83-2	2,4-Dichlorophenol	25000	U
120-82-1	1,2,4-Trichlorobenzene	25000	U
91-20-3	Naphthalene	25000	U
106-47-8	4-Chloroaniline	25000	U
87-68-3	Hexachlorobutadiene	25000	U
59-50-7	4-Chloro-3-Methylphenol	25000	U
91-57-6	2-Methylnaphthalene	25000	U
77-47-4	Hexachlorocyclopentadiene	25000	U
88-06-2	2,4,6-Trichlorophenol	25000	U
95-95-4	2,4,5-Trichlorophenol	62000	U
91-58-7	2-Chloronaphthalene	25000	U
88-74-4	2-Nitroaniline	62000	U
131-11-3	Dimethylphthalate	25000	U
208-96-8	Acenaphthylene	25000	U
606-20-2	2,6-Dinitrotoluene	25000	U
99-09-2	3-Nitroaniline	62000	U
83-32-9	Acenaphthene	25000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN82

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122939

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122939

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 50000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 50.0

GPC Cleanup: (Y/N) N pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
51-28-5	2,4-Dinitrophenol	62000	U
100-02-7	4-Nitrophenol	62000	U
132-64-9	Dibenzofuran	25000	U
121-14-2	2,4-Dinitrotoluene	25000	U
84-66-2	Diethylphthalate	25000	U
7005-72-3	4-Chlorophenyl-phenylether	25000	U
86-73-7	Fluorene	25000	U
100-01-6	4-Nitroaniline	62000	U
534-52-1	4,6-Dinitro-2-methylphenol	62000	U
86-30-6	N-Nitrosodiphenylamine (1)	25000	U
101-55-3	4-Bromophenyl-phenylether	25000	U
118-74-1	Hexachlorobenzene	25000	U
87-86-5	Pentachlorophenol	62000	U
85-01-8	Phenanthrene	25000	U
120-12-7	Anthracene	25000	U
86-74-8	Carbazole	25000	U
84-74-2	Di-n-Butylphthalate	25000	U
206-44-0	Fluoranthene	25000	U
129-00-0	Pyrene	25000	U
85-68-7	Butylbenzylphthalate	25000	U
91-94-1	3,3'-Dichlorobenzidine	25000	U
56-55-3	Benzo(a)Anthracene	25000	U
218-01-9	Chrysene	25000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	25000	U
117-84-0	Di-n-Octyl Phthalate	25000	U
205-99-2	Benzo(b)Fluoranthene	25000	U
207-08-9	Benzo(k)Fluoranthene	25000	U
50-32-8	Benzo(a)Pyrene	25000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	25000	U
53-70-3	Dibenz(a,h)Anthracene	25000	U
191-24-2	Benzo(g,h,i)Perylene	25000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN82

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122939

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122939

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 50000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 50.0

GPC Cleanup: (Y/N) N pH: 7.0

Number TICs found: 9

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN ALKYLBENZENE	6.42	12000	J
2.	UNKNOWN SILANE	13.73	32000	J
3.	UNKNOWN SILANE	14.12	45000	J
4.	UNKNOWN SILANE	14.20	70000	J
5.	UNKNOWN SILANE	14.37	25000	J
6.	UNKNOWN SILANE	14.50	32000	J
7.	UNKNOWN SILANE	15.07	1300000	J
8.	UNKNOWN SILANE	17.08	12000	J
9.	UNKNOWN	18.35	22000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN82

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122939

Sample wt/vol: 1000 (g/mL) ML Lab File ID:

% Moisture: decanted: (Y/N) Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 12/04/95

Concentrated Extract Volume: 50000 (uL) Date Analyzed: 01/05/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) N pH: 7.0 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
319-84-6	alpha-BHC	0.25	U
319-85-7	beta-BHC	0.25	U
319-86-8	delta-BHC	0.25	U
58-89-9	gamma-BHC (Lindane)	0.25	U
76-44-8	Heptachlor	0.25	U
309-00-2	Aldrin	0.25	U
1024-57-3	Heptachlor epoxide	0.25	U
959-98-8	Endosulfan I	0.25	U
60-57-1	Dieldrin	0.50	U
72-55-9	4,4'-DDE	0.50	U
72-20-8	Endrin	0.50	U
33213-65-9	Endosulfan II	0.50	U
72-54-8	4,4'-DDD	0.50	U
1031-07-8	Endosulfan sulfate	0.50	U
50-29-3	4,4'-DDT	0.50	U
72-43-5	Methoxychlor	2.5	U
53494-70-5	Endrin ketone	0.50	U
7421-36-3	Endrin aldehyde	0.50	U
5103-71-9	alpha-Chlordane	0.25	U
5103-74-2	gamma-Chlordane	0.25	U
8001-35-2	Toxaphene	25	U
12674-11-2	Aroclor-1016	5.0	U
11104-28-2	Aroclor-1221	10	U
11141-16-5	Aroclor-1232	5.0	U
53469-21-9	Aroclor-1242	5.0	U
12672-29-6	Aroclor-1248	5.0	U
11097-69-1	Aroclor-1254	5.0	U
11096-82-5	Aroclor-1260	5.0	U

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INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW80

PII

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063
Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78
Matrix (soil/water): WATER Lab Sample ID: 280245
Level (low/med): LOW Date Received: 12/01/95
% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	220			P
7440-36-0	Antimony	2.2	U		P
7440-38-2	Arsenic	2.1	U		P
7440-39-3	Barium	13.1	B		P
7440-41-7	Beryllium	0.20	U		P
7440-43-9	Cadmium	0.30	U		P
7440-70-2	Calcium	26400			P
7440-47-3	Chromium	2.0	B		P
7440-48-4	Cobalt	1.0	U		P
7440-50-8	Copper	4.4	B		P
7439-89-6	Iron	63.7	B		P
7439-92-1	Lead	1.8	B		P
7439-95-4	Magnesium	7240			P
7439-96-5	Manganese	1.6	B		P
7439-97-6	Mercury	0.10	U		CV
7440-02-0	Nickel	1.2	B		P
7440-09-7	Potassium	790	B		P
7782-49-2	Selenium	3.7	U	N	P
7440-22-4	Silver	0.97	B		P
7440-23-5	Sodium	12800		E	P
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	1.1	B		P
7440-66-6	Zinc	21.1			P
	Cyanide				NR

Color Before: WHITE Clarity Before: OPAQUE Texture: _____
Color After: COLORLESS Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN83 ES1 W1

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122940

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122940

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
108-95-2	Phenol	10	U
111-44-4	bis(2-Chloroethyl)Ether	10	U
95-57-8	2-Chlorophenol	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
95-48-7	2-Methylphenol	10	U
108-60-1	2,2'-oxybis(1-Chloropropane)	10	U
106-44-5	4-Methylphenol	10	U
621-64-7	N-Nitroso-Di-n-Propylamine	10	U
67-72-1	Hexachloroethane	10	U
98-95-3	Nitrobenzene	10	U
78-59-1	Isophorone	10	U
88-75-5	2-Nitrophenol	10	U
105-67-9	2,4-Dimethylphenol	10	U
111-91-1	bis(2-Chloroethoxy)Methane	10	U
120-83-2	2,4-Dichlorophenol	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U
91-20-3	Naphthalene	10	U
106-47-8	4-Chloroaniline	10	U
87-68-3	Hexachlorobutadiene	10	U
59-50-7	4-Chloro-3-Methylphenol	10	U
91-57-6	2-Methylnaphthalene	10	U
77-47-4	Hexachlorocyclopentadiene	10	U
88-06-2	2,4,6-Trichlorophenol	10	U
95-95-4	2,4,5-Trichlorophenol	25	U
91-58-7	2-Chloronaphthalene	10	U
88-74-4	2-Nitroaniline	25	U
131-11-3	Dimethylphthalate	10	U
208-96-8	Acenaphthylene	10	U
606-20-2	2,6-Dinitrotoluene	10	U
99-09-2	3-Nitroaniline	25	U
83-32-9	Acenaphthene	10	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN83

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122940

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122940

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
51-28-5	2,4-Dinitrophenol	25	U
100-02-7	4-Nitrophenol	25	U
132-64-9	Dibenzofuran	10	U
121-14-2	2,4-Dinitrotoluene	10	U
84-66-2	Diethylphthalate	10	U
7005-72-3	4-Chlorophenyl-phenylether	10	U
86-73-7	Fluorene	10	U
100-01-6	4-Nitroaniline	25	U
534-52-1	4,6-Dinitro-2-methylphenol	25	U
86-30-6	N-Nitrosodiphenylamine (1)	10	U
101-55-3	4-Bromophenyl-phenylether	10	U
118-74-1	Hexachlorobenzene	10	U
87-86-5	Pentachlorophenol	25	U
85-01-8	Phenanthrene	10	U
120-12-7	Anthracene	10	U
86-74-8	Carbazole	10	U
84-74-2	Di-n-Butylphthalate	10	U
206-44-0	Fluoranthene	10	U
129-00-0	Pyrene	10	U
85-68-7	Butylbenzylphthalate	10	U
91-94-1	3,3'-Dichlorobenzidine	10	U
56-55-3	Benzo(a)Anthracene	10	U
218-01-9	Chrysene	10	U
117-81-7	bis(2-Ethylhexyl)Phthalate	10	U
117-84-0	Di-n-Octyl Phthalate	10	U
205-99-2	Benzo(b)Fluoranthene	10	U
207-08-9	Benzo(k)Fluoranthene	10	U
50-32-8	Benzo(a)Pyrene	10	U
193-39-5	Indeno(1,2,3-cd)Pyrene	10	U
53-70-3	Dibenz(a,h)Anthracene	10	U
191-24-2	Benzo(g,h,i)Perylene	10	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN83

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122940

Sample wt/vol: 1000 (g/mL) ML Lab File ID: S122940

Level: (low/med) LOW Date Received: 12/01/95

% Moisture: decanted: (Y/N) Date Extracted: 12/04/95

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 12/22/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN83

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) WATER Lab Sample ID: 95122940

Sample wt/vol: 1000 (g/mL) ML Lab File ID:

% Moisture: decanted: (Y/N) Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 12/04/95

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 01/05/96

Injection Volume: 2.00 (uL) Dilution Factor: 1.00

GPC Cleanup: (Y/N) N pH: 7.0 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
319-84-6	alpha-BHC	0.050	U
319-85-7	beta-BHC	0.050	U
319-86-8	delta-BHC	0.050	U
58-89-9	gamma-BHC (Lindane)	0.050	U
76-44-8	Heptachlor	0.050	U
309-00-2	Aldrin	0.050	U
1024-57-3	Heptachlor epoxide	0.050	U
959-98-8	Endosulfan I	0.050	U
60-57-1	Dieldrin	0.10	U
72-55-9	4,4'-DDE	0.10	U
72-20-8	Endrin	0.10	U
33213-65-9	Endosulfan II	0.10	U
72-54-8	4,4'-DDD	0.10	U
1031-07-8	Endosulfan sulfate	0.10	U
50-29-3	4,4'-DDT	0.10	U
72-43-5	Methoxychlor	0.50	U
53494-70-5	Endrin ketone	0.10	U
7421-36-3	Endrin aldehyde	0.10	U
5103-71-9	alpha-Chlordane	0.050	U
5103-74-2	gamma-Chlordane	0.050	U
8001-35-2	Toxaphene	5.0	U
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	2.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

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1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW81

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): WATER Lab Sample ID: 280246

Level (low/med): LOW Date Received: 12/01/95

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	18.0	B		P
7440-36-0	Antimony	2.2	U		P
7440-38-2	Arsenic	2.2	B		P
7440-39-3	Barium	3.4	B		P
7440-41-7	Beryllium	0.20	U		P
7440-43-9	Cadmium	0.30	U		P
7440-70-2	Calcium	5590			P
7440-47-3	Chromium	0.67	B		P
7440-48-4	Cobalt	1.0	U		P
7440-50-8	Copper	1.5	B		P
7439-89-6	Iron	677			P
7439-92-1	Lead	1.5	U		P
7439-95-4	Magnesium	1430	B		P
7439-96-5	Manganese	16.2			P
7439-97-6	Mercury	0.14	B		CV
7440-02-0	Nickel	1.2	B		P
7440-09-7	Potassium	805	B		P
7782-49-2	Selenium	3.7	U	N	P
7440-22-4	Silver	1.5	B		P
7440-23-5	Sodium	13800		E	P
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	1.2	B		P
7440-66-6	Zinc	2.3	B		P
	Cyanide				NR

Color Before: COLORLESS Clarity Before: CLEAR Texture: _____

Color After: COLORLESS Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN84 B#13

b Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122941R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	22000	U
111-44-4	bis(2-Chloroethyl)Ether	22000	U
95-57-8	2-Chlorophenol	22000	U
541-73-1	1,3-Dichlorobenzene	17000	J
106-46-7	1,4-Dichlorobenzene	67000	
95-50-1	1,2-Dichlorobenzene	22000	U
95-48-7	2-Methylphenol	22000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	22000	U
106-44-5	4-Methylphenol	22000	U
621-64-7	N-Nitroso-Di-n-Propylamine	22000	U
67-72-1	Hexachloroethane	22000	U
98-95-3	Nitrobenzene	22000	U
78-59-1	Isophorone	22000	U
88-75-5	2-Nitrophenol	22000	U
105-67-9	2,4-Dimethylphenol	22000	U
111-91-1	bis(2-Chloroethoxy)Methane	22000	U
120-83-2	2,4-Dichlorophenol	22000	U
120-82-1	1,2,4-Trichlorobenzene	22000	U
91-20-3	Naphthalene	22000	U
106-47-8	4-Chloroaniline	22000	U
87-68-3	Hexachlorobutadiene	22000	U
59-50-7	4-Chloro-3-Methylphenol	22000	U
91-57-6	2-Methylnaphthalene	22000	U
77-47-4	Hexachlorocyclopentadiene	22000	U
88-06-2	2,4,6-Trichlorophenol	22000	U
95-95-4	2,4,5-Trichlorophenol	54000	U
91-58-7	2-Chloronaphthalene	22000	U
88-74-4	2-Nitroaniline	54000	U
131-11-3	Dimethylphthalate	22000	U
208-96-8	Acenaphthylene	22000	U
606-20-2	2,6-Dinitrotoluene	22000	U
99-09-2	3-Nitroaniline	54000	U
83-32-9	Acenaphthene	22000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN84

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122941R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	54000	U
100-02-7	4-Nitrophenol	54000	U
132-64-9	Dibenzofuran	22000	U
121-14-2	2,4-Dinitrotoluene	22000	U
84-66-2	Diethylphthalate	22000	U
7005-72-3	4-Chlorophenyl-phenylether	22000	U
86-73-7	Fluorene	22000	U
100-01-6	4-Nitroaniline	54000	U
534-52-1	4,6-Dinitro-2-methylphenol	54000	U
86-30-6	N-Nitrosodiphenylamine (1)	22000	U
101-55-3	4-Bromophenyl-phenylether	22000	U
118-74-1	Hexachlorobenzene	22000	U
87-86-5	Pentachlorophenol	54000	U
85-01-8	Phenanthrene	13000	JX
120-12-7	Anthracene	22000	U
86-74-8	Carbazole	22000	U
84-74-2	Di-n-Butylphthalate	22000	U
206-44-0	Fluoranthene	18000	JX
129-00-0	Pyrene	15000	J
85-68-7	Butylbenzylphthalate	22000	U
91-94-1	3,3'-Dichlorobenzidine	22000	U
56-55-3	Benzo(a)Anthracene	13000	J
218-01-9	Chrysene	6800	J
117-81-7	bis(2-Ethylhexyl)Phthalate	19000	J
117-84-0	Di-n-Octyl Phthalate	22000	U
205-99-2	Benzo(b)Fluoranthene	7400	J
207-08-9	Benzo(k)Fluoranthene	22000	U
50-32-8	Benzo(a)Pyrene	22000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	22000	U
53-70-3	Dibenz(a,h)Anthracene	22000	U
191-24-2	Benzo(g,h,i)Perylene	22000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN84

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122941R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN PCB	17.25	100000	J
2.	UNKNOWN PCB	18.08	87000	J
3.	UNKNOWN PCB	18.23	150000	J
4.	UNKNOWN PCB	19.18	350000	J
5.	UNKNOWN PCB	19.60	120000	J
6.	UNKNOWN PCB	19.97	100000	J
7.	UNKNOWN PCB	20.20	300000	J
8.	UNKNOWN PCB	20.40	110000	J
9.	UNKNOWN PCB	20.57	63000	J
10.	UNKNOWN PCB	20.90	200000	J
11.	UNKNOWN PCB	21.00	100000	J
12.	UNKNOWN PCB	21.33	120000	J
13.	UNKNOWN PCB	21.58	67000	J
14.	UNKNOWN PCB	22.13	98000	J
15.	UNKNOWN PCB	22.23	96000	J
16.	UNKNOWN PCB	22.55	100000	J
17.	UNKNOWN PCB	22.67	110000	J
18.	UNKNOWN PCB	22.77	61000	J
19.	UNKNOWN PCB	23.42	110000	J
20.	UNKNOWN PCB	23.90	120000	J

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN84RE

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122941RE

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	22000	U
111-44-4	bis(2-Chloroethyl)Ether	22000	U
95-57-8	2-Chlorophenol	22000	U
541-73-1	1,3-Dichlorobenzene	18000	J
106-46-7	1,4-Dichlorobenzene	67000	
95-50-1	1,2-Dichlorobenzene	22000	U
95-48-7	2-Methylphenol	22000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	22000	U
106-44-5	4-Methylphenol	22000	U
621-64-7	N-Nitroso-Di-n-Propylamine	22000	U
67-72-1	Hexachloroethane	22000	U
98-95-3	Nitrobenzene	22000	U
78-59-1	Isophorone	22000	U
88-75-5	2-Nitrophenol	22000	U
105-67-9	2,4-Dimethylphenol	22000	U
111-91-1	bis(2-Chloroethoxy)Methane	22000	U
120-83-2	2,4-Dichlorophenol	22000	U
120-82-1	1,2,4-Trichlorobenzene	6600	J
91-20-3	Naphthalene	22000	U
106-47-8	4-Chloroaniline	22000	U
87-68-3	Hexachlorobutadiene	22000	U
59-50-7	4-Chloro-3-Methylphenol	22000	U
91-57-6	2-Methylnaphthalene	22000	U
77-47-4	Hexachlorocyclopentadiene	22000	U
88-06-2	2,4,6-Trichlorophenol	22000	U
95-95-4	2,4,5-Trichlorophenol	54000	U
91-58-7	2-Chloronaphthalene	22000	U
88-74-4	2-Nitroaniline	54000	U
131-11-3	Dimethylphthalate	22000	U
208-96-8	Acenaphthylene	22000	U
606-20-2	2,6-Dinitrotoluene	22000	U
99-09-2	3-Nitroaniline	54000	U
83-32-9	Acenaphthene	22000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN84RE

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122941RE

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	54000	U
100-02-7	4-Nitrophenol	54000	U
132-64-9	Dibenzofuran	22000	U
121-14-2	2,4-Dinitrotoluene	22000	U
84-66-2	Diethylphthalate	22000	U
7005-72-3	4-Chlorophenyl-phenylether	22000	U
86-73-7	Fluorene	22000	U
100-01-6	4-Nitroaniline	54000	U
534-52-1	4,6-Dinitro-2-methylphenol	54000	U
86-30-6	N-Nitrosodiphenylamine (1)	22000	U
101-55-3	4-Bromophenyl-phenylether	22000	U
118-74-1	Hexachlorobenzene	22000	U
87-86-5	Pentachlorophenol	54000	U
85-01-8	Phenanthrene	9800	JX
120-12-7	Anthracene	22000	U
86-74-8	Carbazole	22000	U
84-74-2	Di-n-Butylphthalate	22000	U
206-44-0	Fluoranthene	18000	JX
129-00-0	Pyrene	13000	J
85-68-7	Butylbenzylphthalate	22000	U
91-94-1	3,3'-Dichlorobenzidine	22000	U
56-55-3	Benzo(a)Anthracene	7700	J
218-01-9	Chrysene	22000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	17000	J
117-84-0	Di-n-Octyl Phthalate	22000	U
205-99-2	Benzo(b)Fluoranthene	7000	J
207-08-9	Benzo(k)Fluoranthene	22000	U
50-32-8	Benzo(a)Pyrene	22000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	22000	U
53-70-3	Dibenz(a,h)Anthracene	22000	U
191-24-2	Benzo(g,h,i)Perylene	22000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN84RE

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122941RE

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/31/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 01/03/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN PCB	17.23	98000	J
2.	UNKNOWN PCB	18.07	93000	J
3.	UNKNOWN PCB	18.22	140000	J
4.	UNKNOWN PCB	19.17	390000	J
5.	UNKNOWN PCB	19.58	120000	J
6.	UNKNOWN PCB	19.97	72000	J
7.	UNKNOWN PCB	20.17	280000	J
8.	UNKNOWN PCB	20.38	100000	J
9.	UNKNOWN PCB	20.55	63000	J
10.	UNKNOWN PCB	20.88	170000	J
11.	UNKNOWN PCB	20.98	100000	J
12.	UNKNOWN PCB	21.32	110000	J
13.	UNKNOWN PCB	21.57	65000	J
14.	UNKNOWN PCB	22.13	80000	J
15.	UNKNOWN PCB	22.22	120000	J
16.	UNKNOWN PCB	22.55	80000	J
17.	UNKNOWN PCB	22.65	120000	J
18.	UNKNOWN PCB	22.77	70000	J
19.	UNKNOWN PCB	23.40	100000	J
20.	UNKNOWN PCB	23.90	120000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN84

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941

Sample wt/vol: 30.0 (g/mL) G Lab File ID: S122941R

% Moisture: 54 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 500

GPC Cleanup: (Y/N) Y pH: 8.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1800	U
319-85-7	beta-BHC	1800	U
319-86-8	delta-BHC	1800	U
58-89-9	gamma-BHC (Lindane)	1800	U
76-44-8	Heptachlor	1800	U
309-00-2	Aldrin	1800	U
1024-57-3	Heptachlor epoxide	1800	U
959-98-8	Endosulfan I	1800	U
60-57-1	Dieldrin	3600	U
72-55-9	4,4'-DDE	3600	U
72-20-8	Endrin	3600	U
33213-65-9	Endosulfan II	3600	U
72-54-8	4,4'-DDD	3600	U
1031-07-8	Endosulfan sulfate	3600	U
50-29-3	4,4'-DDT	3600	U
72-43-5	Methoxychlor	18000	U
53494-70-5	Endrin ketone	3600	U
7421-36-3	Endrin aldehyde	3600	U
5103-71-9	alpha-Chlordane	1800	U
5103-74-2	gamma-Chlordane	1800	U
8001-35-2	Toxaphene	180000	U
12674-11-2	Aroclor-1016	36000	U
11104-28-2	Aroclor-1221	73000	U
11141-16-5	Aroclor-1232	36000	U
53469-21-9	Aroclor-1242	2600000	EC
12672-29-6	Aroclor-1248	36000	U
11097-69-1	Aroclor-1254	1700000	EC
11096-82-5	Aroclor-1260	36000	U

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN84DL

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122941DL

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 54 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 5000

GPC Cleanup: (Y/N) Y pH: 8.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	18000	U
319-85-7	beta-BHC	18000	U
319-86-8	delta-BHC	18000	U
58-89-9	gamma-BHC (Lindane)	18000	U
76-44-8	Heptachlor	18000	U
309-00-2	Aldrin	18000	U
1024-57-3	Heptachlor epoxide	18000	U
959-98-8	Endosulfan I	18000	U
60-57-1	Dieldrin	36000	U
72-55-9	4,4'-DDE	36000	U
72-20-8	Endrin	36000	U
33213-65-9	Endosulfan II	36000	U
72-54-8	4,4'-DDD	36000	U
1031-07-8	Endosulfan sulfate	36000	U
50-29-3	4,4'-DDT	36000	U
72-43-5	Methoxychlor	180000	U
53494-70-5	Endrin ketone	36000	U
7421-36-3	Endrin aldehyde	36000	U
5103-71-9	alpha-Chlordane	18000	U
5103-74-2	gamma-Chlordane	18000	U
8001-35-2	Toxaphene	1800000	U
12674-11-2	Aroclor-1016	360000	U
11104-28-2	Aroclor-1221	730000	U
11141-16-5	Aroclor-1232	360000	U
53469-21-9	Aroclor-1242	4200000	D
12672-29-6	Aroclor-1248	360000	U
11097-69-1	Aroclor-1254	2400000	D
11096-82-5	Aroclor-1260	360000	U

U.S. EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW82 B#13

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063

Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78

Matrix (soil/water): SOIL_ Lab Sample ID: 280247

Level (low/med): LOW__ Date Received: 12/01/95

% Solids: _44.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	10600		E	P
7440-36-0	Antimony	0.98	B	N	P
7440-38-2	Arsenic	8.8			P
7440-39-3	Barium	136		E	P
7440-41-7	Beryllium	0.50	B		P
7440-43-9	Cadmium	10.8		N	P
7440-70-2	Calcium	5230			P
7440-47-3	Chromium	250		E	P
7440-48-4	Cobalt	6.0	B	E	P
7440-50-8	Copper	638			P
7439-89-6	Iron	18200		E	P
7439-92-1	Lead	463			P
7439-95-4	Magnesium	5590		E	P
7439-96-5	Manganese	151		E	P
7439-97-6	Mercury	1.0			CV
7440-02-0	Nickel	43.7		E	P
7440-09-7	Potassium	2130		E	P
7782-49-2	Selenium	1.4	U		P
7440-22-4	Silver	2.2	B		P
7440-23-5	Sodium	10400			P
7440-28-0	Thallium	1.1	U		P
7440-62-2	Vanadium	35.8		E	P
7440-66-6	Zinc	1470			P
	Cyanide				NR

Color Before: BROWN Clarity Before: _____ Texture: MEDIUM

Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN85 B#15

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122942

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	22000	U
111-44-4	bis(2-Chloroethyl)Ether	22000	U
95-57-8	2-Chlorophenol	22000	U
541-73-1	1,3-Dichlorobenzene	23000	
106-46-7	1,4-Dichlorobenzene	82000	
95-50-1	1,2-Dichlorobenzene	22000	U
95-48-7	2-Methylphenol	22000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	22000	U
106-44-5	4-Methylphenol	22000	U
621-64-7	N-Nitroso-Di-n-Propylamine	22000	U
67-72-1	Hexachloroethane	22000	U
98-95-3	Nitrobenzene	22000	U
78-59-1	Isophorone	22000	U
88-75-5	2-Nitrophenol	22000	U
105-67-9	2,4-Dimethylphenol	22000	U
111-91-1	bis(2-Chloroethoxy)Methane	22000	U
120-83-2	2,4-Dichlorophenol	22000	U
120-82-1	1,2,4-Trichlorobenzene	7600	J
91-20-3	Naphthalene	22000	U
106-47-8	4-Chloroaniline	22000	U
87-68-3	Hexachlorobutadiene	22000	U
59-50-7	4-Chloro-3-Methylphenol	22000	U
91-57-6	2-Methylnaphthalene	22000	U
77-47-4	Hexachlorocyclopentadiene	22000	U
88-06-2	2,4,6-Trichlorophenol	22000	U
95-95-4	2,4,5-Trichlorophenol	54000	U
91-58-7	2-Chloronaphthalene	22000	U
88-74-4	2-Nitroaniline	54000	U
131-11-3	Dimethylphthalate	22000	U
208-96-8	Acenaphthylene	22000	U
606-20-2	2,6-Dinitrotoluene	22000	U
99-09-2	3-Nitroaniline	54000	U
83-32-9	Acenaphthene	22000	U

60

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN85

Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122942

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	54000	U
100-02-7	4-Nitrophenol	54000	U
132-64-9	Dibenzofuran	22000	U
121-14-2	2,4-Dinitrotoluene	22000	U
84-66-2	Diethylphthalate	22000	U
7005-72-3	4-Chlorophenyl-phenylether	22000	U
86-73-7	Fluorene	22000	U
100-01-6	4-Nitroaniline	54000	U
534-52-1	4,6-Dinitro-2-methylphenol	54000	U
86-30-6	N-Nitrosodiphenylamine (1)	22000	U
101-55-3	4-Bromophenyl-phenylether	22000	U
118-74-1	Hexachlorobenzene	22000	U
87-86-5	Pentachlorophenol	54000	U
85-01-8	Phenanthrene	22000	U
120-12-7	Anthracene	22000	U
86-74-8	Carbazole	22000	U
84-74-2	Di-n-Butylphthalate	22000	U
206-44-0	Fluoranthene	12000	JX
129-00-0	Pyrene	10000	J
85-68-7	Butylbenzylphthalate	22000	U
91-94-1	3,3'-Dichlorobenzidine	22000	U
56-55-3	Benzo(a)Anthracene	22000	U
218-01-9	Chrysene	22000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	18000	J
117-84-0	Di-n-Octyl Phthalate	22000	U
205-99-2	Benzo(b)Fluoranthene	22000	U
207-08-9	Benzo(k)Fluoranthene	22000	U
50-32-8	Benzo(a)Pyrene	22000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	22000	U
53-70-3	Dibenz(a,h)Anthracene	22000	U
191-24-2	Benzo(g,h,i)Perylene	22000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN85

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122942

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN PCB	17.17	96000	J
2.	UNKNOWN PCB	18.00	91000	J
3.	UNKNOWN PCB	18.15	170000	J
4.	UNKNOWN PCB	19.10	220000	J
5.	UNKNOWN PCB	19.50	120000	J
6.	UNKNOWN PCB	19.88	76000	J
7.	UNKNOWN PCB	20.08	190000	J
8.	UNKNOWN PCB	20.30	110000	J
9.	UNKNOWN PCB	20.47	74000	J
10.	UNKNOWN PCB	20.82	150000	J
11.	UNKNOWN PCB	20.90	130000	J
12.	UNKNOWN PCB	21.25	91000	J
13.	UNKNOWN PCB	21.33	70000	J
14.	UNKNOWN PCB	22.03	93000	J
15.	UNKNOWN PCB	22.13	220000	J
16.	UNKNOWN PCB	22.47	83000	J
17.	UNKNOWN PCB	22.57	200000	J
18.	UNKNOWN PCB	22.70	110000	J
19.	UNKNOWN PCB	23.33	140000	J
20.	UNKNOWN PCB	23.83	130000	J

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN85RE B#15

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122942R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	22000	U
111-44-4	bis(2-Chloroethyl)Ether	22000	U
95-57-8	2-Chlorophenol	22000	U
541-73-1	1,3-Dichlorobenzene	23000	
106-46-7	1,4-Dichlorobenzene	85000	
95-50-1	1,2-Dichlorobenzene	22000	U
95-48-7	2-Methylphenol	22000	U
108-60-1	2,2'-oxybis(1-Chloropropane)	22000	U
106-44-5	4-Methylphenol	22000	U
621-64-7	N-Nitroso-Di-n-Propylamine	22000	U
67-72-1	Hexachloroethane	22000	U
98-95-3	Nitrobenzene	22000	U
78-59-1	Isophorone	22000	U
88-75-5	2-Nitrophenol	22000	U
105-67-9	2,4-Dimethylphenol	22000	U
111-91-1	bis(2-Chloroethoxy)Methane	22000	U
120-83-2	2,4-Dichlorophenol	22000	U
120-82-1	1,2,4-Trichlorobenzene	7000	J
91-20-3	Naphthalene	22000	U
106-47-8	4-Chloroaniline	22000	U
87-68-3	Hexachlorobutadiene	22000	U
59-50-7	4-Chloro-3-Methylphenol	22000	U
91-57-6	2-Methylnaphthalene	22000	U
77-47-4	Hexachlorocyclopentadiene	22000	U
88-06-2	2,4,6-Trichlorophenol	22000	U
95-95-4	2,4,5-Trichlorophenol	54000	U
91-58-7	2-Chloronaphthalene	22000	U
88-74-4	2-Nitroaniline	54000	U
131-11-3	Dimethylphthalate	22000	U
208-96-8	Acenaphthylene	22000	U
606-20-2	2,6-Dinitrotoluene	22000	U
99-09-2	3-Nitroaniline	54000	U
83-32-9	Acenaphthene	22000	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN85RE

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122942R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	54000	U
100-02-7	4-Nitrophenol	54000	U
132-64-9	Dibenzofuran	22000	U
121-14-2	2,4-Dinitrotoluene	22000	U
84-66-2	Diethylphthalate	22000	U
7005-72-3	4-Chlorophenyl-phenylether	22000	U
86-73-7	Fluorene	22000	U
100-01-6	4-Nitroaniline	54000	U
534-52-1	4,6-Dinitro-2-methylphenol	54000	U
86-30-6	N-Nitrosodiphenylamine (1)	22000	U
101-55-3	4-Bromophenyl-phenylether	22000	U
118-74-1	Hexachlorobenzene	22000	U
87-86-5	Pentachlorophenol	54000	U
85-01-8	Phenanthrene	22000	U
120-12-7	Anthracene	22000	U
86-74-8	Carbazole	22000	U
84-74-2	Di-n-Butylphthalate	22000	U
206-44-0	Fluoranthene	12000	JX
129-00-0	Pyrene	9600	J
85-68-7	Butylbenzylphthalate	22000	U
91-94-1	3,3'-Dichlorobenzidine	22000	U
56-55-3	Benzo(a)Anthracene	22000	U
218-01-9	Chrysene	22000	U
117-81-7	bis(2-Ethylhexyl)Phthalate	18000	J
117-84-0	Di-n-Octyl Phthalate	22000	U
205-99-2	Benzo(b)Fluoranthene	22000	U
207-08-9	Benzo(k)Fluoranthene	22000	U
50-32-8	Benzo(a)Pyrene	22000	U
193-39-5	Indeno(1,2,3-cd)Pyrene	22000	U
53-70-3	Dibenz(a,h)Anthracene	22000	U
191-24-2	Benzo(g,h,i)Perylene	22000	U

(1) - Cannot be separated from Diphenylamine

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

ALN85RE

Lab Name: ENVIROSYSTEMS Contract: 68-D4-0025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 1.0 (g/mL) G Lab File ID: S122942R

Level: (low/med) MED Date Received: 12/01/95

% Moisture: 54 decanted: (Y/N) N Date Extracted: 12/08/95

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/29/95

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 8.1

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN PCB	17.17	100000	J
2.	UNKNOWN PCB	18.00	85000	J
3.	UNKNOWN PCB	18.15	170000	J
4.	UNKNOWN PCB	19.10	210000	J
5.	UNKNOWN PCB	19.50	110000	J
6.	UNKNOWN PCB	20.08	200000	J
7.	UNKNOWN PCB	20.30	110000	J
8.	UNKNOWN PCB	20.48	70000	J
9.	UNKNOWN PCB	20.82	140000	J
10.	UNKNOWN PCB	20.90	130000	J
11.	UNKNOWN PCB	21.25	98000	J
12.	UNKNOWN PCB	21.33	76000	J
13.	UNKNOWN PCB	22.05	110000	J
14.	UNKNOWN PCB	22.13	260000	J
15.	UNKNOWN PCB	22.47	80000	J
16.	UNKNOWN PCB	22.57	240000	J
17.	UNKNOWN PCB	22.70	120000	J
18.	UNKNOWN PCB	23.33	180000	J
19.	UNKNOWN PCB	23.83	140000	J
20.	UNKNOWN PCB	24.23	80000	J

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN85

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942

Sample wt/vol: 30.0 (g/mL) G Lab File ID: S122942

% Moisture: 54 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 500

GPC Cleanup: (Y/N) Y pH: 8.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	1800	U
319-85-7	beta-BHC	1800	U
319-86-8	delta-BHC	1800	U
58-89-9	gamma-BHC (Lindane)	1800	U
76-44-8	Heptachlor	1800	U
309-00-2	Aldrin	1800	U
1024-57-3	Heptachlor epoxide	1800	U
959-98-8	Endosulfan I	1800	U
60-57-1	Dieldrin	3600	U
72-55-9	4,4'-DDE	3600	U
72-20-8	Endrin	3600	U
33213-65-9	Endosulfan II	3600	U
72-54-8	4,4'-DDD	3600	U
1031-07-8	Endosulfan sulfate	3600	U
50-29-3	4,4'-DDT	3600	U
72-43-5	Methoxychlor	18000	U
53494-70-5	Endrin ketone	3600	U
7421-36-3	Endrin aldehyde	3600	U
5103-71-9	alpha-Chlordane	1800	U
5103-74-2	gamma-Chlordane	1800	U
8001-35-2	Toxaphene	180000	U
12674-11-2	Aroclor-1016	36000	U
11104-28-2	Aroclor-1221	73000	U
11141-16-5	Aroclor-1232	36000	U
53469-21-9	Aroclor-1242	3100000	EC
12672-29-6	Aroclor-1248	36000	U
11097-69-1	Aroclor-1254	2100000	EC
11096-82-5	Aroclor-1260	36000	U

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

ALN85DL

Lab Name: ENVIROSYSTEMS Contract: 68D40025

Lab Code: ENVSYS Case No.: 24253 SAS No.: SDG No.: ALN74

Matrix: (soil/water) SOIL Lab Sample ID: 95122942DL

Sample wt/vol: 30.0 (g/mL) G Lab File ID:

% Moisture: 54 decanted: (Y/N) N Date Received: 12/01/95

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 12/08/95

Concentrated Extract Volume: 5000 (uL) Date Analyzed: 01/04/96

Injection Volume: 2.00 (uL) Dilution Factor: 5000

GPC Cleanup: (Y/N) Y pH: 8.1 Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	18000	U
319-85-7	beta-BHC	18000	U
319-86-8	delta-BHC	18000	U
58-89-9	gamma-BHC (Lindane)	18000	U
76-44-8	Heptachlor	18000	U
309-00-2	Aldrin	18000	U
1024-57-3	Heptachlor epoxide	18000	U
959-98-8	Endosulfan I	18000	U
60-57-1	Dieldrin	36000	U
72-55-9	4,4'-DDE	36000	U
72-20-8	Endrin	36000	U
33213-65-9	Endosulfan II	36000	U
72-54-8	4,4'-DDD	36000	U
1031-07-8	Endosulfan sulfate	36000	U
50-29-3	4,4'-DDT	36000	U
72-43-5	Methoxychlor	180000	U
53494-70-5	Endrin ketone	36000	U
7421-36-3	Endrin aldehyde	36000	U
5103-71-9	alpha-Chlordane	18000	U
5103-74-2	gamma-Chlordane	18000	U
8001-35-2	Toxaphene	1800000	U
12674-11-2	Aroclor-1016	360000	U
11104-28-2	Aroclor-1221	730000	U
11141-16-5	Aroclor-1232	360000	U
53469-21-9	Aroclor-1242	4900000	D
12672-29-6	Aroclor-1248	360000	U
11097-69-1	Aroclor-1254	2900000	D
11096-82-5	Aroclor-1260	360000	U

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1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MAEW83 B#15

Lab Name: ITS_ENVIRONMENTAL_LABORAT Contract: 68-D5-0063
Lab Code: INCHVT Case No.: 24253 SAS No.: _____ SDG No.: MAEW78
Matrix (soil/water): SOIL_ Lab Sample ID: 280248
Level (low/med): LOW__ Date Received: 12/01/95
% Solids: _41.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	9880		E	P
7440-36-0	Antimony	0.87	U	N	P
7440-38-2	Arsenic	7.9			P
7440-39-3	Barium	117		E	P
7440-41-7	Beryllium	0.48	B		P
7440-43-9	Cadmium	10.5		N	P
7440-70-2	Calcium	16200			P
7440-47-3	Chromium	237		E	P
7440-48-4	Cobalt	5.5	B	E	P
7440-50-8	Copper	598			P
7439-89-6	Iron	16800		E	P
7439-92-1	Lead	425			P
7439-95-4	Magnesium	5660		E	P
7439-96-5	Manganese	140		E	P
7439-97-6	Mercury	0.97			CV
7440-02-0	Nickel	43.4		E	P
7440-09-7	Potassium	2110		E	P
7782-49-2	Selenium	1.5	U		P
7440-22-4	Silver	2.2	B		P
7440-23-5	Sodium	11900			P
7440-28-0	Thallium	1.2	U		P
7440-62-2	Vanadium	33.5		E	P
7440-66-6	Zinc	1410			P
	Cyanide				NR

Color Before: BROWN Clarity Before: _____ Texture: MEDIUM
Color After: YELLOW Clarity After: CLEAR Artifacts: _____

Comments:

Attachment D
Material Safety Data Sheets (MSDSs)
For S/S Reagents

RFP No. 8860-45P-3006

SECTION 1.0 - REAGENT # 1 LPCII

Used for heavy contamination levels in sediment, as well it is used in moderate contamination level in sediment.

CETCO
COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY

TECHNICAL DATA SHEET

TECHNICAL DATA
LPCII

GENERAL DESCRIPTION: Custom blended agent used to stabilize, solidify , and fixate a variety of non-hazardous and hazardous wastes.

APPEARANCE: Light grey powder material

CHEMICAL FORMULA
(moisture free)

SiO_2	14.4 - 15.6
Al_2O_3	3.1 - 3.5
Fe_2O_3	1.6 - 1.9
CaO	63.2 - 73.2
MgO	5.1 - 6.0
SO_3	1.4 - 1.8
K_2O	0.4 - 0.7
Na_2O	0.8 - 1.2
$CaCO_3$	0.3 - 0.5

DENSITY: 70 - 80 lbs. per cubic foot depending on compaction.

MOISTURE: Less than 10%

PARTICLE SIZE:
2% max retained on #100 Sieve
5% max retained on #200 Sieve
10% max retained on #325 Sieve

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MATERIAL SAFETY DATA SHEET - May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

8401
8401

PRODUCT NAME: SORBOND LPC II

Section I MANUFACTURER'S INFORMATION

Manufacturer's Name & Address:

American Colloid Company
1500 West Shure Drive
One North Arlington
Arlington Heights, Illinois 60004

Emergency Telephone Number: 708-392-4600
Telephone Number for Information: 708-392-4600
Date Prepared: August 31, 1994

Section II HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Crystalline Quartz CAS# 14808-60-7	-	-	*	2-6%
Respirable Crystalline Quartz				
			NIOSH	
present (TWA)	0.1mg/m^3	0.1mg/m^3 TWA	50ug/m^3 TWA	<2%
proposed (TWA)		50ug/m^3 TWA	-	-
Calcium Silicate CAS# 65997-15-1				
- Respirable	5mg/m^3	5mg/m^3	-	-
- Total Dust	10mg/m^3	10mg/m^3	-	-
Calcium Hydroxide CAS# 1305-62-0	5mg/m^3	5mg/m^3	-	-
Nuisance Dust				
- Respirable	5mg/m^3	5mg/m^3	-	-
- Total Dust	15mg/m^3	10mg/m^3	-	-

* **WARNING:**
This product contains a small amount of crystalline silica which may cause delayed respiratory disease if inhaled over a prolonged period of time. Avoid breathing dust. Use NIOSH/MSHA approved respirator where TLV for crystalline silica may be exceeded. IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

PRODUCT IDENTIFICATION

Chemical Name: Mixture of inorganic silicates and oxides
NFPA/HMIS: Health - 1, Fire - 0, Reactivity - 0, Specific Hazard - See Section VI
Dot Class: Not Regulated

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PRODUCT NAME: SORBOND LPC II

Section III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point - Not Applicable
Vapor Pressure (mm Hg.) - Not Applicable
Vapor Density (AIR = 1) - Not Applicable
Solubility in Water - Negligible
Appearance and Odor - Tan powder, odorless

Specific Gravity (H_2O = 1) - 2.5 (Approx.)
Melting Point - Not Applicable
Evaporation Rate (Butyl Acetate = 1) - Not Applicable

Section IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used) - Not Applicable
Flammable Limits - Not Applicable LEL- - UEL- -
Extinguishing Media - Not Applicable
Special Fire Fighting Procedures - Inorganic/Non-Flammable
Unusual Fire and Explosion Hazards - Not Applicable

Section V REACTIVITY DATA

Stability Unstable - Conditions to Avoid - None Known
Stable - X

Incompatibility (Materials to Avoid) - None Known
Hazardous Decomposition or By-products - None Known

Hazardous Polymerization May Occur - Conditions to Avoid - None Known
Will Not Occur - X

Section VI HEALTH HAZARD DATA

Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No

Health Hazards (Acute and Chronic) - Inhalation of dust may cause respiratory irritation or delayed respiratory disease if dust inhaled over a prolonged period of time. Contact with skin or eyes may result in irritation or alkali burns with prolonged contact.

Carcinogenicity: NTP? No IARC Monographs? Yes OSHA Regulated? No

IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

Signs and Symptoms of Exposure - Irritation of skin, eyes, or respiratory tract.

Medical Conditions Generally Aggravated by Exposure - Individuals with pulmonary and/or respiratory disease including but not limited to asthma and bronchitis should be precluded from exposure to dust.

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8401
8401

PRODUCT NAME: SORBOND LPC II

Emergency and First Aid Procedures - Skin - Wash with mild soap and water.
- Eyes - Flush with water.
- Gross inhalation of dust - Remove to fresh air; give oxygen or artificial respiration if necessary; get medical attention.

Section VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken in Case Material is Released or Spilled - Vacuum if possible to avoid generating airborne dust. Avoid breathing dust. Wear an approved respirator. Avoid adding water, the product will become slippery when wet.

Waste Disposal Method - Follow federal, state and local regulations for solid waste.

Precautions to Be Taken in Handling and Storing - Avoid breathing dust, use NIOSH/MSHA approved respirator where TLV limits for Crystalline Silica may be exceeded.

Other Precautions - Slippery when wet.

Section VIII CONTROL MEASURES

Respiratory Protection (Specify Type) - OSHA standard 1910.134 or ANSI Z88.2-1980 specification.

Ventilation	- Local Exhaust	- As appropriate	Special	- None
	- Mechanical (General)	- As appropriate	Other	- None
Protective Gloves	- Recommended		Eye Protection	- Recommended

Other Protective Clothing or Equipment - As appropriate to avoid contact.
Work/Hygienic Practices - Use good housekeeping practices.

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, American Colloid Company cannot give any guarantees regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.

RFP No. 8860-45P-3006

SECTION 1.0 - REAGENT # 2 SM399

Used for heavy contamination levels in sediment, as well it is used in moderate contamination level in sediment.

CETCO
COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY

TECHNICAL DATA SHEET

Clarion SM-399

Dewatering and Stabilization of Waste Sludges Containing Organics

SM-399 is specifically designed for dewatering and stabilization of wastes that contain large amounts of organic compounds. The advantages of SM-399 are:

- Minimizes the water content of treated sludges by dewatering.
- SM-399 improves the BTU value of the stabilized sludge.
- Lowers the leachability of the organics in the waste.
- Minimizes the interference of organics with cementitious and hydration reactions.
- Reduces the ultimate volume and mass of waste needing disposal relative to conventional technology.
- Lowers the overall cost of treating the waste.

If the sludge treated with SM-399 is not intended for use in a fuels program or incineration, SM-399 can be used with cement or other pozzolans for solidification.

In solidification applications, it is recommended to mix SM-399 with waste prior to addition of cement or other pozzolans. This may result in dewatering of the sludge, and thereby reducing the total volume of waste to be disposed of. If premixing is not feasible, SM-399 can be added to the waste as a premix of cement or other pozzolans.

SM-399: Dewatering of Organic Sludges

In many cases, organic-containing waste is best handled by burning in a fuels program or incineration in a waste incinerator. Often, the use as a fuel is severely restricted because of the low BTU value, and the addition of SM-399 to the sludge can remove large amounts of water, resulting in a major increase in BTU value and large reduction in volume of waste. This point is illustrated by Table 1, in which a number of organic sludges were treated with SM-399 technology. In all cases, better that 90% reduction in water content were reached and in most cases at very low dosage. A side benefit is that the resulting sludge is much more amenable to filter pressing; and, with the volume reduced, if cementitious materials are added to take the waste to a landfill, the overall volume of waste is radically reduced.

Type of Emulsions	Composition	SM-399 Dose Requirement*	% of Water Recovered
Refinery API Sludge #1	60% organic, 40% water	2.5%	98%
Refinery API Sludge #2	80% organic, 20% water	2.5%	95%
Hazardous Waste Lagoon	1/3 solids, 1/3 organic, 1/3 water	2.5%	98%
Aluminum Rolling Mill Emulsion	10% solids,40% organic, 50% water	7.0%	90%

*Weight % of Total Sludge

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SM-399: Utilized to Stabilize Organic Sludges for Land Disposal

The solidification and fixation of hazardous waste containing heavy metals has been conducted successfully for many years. They generally do not cause large increases in volume relative to the original waste volumes and are relatively economical.

However, the solidification and fixation of waste containing substantial amounts of organics is much less straightforward. When substantial amounts of organics are present in a waste, they interfere with the cementitious reactions. These cementitious reactions are responsible for imparting the physical strength necessary for land filling. The organic interference requires that much larger amounts of cement be added to the waste to reach an acceptable physical strength. This causes an inordinate increase in volume and cost per ton of waste solidified. In addition, the organic constituents are only physically trapped in the matrix of the cement and not truly fixed. In at least one case, waste containing substantial amounts of oil (20-30%) has failed after land burial and resulted in the migration of pure oil into the surrounding soils and groundwaters.

In the new process utilizing SM-399, surface modified clays are added to the organic containing waste along with conventional inorganic solidification agents. The surface modified clays perform the functions of removing the interference between organics and the cementitous materials, thus substantially lowering the leachability of the organics. In the case of the organic interference, the amount of cement required to reach a given physical strength can be reduced from 2 to 3 tons per ton of waste to 20 to 30% by weight with a concomitant reduction in total mass and volume of waste to be disposed of in a landfill. This can have a drastic effect on the cost of materials, mixing, transportation and ultimate disposal. Secondly, the surface modified clays sorb the organic contaminants, thus lowering their solubility.

Using SM-399, the normal reduction in leachability found in a Toxicity Characteristic Leaching Procedure is 1 to 3 orders of magnitude. This process yields fixed waste containing organics that have high physical strength, low volume increases, and low leachability at a reasonable cost.

SM-399: Recommend Lab Scale Testing Procedures

For Dewatering:

1) Mix 5 to 10% (5% is a good starting point) by weight of SM-399 with the waste. The mixing may be conducted with a Hobart type mixer and extruded with a commercial lab size meat grinder. This will match the type of mixing of a full scale pug mill and extruder combination.

For Stabilization (continue):

2) Mix in from 10 to 50% by weight of cement or other pozzolanic material in the Hobart type mixer.

3) Place sample(s) in appropriate container(s) for physical testing at intervals of 24 hours, 48 hours and 1 week.

4) Samples should also be ground and tested for leachability after proper curing time in the appropriate standard leaching procedures.

5) Increase or decrease SM-399 by weight with waste to obtain desired fixation.

SM-399 Specifications

Particle Size - 70 x 170 mesh (U.S. Standard Sieve)
Bulk Density - 52 lb./cu. ft. (dry settled)
Packaging - Standard packaging for SM-399 is in 2,000 lb. Super Sacks. Packaging in 75 lb. Fiber Drums and Bulk Transport is also available.

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MATERIAL SAFETY DATA SHEET - May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements. 17105 17103

PRODUCT NAME: SM-399

Section I MANUFACTURER'S INFORMATION

Manufacturer's Name & Address:

American Colloid Company
1500 West Shure Drive
One North Arlington
Arlington Heights, Illinois 60004

Emergency Telephone Number: 708-392-4600
Telephone Number for Information: 708-392-4600
Date Prepared: July 15, 1994

Section II HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Crystalline Quartz CAS# 14808-60-7	-	-	*	<5%
Respirable Crystalline Quartz			NIOSH	<1.5%
present (TWA)	0.1mg/m^3	0.1mg/m^3 TWA	50ug/m^3 TWA	
proposed (TWA)		50ug/m^3 TWA	-	-
Nuisance Dust				
- Respirable	5mg/m^3	5mg/m^3	-	-
- Total Dust	15mg/m^3	10mg/m^3	-	-

* **WARNING:**
This clay product contains a small amount of crystalline silica which may cause delayed respiratory disease if inhaled over a prolonged period of time. Avoid breathing dust. Use NIOSH/MSHA approved respirator where TLV for crystalline silica may be exceeded. IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

PRODUCT IDENTIFICATION

Chemical Family: Quaternary Ammonium Compounds/Clay
Chemical Name: Surface Modified Clay
FORMULA: Complex of Montmorillonite clay & quaternary ammonium compound.

NFPA/HMIS: Health - 1, Fire - 0, Reactivity - 0, Specific Hazard - See Section VI

DOT Class: Not Regulated

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PRODUCT NAME: SM-399

Section III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	- Not Applicable	Specific Gravity (H_2O = 1)	- Approx 1.7
Vapor Pressure (mm Hg.)	- Not Applicable	Melting Point	- Not Applicable
Vapor Density (AIR = 1)	- Not Applicable	Evaporation Rate (Butyl Acetate = 1)	- Not Applicable
Solubility in Water	- Negligible		
Appearance and Odor	- White or Gray with negligible odor.		

Section IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used) - Not Applicable
Flammable Limits - Not Applicable LEL-0.07 oz./cu. ft. UEL- -
Extinguishing Media - For dust fire, use CO2, dry chemical, water fog
Special Fire Fighting Procedures - None known
Unusual Fire and Explosion Hazards - Does not typically present a fire or dust explosion hazard; however Dust concentrations of 0.07 oz./cu. ft. may ignite at 510 deg. Celsius or when exposed to ignition source.

Section V REACTIVITY DATA

Stability Unstable - Conditions to Avoid - None Known
Stable - X

Incompatibility (Materials to Avoid) - None known.
Hazardous Decomposition or By-products - Possible generation of CO, CO2, NOx, HCL and unknowns if burned.

Hazardous Polymerization May Occur - Conditions to Avoid - None known
Will Not Occur - X

Section VI HEALTH HAZARD DATA

Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No

Health Hazards (Acute and Chronic) - May cause delayed respiratory disease if dust inhaled over a prolonged period of time.

Carcinogenicity: NTP? No IARC Monographs? Yes OSHA Regulated? No

IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

Signs and Symptoms of Exposure - Excessive inhalation of dust may result in shortness of breath and reduced pulmonary function. Continued exposure to mucous membranes may cause irritation. Eye contact can cause irritation.

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PRODUCT NAME: SM-399

Medical Conditions Generally Aggravated by Exposure - Individuals with pulmonary and/or respiratory disease including but not limited to asthma and bronchitis should be precluded from exposure to dust.

Emergency and First Aid Procedures - Skin - Wash with soap & water for good hygiene.
- Eyes - Flush with water for at least 15 minutes get medical attention if needed.
- Gross inhalation of dust - Remove to fresh air; give oxygen or artificial respiration if necessary; get medical attention.
- Ingestion - Drink plenty of water, do not induce vomiting, get medical attention if needed.

Section VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken in Case Material is Released or Spilled - Vacuum if possible to avoid generating airborne dust. Avoid breathing dust. Wear an approved respirator. Avoid adding water, the product will become slippery when wet.

Waste Disposal Method - Follow federal, state and local regulations for solid waste.

Precautions to Be Taken in Handling and Storing - Use precautions for flammable dust including avoidance of dust generation and use of adequate dust collection systems. Use properly grounded electrical equipment to prevent static discharge. Keep away from open flame, heat or other ignition sources.
Avoid breathing dust, use NIOSH/MSHA approved respirator where TLV limits for Crystalline Silica may be exceeded.

Other Precautions - Slippery when wet.

Section VIII CONTROL MEASURES

Respiratory Protection (Specify Type) - OSHA standard 1910.134 or ANSI Z88.2-1980 specification.

Ventilation	- Local Exhaust	- As appropriate	Special	- None
	- Mechanical (General)	- As appropriate	Other	- None
Protective Gloves	- Recommended		Eye Protection	- Recommended

Other Protective Clothing or Equipment - None
Work/Hygienic Practices - *Use good housekeeping practices.*

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, American Colloid Company cannot give any guarantees regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.

RFP No. 8860-45P-3006

SECTION 1.0 - REAGENT # 3 P1

Used for heavy contamination levels in sediment.

WEI REAGENT 3 P1

CHEMICAL CONTENT ANALYSIS

ACETONE	P.P.M.	6.6	REFERENCE...	30><200
B-45/ADENINE	P.P.M.	4.8	REFERENCE...	
CHOLINE	P.P.M.	20.6	REFERENCE...	
TRYGLYCERIDE	P.P.M.	24.7	REFERENCE...	<165
ASCORBIC ACID	P.P.M.	9.5	REFERENCE...	25><50
PANTOTHENIC B-5 ACID	P.P.M.	12.4	REFERENCE...	
B-6/PYRIDOXIN/PHOSP.	P.P.M.	9.9	REFERENCE...	
B-8/BIOTINE	P.P.M.	14.1	REFERENCE...	
LINOLENIC ACID	P.P.M.	16.1	REFERENCE...	
LINOLEIC ACID	P.P.M.	0.8	REFERENCE...	
OLEIC	P.P.M.	2.5	REFERENCE...	
ARACHIDONIC ACID	P.P.M.	1.4	REFERENCE...	
CHOLESTEROL	P.P.M.	6.3	REFERENCE...	150><280
B-2/RIBOFLANIN	P.P.M.	5.1	REFERENCE...	
TRI-IODO-THYROXIN	P.P.M.	7.0	REFERENCE...	
HEMOGLOBIN	P.P.M.	8.0	REFERENCE...	12><18
LACTIC ACID	P.P.M.	2.3	REFERENCE...	4><6
B-12/CYANO-COBALT-AMINE	P.P.M.	3.1	REFERENCE...	TRACES
TRYPTOPHANE-AROM	P.P.M.	24.0	REFERENCE...	
TYROSINE-AROM	P.P.M.	15.1	REFERENCE...	
SERINE-OH	P.P.M.	2.7	REFERENCE...	
HISTIDINE-BASI	P.P.M.	21.2	REFERENCE...	
VALINE-NH2	P.P.M.	20.3	REFERENCE...	
THREONINE-OH	P.P.M.	2.1	REFERENCE...	
LEUCINE...ISOLEUCINE-CH3	P.P.M.	1.5	REFERENCE...	
ARGININE-BASI	P.P.M.	26.9	REFERENCE...	
PROLINE	P.P.M.	3.1	REFERENCE...	
HYDROXY-PROLINE	P.P.M.	3.3	REFERENCE...	
PHENYL-ALANINE-AROM	P.P.M.	0.6	REFERENCE...	
ALANINE-CH3	P.P.M.	4.9	REFERENCE...	
C	P.P.M.	0.50	REFERENCE...	
IODE	TRACE	***	REFERENCE...	3><7
N	P.P.M.	13.90	REFERENCE...	3><19
F	P.P.M.	2.90	REFERENCE...	0.6><
HG	TRACE	***	REFERENCE...	TRACE
AL	P.P.M.	0.95	REFERENCE...	0.5><
SI	TRACE	***	REFERENCE...	0.5><
P	P.P.M.	1.45	REFERENCE...	9><11
S	P.P.M.	0.78	REFERENCE...	
CR	TRACE	***	REFERENCE...	<5
MN	TRACE	***	REFERENCE...	
FE	TRACE	***	REFERENCE...	150><
CO	TRACE	***	REFERENCE...	TRACE
CU	TRACE	***	REFERENCE...	100>
BR	TRACE	***	REFERENCE...	

RFP No. 8860-45P-3006

SECTION 1.0 - REAGENT # 4 P2

Used for heavy contamination levels in sediment.

WEI REAGENT 4 P2

Description

WEI P2 is a unique patent applied for water-based alkylalkoxysilane containing forty percent (40%) active alkoxysilane emulsified in water.

Recommended Use

WEI P2 is designed to deposit a reactive hydrophobic silane treatment to inorganic substrates. Alkoxysilanes react readily with inorganic materials like glass, mica, talc, or wollastonite to form a durable treatment. Due to the highly organic nature of alkyl silane treatment, they improve the compatibility of inorganic materials in organic resins, both thermoplastic and thermoset.

WEI P2 is designed for easy dilution in water. WEI P2 is mixable in all proportions with water and also with may aqueous solutions of chemicals such as polymer latices or even aqueous solution of prehydrolyzed organo-functional silanes.

WEI P2 can be used to impart a more hydrophobic nature to the resin/inorganic modifier interface.

WEI P2 has been shown to soften fiberglass fabric to provide a more pliable cloth for hand lay-up applications.

WEI P2 is an unique product which provides a much needed solution to an industry problem. it delivers silane value in a low toxicity, non-flammable, water-based system.

WEI P2 Features	WEI P2 Benefits
Increases hydrophobicity	Reduces degradation of composite strength over time
Improves compatibility in resin systems	Reduces viscosity at comparable loadings. Allows potential of increased loading levels.

Non-flammable	Increases safety of the work environment
Water-based	No toxic organic solvents to contend with. Readily mixes with aqueous systems
Compatible with organofunctional silanes	Can be mixes with other aqueous solutions
Alkoxy silane	No harmful and corrosive HCI by-products
Long term shelf stability	Longer "pot life"

WEI P2 can be used to treat hydroxyl-containing inorganic substrates including:

Perlite	Clay
Fiberglass	Mica
Silica	ATH]
Wollastonite	

How to Use

WEI P2 is by design a water dilutable product. Mixing with aqueous systems can be easily accomplished by simple blending with minimal shear. High shear mixing should be avoided to minimize foaming and reduction of emulsion stability.

Inorganic substrates can be treated by many different techniques. Please contact our Applications Development Specialist to determine what technique may be best suited to your application.

Typical Properties

Appearance:	White, milky liquid
Active Alkyl Alkoxysilane Content:	40 weight %
Solvent:	Water
Specific Gravity @ 25°C	.95
Flash Point, T.C.C.	> 200°F
Shelf Life Stability	6 month (minimum)

Values shown are not intended for specification preparation.

Handling Precautions

Avoid contact with eyes, skin, and clothing. Do not take internally. Use with adequate ventilation and avoid breathing vapor. If accidentally splashed into the eye, WEI P2 could produce mile irritation. Flush with water immediately and get medical attention. Contact with skin may result in transient erythema, but harmful amounts of the material are unlikely to be absorbed.

KEEP FROM FREEZING. Containers must be stored above 32°F (0°C). Containers should be tightly closed and also should not be stored at temperatures above 120°F (40°C). Empty containers can be rinsed with soap and water and then disposed of as regular refuse.

Availability

WEI P2 is available in sample quantities for customer evaluation.

INDUSTRIAL WASTE TREATMENTS, INC.
8728 West Greenfield Avenue • West Allis, Wisconsin 53214
414-774-9690 • FAX 414-774-1560

DATA SHEET

INDUSTRIAL WASTE TREATMENTS, Inc.
8728 W. Greenfield Avenue
West Allis, WI 53214
(414) 774-0910

PRODUCT: HWT-27
DATE OF PREPARATION: August 8, 1995

SECTION 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: HWT-27 (CAS #65997-15-1)

TRADE NAME & SYNONYMS: HWT-27

SECTION 2 - CHEMICAL DATA

Chemical family: Calcium Salts

Formula: HWT-27 is a sintered material produced by heating to a high temperature (greater than 1200 degrees celsius) a mixture of substances such as limestone and shale from the earth's crust. The substances manufactured are essentially hydraulic calcium silicates contained in a crystalline mass not separable into the individual components.

Substances similar to the following are known to be present in HWT-27:

$3CaO.SiO_2$	(CAS # 12168-85-3)
$2CaO.SiO_2$	(CAS # 10034-77-2)
$3CaO.Al_2O_3$	(CAS # 12042-78-3)
$4CaO.Al_2O_3Fe_2O_3$	(CAS # 12068-35-8)
$CaSO_4.XH_2O$	(CAS # 13397-24-5)

Small amounts of CaO, MgO, K_2SO_4, Na_2SO_4 may also be present.

Physical Immobilization
and Chemical Alteration

SECTION 3 - HAZARDOUS INGREDIENTS

Ingredients: HWT-27 is listed as a nuisance dust. HWT-27 is NOT listed by NTP, IARC, or OSHA as carcinogens. However, since HWT-27 is manufactured from raw materials mined from the earth (limestone, marl, sand, shale, clay, etc.), and process heat is provided by burning fossil fuels, trace, but detectable amounts of naturally occurring, and possibly harmful elements may be found during chemical analysis. Under ASTM standards, HWT-27 may contain .75 percent insoluble residue. A fraction of these residues may be free crystalline silica.

SECTION 4 - PHYSICAL DATA

BOILING POINT, DEG F:	Not applicable, HWT-27 is a powdered solid
VAPOR PRESSURE:	Not applicable, HWT-27 is a powdered solid
VAPOR DENSITY:	Not applicable, HWT-27 is a powdered solid
SOLUBILITY (WT IN WATER):	Slight (0.1-1.0%)
SPECIFIC GRAVITY IN WATER:	(H_2O=1) 3.15)
EVAPORATION RATE	Not applicable, HWT-27 is a powdered solid
APPEARANCE/ODOR:	Gray or white powder; no odor
MELTING POINT, DEF F:	Not applicable

SECTION 5 - FIRE & EXPLOSION HAZARD DATA

FLASH POINT, DEG F:	HWT-27 is noncombustible and not explosive.
FLAMMABLE LIMITS IN AIR, %	Not applicable
EXTINGUISHING MEDIA:	Not applicable
SPECIAL FIRE FIGHTING PROCEDURES:	Not applicable
UNUSUAL FIRE AND EXPLOSION HAZARDS:	None
LOWER EXPLOSIVE LIMIT:	Not applicable
UPPER EXPLOSIVE LIMIT:	Not applicable

SECTION 6 - HEALTH HAZARD INFORMATION

ACGIH Threshold Limit Value (1988-89):	Total dust containing no asbestos and less than 1% silica - 10 mg/m^3
OSHA PEL (Transitional):	Total dust - 50 million particles/$ft.^3$
OSHA PEL (Final):	Total dust - 10 mg/m^3 Respirable Dust - 5 mg/m^3

POSSIBLE EFFECTS OF EXPOSURE:

ACUTE: HWT-27, especially as an ingredient in slurries, can dry the skin and cause caustic burns. Direct contact with the eyes can cause irritation. Inhalation can irritate the upper respiratory system.

CHRONIC: HWT-27 can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis. (HWT-27 may contain trace (less than 0.05%) amounts of chromium salts or compounds, including hexavalent chromium or other metals found to be hazardous or toxic in some chemical forms. These metals are mostly present as trace substitutions within the principle minerals.)

Emergency and First Aid Procedures: Irrigate eyes immediately and repeatedly with water and get prompt medical attention. Wash exposed skin areas with soap and water. Apply sterile dressings. If ingested, consult a physician immediately. Drink water.

SECTION 7 - REACTIVITY DATA

STABILITY: Product is stable. Keep dry until used.

INCOMPATIBILITY: Aluminum powder and other alkali and alkaline earth elements will react in wet HWT-27, liberating hydrogen gas.

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: Will not occur

SECTION 8 - SPILL PROCEDURES

Steps to be taken in case material is spilled: Use dry cleanup methods that do not disperse the dust into the air. Avoid breathing the dust. Emergency procedures are not required.

Disposal Method: Small amounts of material can be disposed of as common waste or returned to the container or later use if it is not contaminated. Large volumes may require special handling.

SECTION 9 - SPECIAL PROTECTION INFORMATION

Respiratory Protection: In dusty environments, the use of a MSHA/NIOSH-approved respirator is recommended.

Ventilation: Local exhaust can be used to control airborne dust levels

Eye Protection: Use tight-fitting goggles in dusty environments.

Skin Protection: Use barrier creams, impervious, abrasion, and alkali-resistant gloves, boots and protective clothing to protect the skin from prolonged contact with wet cement in plastic concrete, mortar or slurries. Immediately after working with cement or cement-containing materials, workers should shower with soap and water. Precautions must be taken. Cement burns with little warning-little heat is sensed.

INFORMATION PRESENTED HEREIN HAS BEEN COMPLIED FROM SOURCES CONSIDERED TO BE DEPENDABLE AND IS ACCURATE AND RELIABLE TO THE BEST OF OUR KNOWLEDGE AND BELIEF BUT IS NOT GUARANTEED TO BE SO. NOTHING HEREIN IS TO BE CONSTRUED AS RECOMMENDING ANY PRACTICE OR ANY PRODUCT IN VIOLATION OF ANY PATENT OR IN VIOLATION OF ANY LAW OR REGULATION. IT IS THE USER'S RESPONSIBILITY TO DETERMINE FOR HIMSELF THE SUITABILITY OF ANY MATERIAL FOR A SPECIFIC PURPOSE AND TO ADOPT SUCH SAFETY PRECAUTIONS AS MAY BE NECESSARY. WE MAKE NO WARRANTY AS TO THE RESULTS TO BE OBTAINED IN USING ANY MATERIAL AND, SINCE CONDITIONS OF USE ARE NOT UNDER OUR CONTROL, WE MUST NECESSARILY DISCLAIM ALL LIABILITY WITH RESPECT TO THE USE OF ANY MATERIAL SUPPLIED BY US.

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COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY

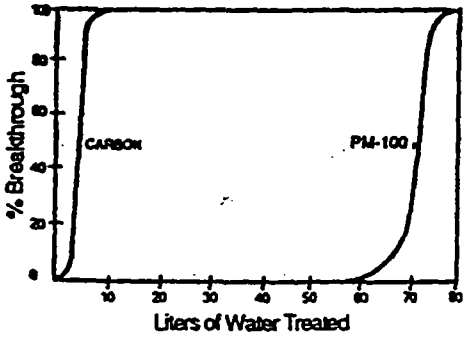
TECHNICAL DATA SHEET

Clarion PM-100

The Filtration Media Designed to Remove Oil and Sparingly Soluble Organics from Water

PM-100 is a proprietary granular filtration material made for column operation which reliably absorbs oil and similar organics from water. By removing oil and grease from water, the effectiveness of many other treatment products and equipment is enhanced. The standard product is a mixture of 30% active sorbent and 70% anthracite filter media that allows for the maximum utilization of the large sorption capacity of the PM-100 without excessive pressure build up in the column.

Figure 1 contains the breakthrough curves for a waste water containing 50 ppm oil and grease when treated with activated carbon and PM-100. It is obvious that PM-100 is far superior to carbon for treating this water.



The following specific applications are examples of where PM-100 has been used:

- Clean up of gasoline and diesel contaminated groundwater.
- Clean up of produced water in crude oil production wells.
- Removal of emulsified organics from steam condensates.
- Removal of creosote and pentachlorophenols from wood treatment plant effluent.
- Clean-up of oily lagoons at "Super Fund" sites.
- Removal of oil and grease emulsions from manufacturing process water streams.
- Removal of organic pigments from pigment production waste streams.

PM-100 Application Mode

Stand Alone Mode: PM-100 is the best technology available for treatment of oil contaminated steam condensate when recycling back to a boiler is preferred to save make-up water cost and BTU value.

Pre-Treatment Mode: PM-100 is excellent for pre-treatment of water to protect other unit processes, such as activated carbon, reverse osmosis and desalination systems, from oil and grease extractables.

Post-Treatment Mode: PM-100 is extremely efficient as a polishing agent downstream of equipment such as dissolved or induced air flotation units, API oil separators, corrugated plate separators, granular media oil coalescers, ultrafiltration, air strippers and System AC

Operating Cost of a PM-Series System

The cost of operating a PM-Series System can be determined by measuring the oil and grease level of the water to be treated. The oil and grease concentration in ppm multiplied by 2 will yield the approximate cost of operating the system in cents per 1,000 gallons (¢/1,000 gal.). In most cases, we recommend laboratory column test to determine actual cost for a given waste water. We have found that traditional batch equilibration measurements are not a good indicator for the PM-Series technology.

Advantages and Benefits

- Economical to use - PM-100's large capacity (up to 60% its weight) for oil and other high molecular weight organics makes it the cost effective oil-removal alternative relative to other quality filtration materials.
- Dependable - PM-100 can accommodate increases in flow rates and contaminant concentration levels caused by accidental spills and plant upsets. When oil is not present, PM-100 is not being expended, thus providing a "fail-safe" method to prevent oil contamination.
- Simple to apply - PM-100 is employed in conventional filtration contactors.
- Non-hazardous - Fresh PM-100 is non-hazardous; therefore, the waste classification of the spent material is determined by the constituents removed.

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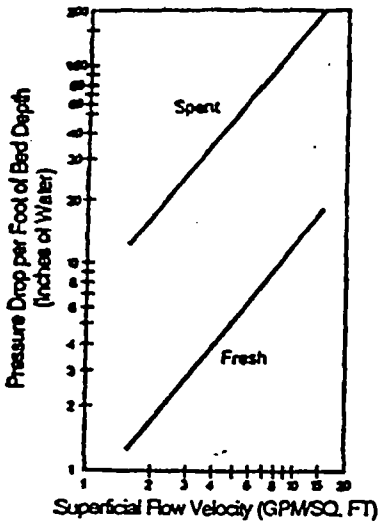
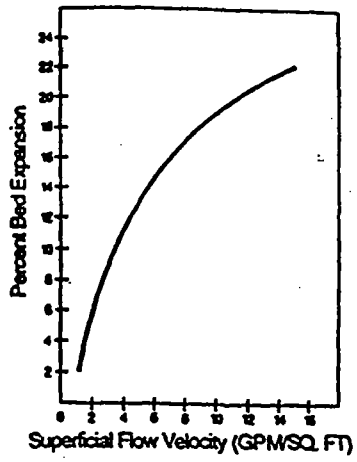


PM-100 Use in Column Filter Systems

PM-100 is available in 16 x 40 mesh size (U.S. Standard Series Sieve Sizes) and is employed in pressurized contactor vessels as a single stage unit process for insoluble oil removal. It is not generally recommended for application in gravity filters.

Where the PM-100 bed has an extended on-stream life, suspended solids removal through chemical clarification and settling may be recommended. The requirement is commonly associated with conditions of oil removal in lower concentration (i.e., 0-25 ppm) and high flow rates, or unit process protection from infrequent oil intrusion.



Activated carbon adsorbers are normally suitable for use as PM-100 absorption contactors. The pressure drop for fresh PM-100 is shown in Figure 2. Because the active ingredient swells on application as it absorbs insoluble oil, the pressure drop at any superficial flow velocity will increase (by approximately 5 times at maximum media saturation) in a solids free stream. If the maximum oil capacity on PM-100 reaches 50-60% by weight the associated operating pressure drop will frequently determine the need for PM-100 replacement.

A backwash curve is also shown for fresh PM-100 (Figure 3). The physical characteristics of spent PM-100, however, makes backwashing of spent media with greater than 30-50% oil retention impractical in most instances.

Spent PM-100 Disposal

PM-100 is commonly disposed of at either an appropriate landfill facility, or through incineration. Relative to landfill disposal, the composition of fresh PM-100 is non-hazardous; therefore, the waste classification of the spent material is determined by the constituents removed. Spent PM-100's fuel value of approximately 15,000 BTU/lb. compares favorably with many grades of bituminous coal.

PM-100 System Design Criteria

The design criteria of PM-100 systems is similar to a typical granular activated carbon system. The following design parameters are recommended:

Granular oil absorbent PM-100
Bed depth (recommended) ..... 3 feet (min.)
Hydraulic loading (recommended) .... 3-4 gpm/sq. ft. (max.)
Contact time (recommended) ..... 2-5 minutes
Bed expansion (if required) 20%

Mechanical features for PM-100 filter systems should include:

- Suitable underdrain to assure uniform water throughout the PM-100 bed.
- Where required, pack gravel around underdrains for applications involving infrequent PM-100 replacement and high oil loading.
- Adequate free board to allow for proper bed expansion if backwash capability is necessary. (Note: Bed expansion caused by oil retention in the PM-100 is negligible.)
- Access for mechanical or vacuum removal of spent PM-100.

Specifications:

Particle Size (U.S. Standard Sieve Sized) -16 x 40 mesh
Moisture - 8%
Water Retention, Drained -10%
Density-Shipped 52-54 lb./cu. ft. Backflushed, settled in column 61 lb./cu. ft.
Packaging - Standard Packaging for PM-100 is in 2,000 lb. Super Sacks. Packaging in 75 lb. Fiber Drums and Bulk Transport is also available.

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COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY

TECHNICAL DATA SHEET

Clarion PM-100

Calculation of Heat Combustion of Fresh PM-100*

High BTU Value Calculations:

Material	Weight %		BTU/lb.		PM-100 BTU/lb.
Clay	18.2%	@	Inert	=	0
Additives	9.4%	@	18,052	=	1,697
Anthracite	64.4%	@	12,900	=	8,308
Water	8.0%	@	Inert	=	0
	High BTU Value (BTU/lb.)			=	10,005

Low BTU Value Calculations:

High BTU Value	=	10,005
Less: Hydrogen in Compound	=	(116)
Less: Free Moisture	=	(80)
Low BTU Value (BTU/lb.	=	9,809

*Assuming 30% absorption by weight of oil and grease per pound of PM-100, and oil and grease of 18,000 BTU/lb, the High BTU Value of "spent" PM-100 calculates to 15,405 BTU/lb and the Low BTU Value of "spent" PM-100 calculates to 15,209 BTU/lb.

PM-100 is specifically designed for removal of higher molecular weight, less water soluble organic compounds, which often occur as emulsions. The advantages of PM-100 are:

- Extends the life and absorbency of activated carbon by removal of larger molecular organics which blind the pore structure of activated carbon.
- Improves the effectiveness of other treatment products and equipment by removing oil and grease from the water.
- Operates in the stand alone mode for treatment of oil contaminated water or steam condensate.
- Operates in the pre-treatment mode to protect other unit processes (activated carbon, reverse osmosis units, etc.) from oil and grease extractables.
- Operates in the post-treatment mode as a polishing agent downstream of dissolved air flotation units, API oil separators, corrugated plate separators, System AC, etc.
- Lowers overall operating cost relative to utilizing activated carbon alone.
- Smooths out upsets that result from large intermittent oil incursions.
- Removes dissolved, mechanically emulsified, and free oil from waste water.

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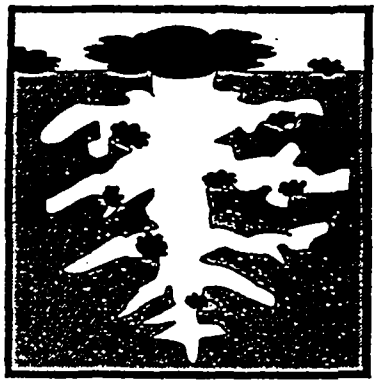
Clarion PM-100

Sorption Technology of PM-100

The PM-100 technology is a unique approach to sorption of organics from water. However, it differs from activated carbon in the mechanism of sorption. In Figure 1, activated carbon adsorbs organics through a surface area related mechanism. PM-100 operates through a partitioning phenomenon that has little relationship to surface area. Higher molecular weight organics, such as humic substances, tend to foul activated carbon by blinding the pore structure of carbon and lowering the available surface area for adsorption, resulting in loss of capacity.

Figure 1

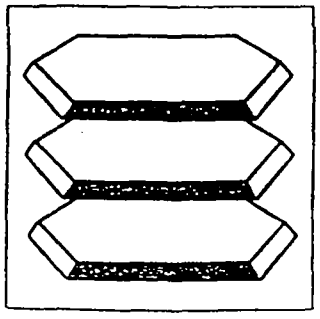
Cross Section of Activated Carbon



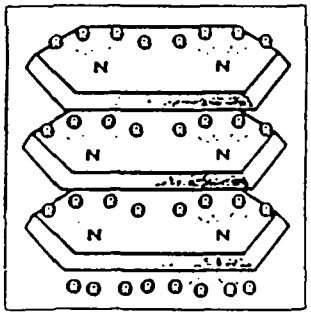
Blinding of Activated Carbon Pore Spaces

As illustrated in Figure 2, the surfaces of the clay platelets in PM-100 are chemically modified, rendering the clay completely hydrophobic. The modified platelets only have an affinity for organics. As the higher molecular weight organics are absorbed, the platelets spread further apart. This phenomenon gives PM-100 a very high absorption capacity relative to activated carbon. PM-100 can also be regenerated with a caustic backwash thereby extending bedlife.

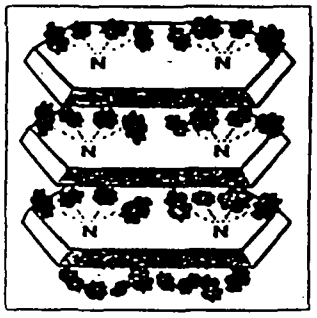
Figure 2



Individual Stack of Expandable Clay Crystals



Clay Surface Modified with Quaternary Amine



Saturation of Organoclay with Contaminants

CET

COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY

TECHNICAL DATA SHEET

Clarion PM-100

Protection for Activated Carbon Water Treatment Systems

A technical problem in the application of activated carbon water treatment systems is the presence of oil and grease extractable organics. These organics tend to be higher molecular weight, less water-soluble compounds occurring many times as emulsions. Such organic contaminants tend to foul activated carbon by blinding the pore structure of the carbon and lowering the available surface area for adsorption, resulting in loss of capacity.

The PM-100 technology is a unique approach to sorption of organics from water. However, it differs from activated charcoal in the mechanism of sorption. Activated carbon adsorbs organics through a surface area related mechanism. PM-100 operates through a partitioning phenomena that has little relationship to surface area. The effectiveness of PM 100 to absorb organics is directly related to the water solubility of the organic. The partition coefficient for several organics on PM-100 versus the water solubility of the organics is presented in Figure 1.

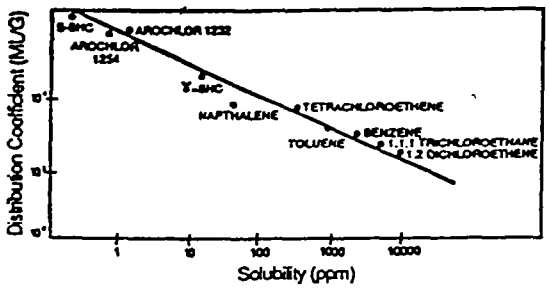


Figure 1.

As can be seen, there is a linear relationship between the partition coefficient and water solubility of the organic. In practical terms this means that any organic that would be extracted in a traditional oil and grease determination will be absorbed strongly by PM-100, but organics that are highly water soluble or that are quite volatile will absorb poorly onto PM-100. The PM-100 will efficiently remove from water, free, mechanical emulsified, and dissolved organics which are sparingly water soluble.

The PM-100 product is specifically designed to solve the blinding problem in activated carbon systems associated with oil and grease. PM-100 will absorb up to 60% of its weight in oil and grease. In contrast, carbon, will adsorb only 2 to 3% of its own weight. In addition, PM-100 will absorb lightly emulsified oil and grease from solution. When PM-100 is utilized as a pre-treatment to carbon, it removes the oil and grease extractables and allows carbon to remove the water soluble organics more efficiently, and with higher capacity. This effect can be dramatic. The lifetime of carbon can be extended when combined with PM-100 by factors of 2 to 10 times, depending upon oil and grease levels in the waste stream. The PM-100, because of its large capacity, must be changed only a fraction of the times that the carbon is changed. In general, any time the oil and grease extractables are 1 ppm or greater, PM-100 will be of an economic advantage in combination with carbon. The overall cost of combining PM-100 with carbon will be lower than carbon alone. In many cases, this cost reduction factor is 1/2 to 1/4 the cost of carbon alone, depending upon the oil and grease level in the waste.

Example of PM-100 Efficacy

The breakthrough curves for the application of PM-100 to a waste water containing 200 ppm oil and grease and 200 ppm toluene is presented in Figure 2.

The first curve is the breakthrough obtained with activated carbon alone. It is obvious that carbon is very in efficient for removing the mix of contaminants.

The second curve is the same waste treated with PM-100 alone. The PM-100 performs substantially better than the carbon column. However, when PM-100 is utilized to protect the carbon from the oil, the resulting break through curve is superior in performance as compared to either technology alone.

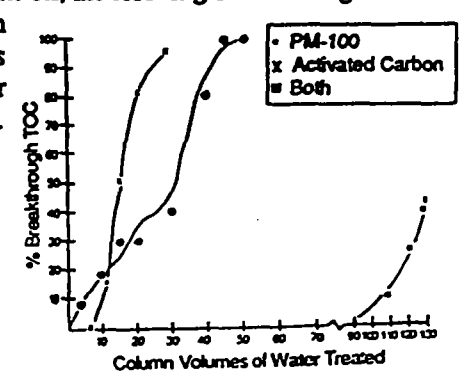


Figure 2

1500 W. Shure Drive • Arlington Heights, Illinois 60004-7803 • (708) 392-5300 • Telex [illegible] 4330321 • FAX (708) 506-6150

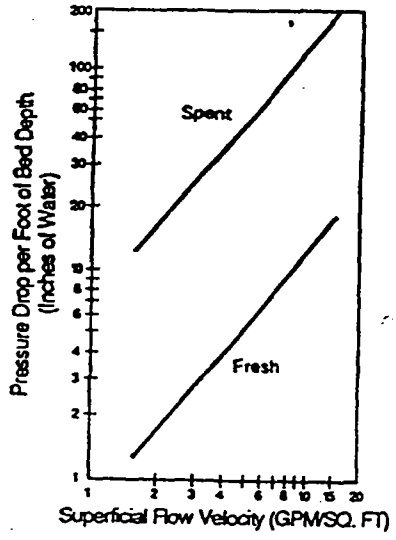
A wholly owned subsidiary of American Colloid Company

The information and data contained herein are believed to be accurate and reliable. CETCO makes no warranty of any kind and accepts no responsibility for the results obtained through application of this information.

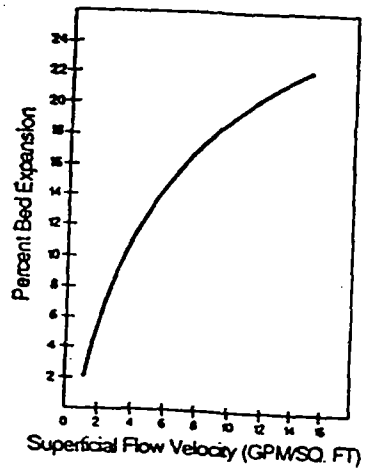
PM-100 System Applications Design Criteria

The criteria for PM-100 systems is similar to a typical granular activated carbon system. The following parameters are recommended:

Granular Oil Absorbent PM-100
Bed Depth (recommended) ..... 3 ft. (minimum)
Hydraulic Loading (recommended) ..... 3-4 gpm/sq. ft. (maximum)
Contact Time (recommended) ..... 2-5 minutes
Bed Expansion (If required) 20%



PM-100 is recommended for column downflow operation in pressure vessels. Activated carbon adsorbers are normally suitable for use as PM-100 absorption contactors. The pressure drop for fresh PM-100 is shown in Figure 3. Because the active ingredient swells on application as it absorbs insoluble oil, the pressure drop at any superficial flow velocity will increase (by approximately 5 times at maximum media saturation) in a solids free stream. If the maximum oil capacity on PM-100 reaches 50 to 60% by weight, the associated operating pressure drop will frequently determine the need for PM-100 replacement. Air release valves are recommended on all vessels in order to eliminate entrapped air and insure proper contact time. If the waste stream contains more than 1 ppm of suspended solids, CETCO strongly recommends the use of bag filters to remove such solids in order to protect the PM-100 from blinding. Detail loading instructions are available upon request.



A backwash curve is also shown for fresh PM-100 (Figure 4.) The physical characteristics of spent PM-100, however, makes backwashing of spent media with greater than 30 to 50% retained oil impractical in most instances. It is important to avoid the entrapment of air during backwash since air can physically raise the PM-100 bed resulting in loss of media and potential damage of under drain systems. Vessels should not be drained prior to backwash. Detail backwash instructions are available upon request.

Attachment E
Worksheets For S/S Mixing And Curing

Attachment E
Worksheets For S/S Mixing And Curing
MARCOR

NEW BEDFORD HARBOR SUPERFUND SITE
BENCH SCALE TREATABILITY STUDY
HOT SPOT SEDIMENTS

VENDOR/SUPPLIER: HARCON ENVIRONMENTAL (NOV. 30, 1995)

REAGENT(S): HWT-27

	SEDIMENT	HWT-27*
BATCH #1	2,500 g	12.5% (312.5 g)
BATCH #2	2,500 g	17.5% (437.5 g)
BATCH #3	1,500 g	25% (375 g)

* HWT-27 WAS ADDED AS A SLURRY. SLURRY MAKE-UP IS PROVIDED BELOW.

MIXING PROCEDURE:

1. PREPARED THE HWT-27 SLURRY BY MIXING 2 lbs OF DRY HWT-27 WITH 2.2 lbs OF TAP WATER. THE HWT-27 AND WATER WERE MIXED IN A GLASS BOWL WITH A STAINLESS STEEL WIRE WISK.

2. WEIGHED OUT 2,500 g OF SEDIMENT FROM BUCKET #13 AND PLACED IT IN THE MIXING BOWL.

3. THE SEDIMENT WAS MIXED FOR 1 MINUTE TO ENSURE THAT THE MATERIAL WAS UNIFORM.

4. AFTER THE INITIAL 1 MINUTE MIX AND WHILE THE SEDIMENT WAS STILL BEING MIXED, THE HWT-27 SLURRY WAS ADDED. THE SLURRY WAS SLOWLY ADDED (~10 SECONDS) AND THEN THE MATERIAL WAS MIXED FOR AN ADDITIONAL 2 MINUTES TO ENSURE UNIFORM MIXING.

5. DURING THE MIXING OF EACH BATCH, THE SIDES OF THE MIXING BOWL WERE SCRAPPED TO ENSURE UNIFORM MIXING OF THE REAGENTS.

6. THE TOTAL MIXING TIME FOR EACH BATCH WAS $1 + (\frac{10}{60}) + 2 = 3.17$ MINUTES.

7. AT THE END OF THE FINAL 2 MINUTES OF MIXING THE MIXER WAS TURNED OFF AND THE FOLLOWING CONTAINERS WERE FILLED FOR EACH BATCH:

	TCLP - STANDARD	TCLP - BLOCK	COMPRESSIVE STRENGTH
1. 4oz TALL, WIDE MOUTH GLASS JARS	3	3	0
2. 2"x4" PLASTIC CYLINDER JARS	0	0	3

8. IN ADDITION TO THE ABOVE SAMPLES, TWO (2) ADDITIONAL 4oz TALL WIDE MOUTH JARS WERE FILLED FOR EACH BATCH. THESE SAMPLES WILL BE HELD FOR POTENTIAL ADDITIONAL TESTING.

9. ALL THE SAMPLES ARE TO BE AIR CURED FOR APPROXIMATELY 30 DAYS PRIOR TO PHYSICAL TESTING.

WORKSHEETS FOR EACH BATCH ARE ATTACHED.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: HARCON

Date: 11/30/95

Container No. 13 (10,400 ppm PCB)

Blend No. 1

Personnel On-Site:
JAMES BRINKMAN
YANAI FRANK
JOHN TRIPP (HEALTH + SAFETY)
HELEN DOUGLAS (SAMPLING)

	Weight %	Weight (g + 0.1)	Volume (ml)
Feed Sediment:	–	2,500 g	–
Stabilization Reagent(s):			
1. HWT-27 (SLURRY)	12.5%	312.5 g	–
* SEE ATTACHED SHEET FOR SLURRY MAKE-UP			
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 0.17 + 2 = 3.17 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: MARCON

Date: 11/30/95

Container No. 13 (10,000 ppm PCB)

Blend No. 2

Personnel On-Site: JAMES BRINKMAN
TANAI FRANK
JOHN TRIPP (HEALTH & SAFETY)
HELEN DOUGLAS (SAMPLING)

	Weight %	Weight (g ± 0.1)	Volume (ml)
Feed Sediment:	–	2,500 g	–
Stabilization Reagent(s):			
1. HWT-27 (SLURRY)	17.5%	437.5 g	
*SEE ATTACHED SHEET FOR SLURRY MAKE-UP			
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 0.17 + 2 = 3.17	Minutes
Temperature of Sediment:	Before Mixing – °F	After Mixing – °F
pH of Sediment:	Before Mixing –	After Mixing –

Comments:

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: MARLON

Date: 11/30/95

Container No. 13 (10,400 ppm PCB)

Blend No. 3

Personnel On-Site:
JAMES BRINKMAN
YANAI FRANK
JOHN TRIPP (HEALTH & SAFETY)
HELEN DOUGLASS

	Weight %	Weight (g ± 0.1)	Volume (ml)
Feed Sediment:	–	1,500	–
Stabilization Reagent(s):			
1. HWT-27 (SLURRY)	25%	375 g	–
*SEE ATTACHED SHEET FOR SLURRY MAKE-UP			
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 0.17 + 2 = 3.17 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

Attachment E
Worksheets For S/S Mixing And Curing
World Environmental

NEW BEDFORD HARBOR SUPERFUND SITE
BENCH SCALE TREATABILITY STUDY
HOT SPOT SEDIMENTS

VENDOR/SUPPLIER: WORLD ENVIRONMENTAL (DEC. 4, 1995)

REAGENT(S): LPC II
CLARION SH-399
ZONECO - P1
OT - P2

	SEDIMENT	① LPC II	② SH-399	③ P1	③ P2
BATCH #1	2,000g	18% (360g)	2% (40g)	2% (40g)	0% (0)
BATCH #2	2,000g	18% (360g)	2% (40g)	0% (0g)	2% (40g)
BATCH #3	2,000g	15% (300g)	2% (40g)	1% (20g)	0% (0g)

MIXING PROCEDURE:

1. WEIGHED OUT 2,000 g OF SEDIMENT FROM BUCKET #15 IN MIXING BOWL.
2. THE SEDIMENT WAS MIXED FOR 1 MINUTE TO ENSURE THAT THE 2,000 g BATCH WAS UNIFORM.
3. AFTER THE INITIAL 1 MINUTE MIX AND WHILE THE SEDIMENT WAS STILL BEING MIXED, THE REAGENTS WERE ADDED SEQUENTLY AS INDICATED ABOVE. EACH REAGENT WAS ALLOWED TO BE THOROUGHLY MIXED PRIOR TO ADDING THE NEXT.
4. AFTER THE FINAL REAGENT WAS ADDED AND ALLOWED TO BE MIXED, THE MATERIAL WAS MIXED FOR AN ADDITIONAL TWO (2) MINUTES. THE TOTAL MIXING TIMES FOR EACH BATCH WERE AS FOLLOWS:

	SEDIMENT	LPC II	SH-399	P1/P2	MIX	TOTAL
BATCH #1	1 MINUTE	1 MINUTE	30 SECONDS	30 SECONDS	2 MIN.	5 MINUTES
BATCH #2	1 MINUTE	1 MINUTE	30 SECONDS	30 SECONDS	2 MIN.	5 MINUTES
BATCH #3	1 MINUTE	1 MINUTE	30 SECONDS	30 SECONDS	2 MIN	5 MINUTES

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

5. DURING THE MIXING OF EACH BATCH, THE SIDES OF THE MIXING BOWL WERE SCRAPPED TO ENSURE UNIFORM MIXING OF THE REAGENTS.

6. AT THE END OF THE FINAL 2 MINUTE MIX, THE MIXER WAS TURNED OFF AND THE FOLLOWING CONTAINERS WERE FILLED FOR EACH BATCH:

	TCLP - STANDARD	TCLP - BLOCK	COMPRESSIVE STRENGTH
1. 4oz TALL, WIDE MOUTH GLASS JARS	3	3	0
2. 2"x4" PLASTIC CYLINDER MOLDS	0	0	3

7. IN ADDITION TO THE ABOVE SAMPLES, TWO (2) ADDITIONAL 4oz GLASS JARS WERE FILLED FOR EACH BATCH. THESE SAMPLES WILL BE HELD FOR POTENTIAL ADDITIONAL TESTING.

8. ALL THE SAMPLES ARE TO BE AIR CURED FOR ~30 DAYS PRIOR TO TESTING

WORKSHEETS FOR EACH BATCH ARE ATTACHED.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: WORLD ENVIRONMENTAL

Date: 12/5/95

Container No. 15 (18,800 ppm PCB)

Blend No. 1

Personnel On-Site: JAMES BRINKMAN
TANA, FRANK
JOHN. TRIPP (HEALTH + SAFETY)

	Weight %	Weight (g + 0.1)	Volume (ml)
Feed Sediment:	–	2000g	–
Stabilization Reagent(s):			
1. LDC II	18%	360g	–
2. CLAHON SM 399	2%	40g	–
3. ZONKO-P1	2%	40g	–
Make-Up Water:	0	0	0

Total Mixing Time:	1+1+0.5+0.5+2 = 5 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: WORLD ENVIRONMENTAL

Date: 12/5/95

Container No. 15 (18,800 ppm PCB)

Blend No. 2

Personnel On-Site: JAMES BLINKMAN
TANAI FRANK
JOHN TRIPP (HEALTH & SAFETY)

	Weight %	Weight (g + 0.1)	Volume (ml)
Feed Sediment:	–	2000 g	–
Stabilization Reagent(s):			
1. LPC II	18%	360 g	
2. CLAMION SM 399	2%	40 g	
3. OT-P2	2%	40 g	
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 1 + 0.5 + 0.5 + 2 = 5 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: WORLD ENVIRONMENTAL

Date: 12/5/95

Container No. 15 (18,800 ppm PCB)

Blend No. 3

Personnel On-Site: JAMES BRINKMAN
YANAI FRANK
JOHN TRIPP (HEALTH + SAFETY)

	Weight %	Weight (g + 0.1)	Volume (ml)
Feed Sediment:	–	2000 g	–
Stabilization Reagent(s):			
1. LPC II	15%	300 g	
2. CLARION SM 389	2%	40 g	
3. ZONELO-P1	1%	20 g	
Make-Up Water:	0	0	0

Total Mixing Time:	1+1+0.5+0.5+2 = 5 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

Attachment E
Worksheets For S/S Mixing And Curing
Foster Wheeler

NEW BEDFORD HARBOR SUPERFUND SITE
BENCH SCALE TREATABILITY STUDY
HOT SPOT SEDIMENTS

VENDOR/SUPPLIER: EBASCO SERVICES (NOV. 30, 1995)

REAGENT(S): PORTLAND CEMENT (TYPE II)
OIL DRY (ABSORBENT CLAY)

	SEDIMENT	PORTLAND CEMENT	OIL DRY
BATCH #1	3,000 g	20% (600 g)	0% (0 g)
BATCH #2	3,000 g	20% (600 g)	2.5% (75 g)
BATCH #3	3,000 g	25% (750 g)	2.5% (75 g)

MIXING PROCEDURE:

1. WEIGHED OUT 3,000 g OF SEDIMENT FROM BUCKET #11 AND PLACED IN THE MIXING BOWL.

2. THE SEDIMENT WAS MIXED FOR 1 MINUTE TO ENSURE THAT THE 3,000 g BATCH WAS UNIFORM.

3. AFTER THE INITIAL 1 MINUTE MIX AND WHILE THE SEDIMENT WAS STILL BEING MIXED, THE PORTLAND CEMENT WAS ADDED. THE PORTLAND CEMENT WAS SLOWLY ADDED (~30 SECONDS) AND THEN THE MATERIAL WAS THEN MIXED FOR AN ADDITIONAL 2 MINUTES TO ENSURE UNIFORM MIXING.

4. FOR BATCHES #2 + #3, THE OIL DRY WAS ADDED AFTER THE PORTLAND CEMENT AND ALLOWED TO MIX FOR 30 SECONDS PRIOR TO STARTING THE FINAL 2 MINUTES OF MIXING

5. THE TOTAL MIXING TIMES FOR EACH BATCH WERE AS FOLLOWS:

	SEDIMENT	PORTLAND CEMENT	OIL DRY	TOTAL
BATCH #1	1 MINUTE	30 SECONDS	—	3.5 MINUTES
BATCH #2	1 MINUTE	30 SECONDS	30 SECONDS	4.0 MINUTES
BATCH #3	1 MINUTE	30 SECONDS	30 SECONDS	4.0 MINUTES

6. DURING THE MIXING OF EACH BATCH, THE SIDES OF THE MIXING BOWL WERE SCRAPPED TO ENSURE UNIFORM MIXING OF THE REAGENTS.

7. AT THE END OF THE FINAL 2 MINUTES OF MIXING THE MIXER WAS TURNED OFF AND THE FOLLOWING CONTAINERS WERE FILLED FOR EACH BATCH:

	TCLP - STANDARD	TCLP - BLOCK	COMPRESSIVE STRENGTH
1. 40z TALL WIDE MOUTH GLASS JARS	3	3	0
2. 2"x4" PLASTIC CYLINDER MOLDS	0	0	3

8. IN ADDITION TO THE ABOVE SAMPLES, TWO ADDITIONAL 40z TALL WIDE MOUTH JARS WERE FILLED FOR EACH BATCH. THESE SAMPLES WILL BE HELD FOR POTENTIAL ADDITIONAL TESTING.

9. THE GLASS JARS WERE SEALED AND 2"x4" CYLINDERS CAPPED, AND THEN ALL THE SAMPLES WERE PLACED IN ZIPLOC BAGS FOR CURING (30 DAYS)

WORKSHEETS FOR EACH BATCH ARE ATTACHED

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: EBASCO SERVICES

Date: 11/30/95

Container No. 11 (10,400 ppm PCB)

Blend No. 1

Personnel On-Site:
JAMES BRINKMAN
TANA FLANY
JOHN TRIPP (HEALTH & SAFETY)
HELEN DOUGLAS (SAMPLING)

	Weight %	Weight (g ± 0.1)	Volume (ml)
Feed Sediment:	–	3000	(~55% solids)
Stabilization Reagent(s):			
1. PORTLAND CEMENT (TYPE II)	20	600 g	–
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 0.5 + 2 = 3.5 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: EBASCO SERVICES

Date: 11/30/95

Container No. 11 (10,400 ppm PCB)

Blend No. 2

Personnel On-Site:
JAMES BRINKMAN
YANAI FRANK
JOHN TRIPP (HEALTH + SAFETY)
HELEN DOUGLAS (SIMPLINE)

	Weight %	Weight (g + 0.1)	Volume (ml)
Feed Sediment:	–	3000 g	(~ 50% SOLIDS)
Stabilization Reagent(s):			
1. PORTLAND CEMENT (TYPE II)	20	600 g	
2. OIL DRY	2.5	75 g	
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 0.5 + 0.5 + 2 = 4.0 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

NEW BEDFORD HARBOR SUPERFUND SITE
HOT SPOT SEDIMENTS
BENCH SCALE TREATABILITY STUDY

VENDOR/SUPPLIER: EBASCO SERVICES

Date: 11/30/95

Container No. 11 (10,400 ppm PCB)

Blend No. 3

Personnel On-Site:
JAMES BRINKMAN
TANA FRANK
JOHN TRIPP (HEALTH + SAFETY)
HELEN DOUGLAS (SAMPLING)

	Weight %	Weight (g + 0.1)	Volume (ml)
Feed Sediment:	–	3000 g	(~50% solids)
Stabilization Reagent(s):			
1. PORTLAND CEMENT (TYPE II)	25	750 g	
2. OIL ONLY	2.5	75 g	
Make-Up Water:	0	0	0

Total Mixing Time:	1 + 0.5 + 0.5 + 2 = 4.0 Minutes
Temperature of Sediment:	Before Mixing – °F After Mixing – °F
pH of Sediment:	Before Mixing – After Mixing –

Comments:

Attachment F
Steel Cage TCLP Method

Federal Register

Tuesday
May 24, 1988

TCLP
Stainless Steel
Cage Mod.
Protocol

Part IV

Environmental Protection Agency

40 CFR Part 268

Land Disposal Restrictions; Proposed Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 268

[FRL-3328-9]

Land Disposal Restrictions

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: The Environmental Protection Agency (EPA) is today proposing to revise the Toxicity Characteristic Leaching Procedure (TCLP), "Method 1311," as proposed on June 13, 1986 as part of the Toxicity Characteristic (TC) and as promulgated on November 7, 1986 as part of the Land Disposal Restrictions Program under the Resource Conservation and Recovery Act (RCRA). The changes to Method 1311 involve the use of a stainless steel cage in the bottle extractor, the addition of new suppliers of equipment, and the addition of a more detailed method flow chart and diagram of the stainless steel cage. The cage modification would allow the elimination of the size reduction step for certain materials.

DATES: Comments on this proposed rule to modify Method 1311 must be submitted on or before June 23, 1988.

ADDRESSES: One original and two copies of all comments on this proposed rule, identified by the Docket number F-88-TCA-FFFFF, should be sent to the following address: EPA RCRA Docket, WH-562, (LG-100), U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460. Please place the Docket number on all comments. The EPA RCRA Docket is located in the sub-basement at the above address and is open from 9:00 a.m. to 4:00 p.m., Monday through Friday, excluding Federal holidays. To review Docket materials, the public must make an appointment by calling (202) 475-9327. A maximum of 50 pages of material may be copied from any one regulatory docket at no cost. Additional copies cost $0.20/page.

FOR FURTHER INFORMATION CONTACT: For general information, contact the RCRA Hotline at (800) 424-9346 (toll-free) or (202) 382-3000.

For information on the technical aspects of this proposed rule contact Gail Hansen, Office of Solid Waste, [illegible] WH-562B, U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202) [illegible].

SUPPLEMENTARY INFORMATION:

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I. Background

On January 14, 1986 (51 FR 1602), EPA proposed the framework for implementing the Congressionally-mandated Land Disposal Restrictions Program (LDR) under the Resource Conservation and Recovery Act (RCRA). This action, among other things, proposed to establish treatment standards that had to be met before wastes could be land disposed. To determine whether the applicable treatment standards had been met, the Agency proposed to employ the Toxicity Characteristic Leaching Procedure (TCLP), or Method 1311. On June 13, 1986 EPA also proposed the use of Method 1311 as part of a new Toxicity Characteristic (TC) for determining whether a waste is hazardous. (51 FR 21648). The TC proposal would expand the existing Extraction Procedure Toxicity Characteristic (EPTC) by requiring that additional chemicals be considered in determining the hazardousness of a waste, and by using Method 1311 to determine the presence of such chemicals in, and their potential to leach from, a waste. In both these proposals, Method 1311 was developed to simulate the mobility of both organic and inorganic compounds. In the TC rule, EPA proposed that Method 1311 would replace the Extraction Procedure (EP) in the EPTC.

In response to these proposals, the Agency received numerous public comments regarding the test protocol. As a result of these comments, several changes and clarifications were incorporated into Method 1311 when it was promulgated as part of the Land Disposal Restrictions Program (LDR) on November 7, 1986 (51 FR 40572). These modifications included (1) specifying that the percent solids determination be performed on a separate sample to prevent problems when volatile species are important, (2) clarifying that multiple extractions might be required for samples of low solids content in order to obtain sufficient extract to conduct the needed analyses, (3) specifying particular quality assurance information which should be maintained and available for inspection, (4) specifying storage periods for the leachate, (5) recommending the use of borosilicate glass bottles over the use of flint glass, and (6) clarifying that, in the bottle protocol, centrifugation may be used as an aid to filtration of either the initial liquid phase of the waste or the extract of the solid phase.

Although these changes were not incorporated into Method 1311 when it was proposed as part of the Toxicity Characteristic (TC), when the TC is finally promulgated, these changes will be added. In addition, EPA is today proposing to make additional changes to Method 1311 (as used both in the LDR program and the TC) in response to comments received from the TC and LDR rules and recent studies conducted by the Agency. These changes consist of incorporating a stainless steel cage in the bottle extractor, which allows the elimination of the particle size reduction step for certain materials; the addition of new equipment suppliers; and the addition of a more detailed method flow chart and diagram of the cage.

The cage modification would respond to those commenters who argued that requiring all wastes to be milled/ground before extraction (as currently required in Method 1311) would penalize those persons who solidify their wastes into a monolithic mass or those persons whose wastes are in a monolithic form. The addition of new equipment suppliers is in response to new information on the availability of suitable testing equipment and would address commenters' concerns that equipment shortages will prevent timely waste testing. The addition of a more detailed method flow chart would address comments that the current method flow chart needs to be explained and clarified. The addition of a diagram of the stainless steel cage is for clarification.

II. Incorporation of Cage and Other Modifications

Method 1311 (as proposed on June 13, 1986 as part of the TC and promulgated on November 7, 1986 as part of the LDR) requires that the waste undergo particle size reduction in those cases where the waste cannot pass through a 9.5 mm sieve or has a surface area of less than 3.1 cm^2/g. This particle size reduction is achieved through milling the waste. The Agency believed, given the uncertainties concerning the long-term environmental stability of solidified wastes, that milling these wastes was an environmentally conservative approach.

However, EPA received numerous comments on the issue of particle size reduction, particularly as it would apply for monolithic and stabilized wastes. In particular, these commenters indicated that wastes are sometimes solidified by stabilization or fixation processes to intentionally prevent contact (and subsequent leaching) between water present in the disposal unit and the toxic species present in the waste.

Additionally, certain wastes may exist as rugged, monolithic materials. These commenters argued that since rugged monolithic solids and well-solidified wastes are not likely to be physically degraded in a landfill, such waste samples should not have to be milled into small particles (to pass through a 9.5 mm sieve) before extraction. The commenters suggested that as a replacement for the milling requirement for monolithic wastes, the structural integrity procedure (SIP), from the Extraction Procedure (EP), be reinstated and improved to simulate the effects of weathering processes (such as wet/dry and freeze/thaw cycles) and vehicular traffic on a landfill.

The Agency has reviewed the use of the SIP, which uses a drop-hammer to test the integrity of the waste and to reduce its size if it fractures. The Agency found that, although it may simulate the potential of a monolithic waste to be degraded by vehicular traffic on a landfill, it cannot address certain other stresses acting on the waste (e.g., wet/dry and freeze/thaw cycles). While evaluating the use of the SIP, the Agency found that, when certain monolithic materials were tested using the SIP, the materials retained their monolithic structure. When these materials were subsequently placed in the glass extractor bottle and rotated, the bottle would break. Consequently, in order to prevent breakage of the bottles, the Agency developed a cage insert for the extractor bottle. The cage, which is designed not to move within the bottle, is constructed of 0.25-inch stainless steel woven mesh. Experiments have shown that the use of the cage prevents bottle breakage (Ref. 7).

While evaluating the utility of the cage, the Agency noticed that wastes which were believed to be well-solidified retained their monolithic nature in the cage during extraction, whereas wastes which were believed to be less well-stabilized (even though some of them had passed the SIP) were broken into small pieces during the extraction.

To further examine this apparent correlation, the Agency obtained a select group of stabilized wastes which had been tested for their apparent resistance to environmental stresses, such as wet/dry (W/D) and freeze/thaw (F/T) cycles. These included wastes which were unlikely to undergo degradation due to F/T or W/D type stresses after placement in a landfill as well as wastes which did not appear to be resistant to such stresses. Resistance was measured by subjecting the wastes to repeated cycles of water submersion and oven drying and freezing and defrosting using draft ASTM methods "Wetting and Drying Test of Solid Wastes" (Ref. 7) and "Freezing and Thawing Test of Solid Wastes" (Ref. 7), respectively. Wastes that did not fall apart or lose 30% of their original weight after 28 cycles of F/T and W/D were assumed to be resistant to environmental stresses. The 30% or more cut-off was based on data from both an EPA/Environment Canada/Industry study and from studies conducted by the Alberta Environment Center (Ref. 7). These studies showed that there was a natural break point between those wastes that were already resistant and lost less than 30% of their original weight and those wastes that were poorly resistant and lost more than 30% of their original weight.

Those wastes that had been previously characterized using the W/D and F/T resistance tests were then subjected to the extractor using the cage insert (Ref. 7). The cage was considered to correlate the behavior of the W/D and F/T resistance tests if the samples that were degraded in the F/T and W/D tests were degraded after tumbling. The results are shown in Table 1. This study confirmed that those wastes that are resistant to environmental stresses were resistant to degradation using the cage-modified extractor. Those that were not deemed resistant to the environmental stresses were degraded by the extractor. For instance, both the wet/dry and freeze/thaw tests completely degraded the poorly stabilized pozzolonic (lime/fly ash) material and the poorly stabilized K028 concrete mixture, but neither test caused significant degradation of the vitrified, polymer encapsulated, or well-stabilized F024 concrete wastes. In addition, experience with the SIP in the laboratory has shown that stabilized solids that were not degraded by the SIP, yet that failed the freeze/thaw and wet/dry procedures, also were degraded by the cage extractor. These preliminary results suggest to the Agency that the cage tumbling procedure may better correlate with the environmental stability of the waste than the SIP. Although these data are scant, the Agency feels that there is sufficient basis to propose this procedure. Commenters should understand that the Agency will continue evaluation of the procedure during the comment period; we encourage submission of data and suggestions of additional sources of useful information.

TABLE 1.—COMPARISON OF WET/DRY, FREEZE/THAW AND TUMBLING WITH CAGE INSERT

Sample	Percent of weight remaining (number of cycles)		Average percent of weight remaining after tumbling
	Wet/dry	Freeze/thaw	
F024 [a] 2:1	73 (28)	77 (28)	[a] 71
F024 5:1	84 (28)	91 (28)	[a] 89
K028 [a] 1:1	0 (3)	0 (17)	[b] 0
K028 5:1	70 (17)	90 (28)	[b] 72
Lime/fly ash 1:1	0 (3)	0 (1)	[b] 0
Lime/fly ash 2:1	0 (5)	0 (2)	[b] 0
Polymer encapsulated	100 (28)	100 (28)	[c] 100
Vitrified [d]	97 (28)	89 (28)	[c] 86

[a] = Tested in duplicate, result is average of 2 experiments.
[b] = Tested in triplicate, result is average of 3 experiments.
[c] = Only a single specimen was tested.
[d] = Includes chlorinated solvents (40CFR, Part 261, App. VII).
[e] = Includes 1,1,1-trichloroethane, vinyl chloride
[f] = 1-L jar used due to small quantity of waste available.

Based on these results, the Agency is proposing that most waste materials are not to be milled to pass the 9.5 mm sieve before testing if (1) the bottle extractor equipped with the cage is employed and (2) an appropriate size representative sample can be taken and analyzed. The exceptions would be wastes which are rendered monolithic by being encapsulated and wastes which are tested for volatiles. The Agency believes that some encapsulated wastes may be well-solidified but is concerned about encapsulants which will corrode (e. g., metal battery cases) or otherwise degrade in the environment, thereby permitting contact between the waste material and landfill leachate. Therefore, the Agency is continuing to require that all encapsulated wastes be milled. The Agency, however, invites comments on how to define stable, non-corrodable, encapsulated wastes. Studies and data are needed of encapsulants that will not be readily breachable. Based on data and comments obtained, the Agency may consider different testing requirements for encapsulated wastes. The Agency also requires that wastes which are tested for volatiles be milled. The extraction of volatiles requires the use of a special extraction device, the Zero Headspace Extractor (ZHE), which is made of Type 316 stainless steel. The Agency does not know how to adapt the ZHE to incorporate a cage insert and therefore, still requires that wastes that are tested for volatiles go through particle size reduction, preferably as the sample is being taken in the field to

minimize volatile loss. The EPA invites comment on how to reduce the particle size of volatile-containing wastes to minimize volatile loss and, based on comments obtained, may consider other alternatives to milling of volatile-containing wastes.

The other modifications, the addition of new equipment suppliers, the addition of a more detailed method flow chart, and the addition of a diagram of the stainless steel cage, are being added primarily to further clarify the method. The new equipment suppliers include two manufacturers of rotary agitation devices, Environmental Machine and Design, Inc. of Lynchburg, VA, and Millipore Corp. of Bedford, MA; one manufacturer of a Zero Headspace Extractor vessel (ZHE), Lars Lande of Whitmore Lake, MI; and two manufacturers of filter media, Millipore Corp. of Bedford, MA, and Nucleopore Corp. of Pleasanton, CA. These manufacturers are listed in Tables 2, 3, and 5, respectively, along with company telephone numbers and equipment model numbers.

III. Economic and Regulatory Impacts

A. Regulotory Impact Analysis

Executive Order 12291 requires regulatory agencies to conduct a Regulatory Impact Analysis (RIA) for any major rule. A major rule is one likely to result in (1) an annual effect on the economy of $100 million or more, (2) a major increase in costs or prices for consumers, individual industries, federal, state, or local government agencies, or geographic regions, or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or the ability of U.S.-based enterprises to compete in domestic or export markets.

The Administrator has determined that today's proposal is not a major rule. In fact, we believe the proposed changes to Method 1311 will result in savings to persons performing the tests using this method. In particular, the time and, therefore, labor costs are lower when using the proposed modification because solid materials will not have to be milled to pass a 9.5 mm sieve but rather only be reduced to a size to fit the extraction cage in the bottle. Therefore, because this proposal is not a major regulation, no Regulatory Impact Analysis was conducted.

B. Regulotory Flexibility Act

Under the Regulatory Flexibility Act, 5 U.S.C. 601–612 whenever an agency is required to issue for publication in the Federal Register any proposed or final rule, it must prepare and make available for comment a Regulatory Flexibility Analysis which describes the impact of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions). This analysis is unnecessary, however, if the Agency's Administrator certifies that the rule will not have a significant economic impact on a substantial number of small entities.

The Agency has examined the potential impact of the proposed rule on small business and has concluded that this regulation will have no adverse impact on small entities since the modification to Method 1311 does not significantly affect the cost of testing. In fact, because the modification reduces labor costs, this proposal may reduce testing costs. Therefore, I certify that this regulation will not have a significant economic impact on a substantial number of small entities.

C. Paperwork Reduction Act

The proposed rule contains no recordkeeping or information collection requirements subject to OMB review under the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 et seq. Because information collection or recordkeeping requirements are not required by this proposal, the Agency has not prepared documentation pursuant to the Paperwork Reduction Act.

List of Subjects in 40 CFR Part 263

Hazardous waste, Reporting and Recordkeeping requirements.

Dated: April 8, 1988.

Lee M. Thomas,

Administrator.

IV. References

(1) Research Triangle Institute. "Toxicity Characteristic Leaching Procedure." Draft Background Document. U.S. EPA, OSW, Washington, DC, 1987.

(2) S-Cubed. "Modification to the Toxicity Characteristic Leaching Procedure." U.S. EPA, Contract No. 68-01-7268, 1987.

(3) Research Triangle Institute. "Evaluation of Analytical Procedures Supporting the Toxicity Characteristic Leaching Procedure (TCLP): Modifications to Protocols." U.S. EPA, Contract No. 68-01-7268, 1987.

(4) S-Cubed. "Modification of the TCLP for Problem Matrices." U.S. EPA, OSW, Washington, DC, 1987.

(5) U.S. EPA. "Toxicity Characteristic Leaching Procedure." Background Document, U.S. EPA, OSW, Washington, DC, 1986.

(6) "EPA TCLP Changes." Internal Document. U.S. EPA, OSW, 1986.

(7) S-Cubed. "Modification of TCLP to Accommodate Solidified Wastes." Draft Final Report, U.S. EPA, OSW, Washington, DC, September, 1987.

For the reasons set out in the preamble, it is proposed to amend Title 40 of the Code of Federal Regulations as follows:

PART 268—LAND DISPOSAL RESTRICTIONS

1. The authority citation for Part 268 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, and 6924.

2. The heading, Steps 4.2.2, 7.0, 7.3, 8.9, 8.10, Table 2, Table 3, Table 5, and Figure 1 of Appendix I are revised and a new Figure 4 is added, to read as follows:

Appendix I to Part 268—Method 1311

* * * * *

4.2.2 *Extraction Bottle with Cage.* When the waste is being evaluated for other than volatile contaminants, a 2-liter jar fitted with a stainless steel cage is used for most samples (see below for exceptions). Headspace is allowed in this vessel. The jar is fitted with a type 316 stainless steel (or equivalent material) cage that will contain all of the solids in the sample. The cage is constructed of 0.25 inch (6.3 mm) woven wire mesh with an inside diameter of 3.0 ± 0.1 in. and a free fall length of 9.9 ± 0.1 in. The cage shall be supported in the extractor bottle in such a manner that it does not move as the bottle is rotated. See Figure 4 for details of construction.

The extraction bottles may be constructed from various materials, depending on the contaminants to be analyzed and the nature of the waste (see Step 4.3.3). It is recommended that borosilicate glass bottles be used instead of other types of glass, especially when inorganics are of concern. Plastic bottles shall not be used if organics are to be investigated. Bottles are available from a number of laboratory suppliers, but the bottle size must be appropriate to contain the cage. When this type of extraction vessel is used, the filtration device discussed in Step 4.3.2 is used for initial liquid/solid separation and final extract filtration.

For the wastes that *must* be reduced to granules in Step 7.3, the cage is not used in the extraction bottle. The cage is used in all other cases, even if the solids are present as small particles.

* * * * *

7.0 PRELIMINARY EVALUATIONS

Preliminary evaluations are performed on a minimum 100 gram representative sample of waste that will not actually undergo extraction (designated as the first sample in Step 6.2). These evaluations include: (1) preliminary determination of the percent solids of the waste; (2) determination of whether the waste contains insignificant solids, and is therefore, its own extract after filtration; (3) determination of whether the waste is encapsulated; and (4) determination of which of the two extraction fluids are to be

used for the non-volatile leaching extraction of the waste.

* * * * *

7.3 *Determination of whether the waste requires size-reduction (particle-size is reduced during this Step):* If an extraction for volatile organics (Step 9.0) is to be performed on the wastes that contain more than 0.5% solids, the solids must be reduced to the particle size prescribed in Step 7.3.3. For the extraction of other analytes (Step 8.0) the solid is reduced to small particles only if it is encapsulated.

7.3.1 The solid portion of the waste is carefully examined to determine if it is encapsulated. If the solid is found to be en capsulated, it must be crushed, cut, or milled to pass a 9.5 mm sieve. If a liquid phase results in this step, the resulting mixture shall be evaluated by Step 7.1.

Note.—This size reduction is meant both for wastes encapsulated with surface coatings and wastes that may naturally be in sealed capsules (e.g., dry cell batteries, electrical parts).

7.3.2 If the solid portion of the waste is not encapsulated and volatile organics are not of concern, representative solid pieces are used in the extraction procedure (Step 8.0), as obtained.

Note.—For wastes that are to be fixated or stabilized before extraction the sample may be cast (or otherwise stabilized) in the form of a cylinder or block that will fit in the cage of the extraction apparatus (see Steps 8.0–8.11). [redacted]

7.3.3 For solids that are to be extracted for volatile organics (Step 9.0) or solids that are encapsulated (Steps 8.0 and 9.0), a particle-size reduction is required, if the solid has a surface area per gram of material equal to or greater than 3.1 cm^2, or is smaller than 1 cm in its narrowest diagonal (i.e., is capable of passing through a 9.5-mm (0.375 inch) standard sieve). Such solids are prepared for extraction by crushing, cutting, or grinding the waste to a surface area or particle-size as described above. If the solids are prepared for organic volatiles extraction, special precautions must be taken, see Step 9.8.

Note.—Surface area requirements are meant for filamentous (e.g., paper, cloth) and similar waste materials. Actual measurement of surface area is not required, nor is it recommended.

* * * * *

8.9 If the waste contains <0.5% dry solids (see Step 7.2), proceed to Step 8.13. If the waste contains >0.5% dry solids (see Step 7.1 or 7.2), and if particle-size reduction of the solid is needed in Step 7.3 (i.e., the solid is encapsulated), proceed to Step 8.10. If particle-size reduction was not required in Step 7.3, quantitatively transfer the solid material into the stainless steel cage of the extractor vessel, and include the filter used to separate the initial liquid from the solid phase, if used. Proceed to Step 8.11.

8.10 If the waste is encapsulated the solid portion is prepared for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described in Step 7.3. When the surface area or particle-size has been appropriately altered, quantitatively transfer the solid material into an extractor bottle, without a stainless steel cage. The filter used to separate the initial liquid from the solid phase is also put into the extractor bottle.

Note.—Sieving of the waste through a sieve is not normally required. If sieving is needed a Teflon-coated sieve should be used to avoid contamination of the sample. Surface area requirements are meant for filamentous (e.g., paper, cloth) and similar waste materials. Actual measurement of surface area is not recommended.

* * * * *

TABLE 2.—SUITABLE ROTARY AGITATION APPARATUS [1]

Company	Location	Model
Analytical Testing and Consulting Services, Inc	Warrington, PA, (215) 343-4490	4-vessel ZHE device or 8-bottle extractor device.
Associated Design and Manufacturing Co	Alexandria, VA, (703) 549-5999	4-vessel device, 6-vessel device.
Environmental Machine & Design, Inc	Lynchburg, VA, (804) 845-6424	4-vessel device, 8-vessel device.
IRA Machine Shop and Laboratory	Santurce, PR, (809) 752-4004	16-vessel device.
Lars Lande Mfg	Whitmore Lake, MI, (313) 449-4116	10-vessel device, 5-vessel device.
Millipore Corp	Bedford, MA, (800) 225-3384	4-vessel ZHE device or 4-one liter bottle extractor device.
REXNORD	Milwaukee, WI, (414) 643-2850	6-vessel device.

[1] Any device that rotates the extraction vessel in an end-over-end fashion at 30 ± 2 rpm is acceptable.

TABLE 3.—SUITABLE ZERO-HEADSPACE EXTRACTOR VESSELS

Company	Location	Model
Analytical Testing and Consulting Services, Inc	Warrington, PA, (215) 343-4490	C102, Mechanical Pressure Device.
Associated Design & Manufacturing Co	Alexandria, VA, (703) 549-5999	3740-ZHB, Gas Pressure Device.
Lars Lande Mfg	Whitmore Lake, MI, (313) 449-4116	Gas Pressure Device.
Millipore Corp	Bedford, MA (800) 225-3384	SDI P581 C5, Gas Pressure Device

* * * * * * * *

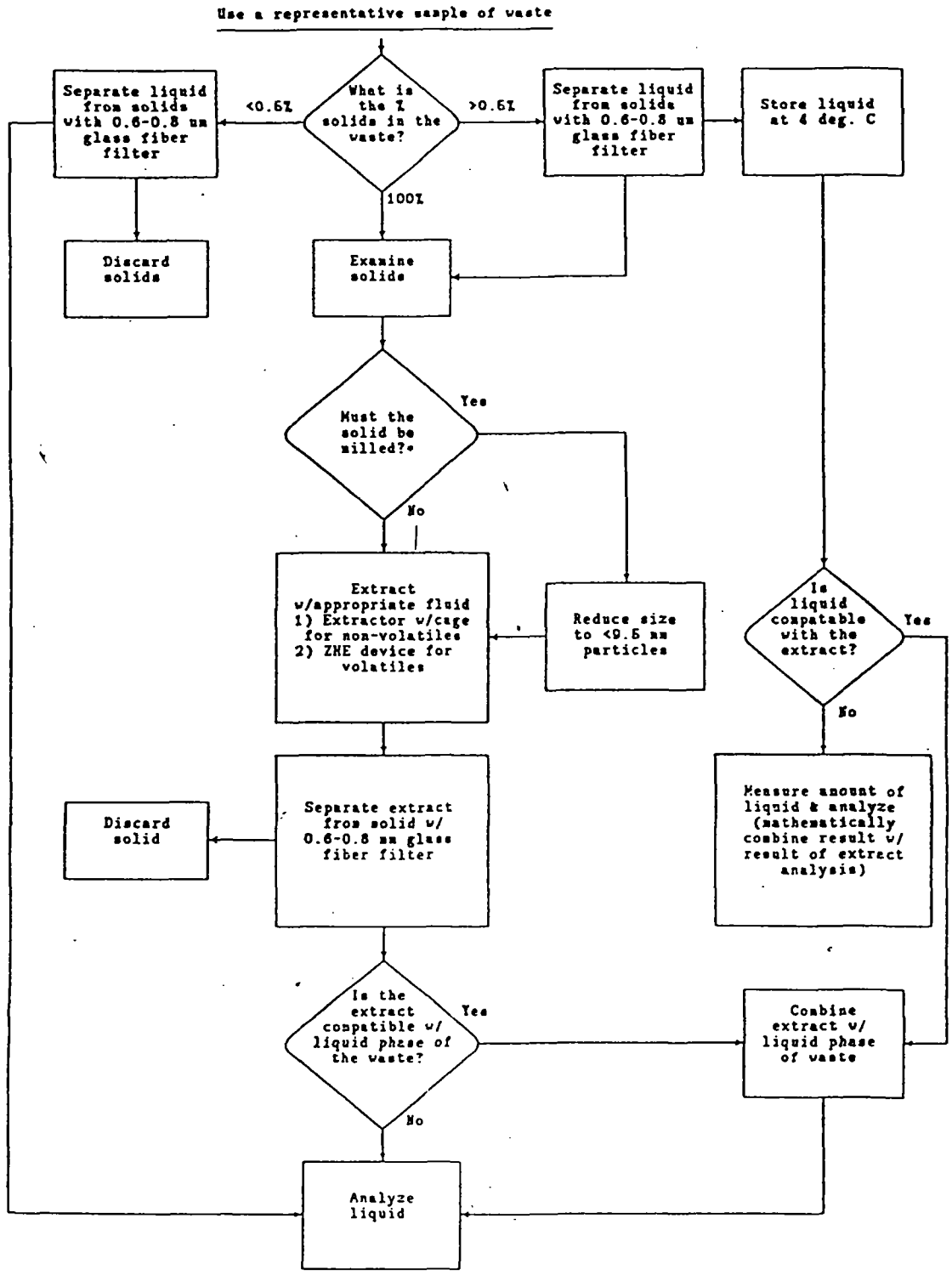
TABLE 5.—SUITABLE FILTER MEDIAL

Company	Location	Model	Size [1]
Millipore Corp	Bedford, MA, (800) 225-3384	AP40	0.7
Nucleopore Corp	Pleasanton, CA, (415) 463-2530	211625	.7
Whatman Laboratory Products, Inc	Clifton, NJ, (201) 773-5800	GFF	.7

[1] Nominal pore size (um).

BILLING CODE 6560-50-M

Figure 1 Method 1311 Flowchart



*If the solids are large pieces(>9.5 mm) and will be extracted in the ZHE device, or they are encapsulated, they must be milled.

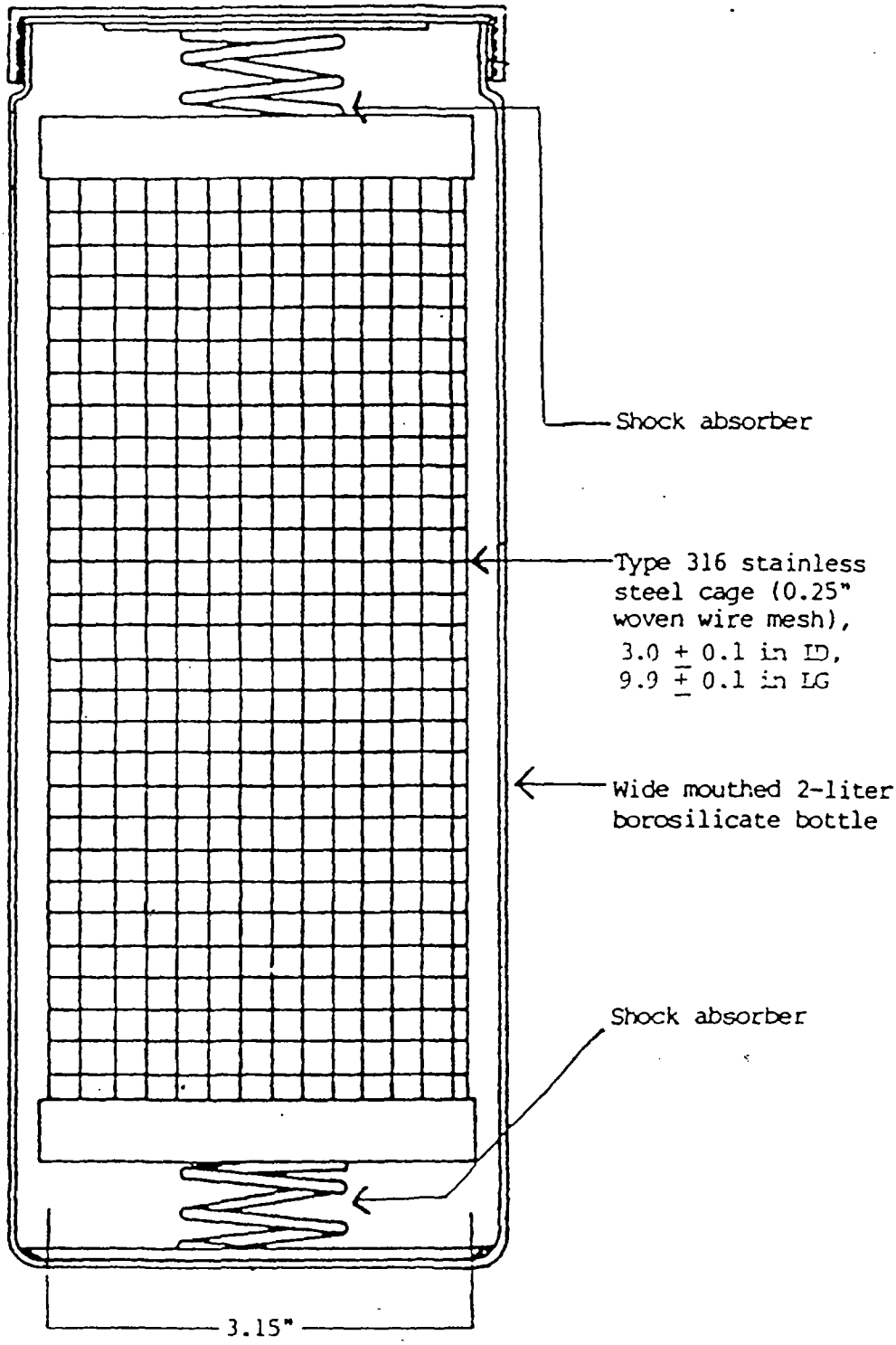


Figure 4. Stainless steel cage used in the tumbling of solid samples

[FR Doc. 88-9993 Filed 5-23-88; 8:45 am]
BILLING CODE 6560-50-C

Attachment G
TCLP Analytical Results

Bedford Harbor Superfund Site - Hot Spot Sediments
Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT								
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average
INORGANIC ANALYTES									
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6
Arsenic	57.7		49.1		56.8		52.7		54.1
Barium	709.0		253.0		712.0		797.0		617.8
Beryllium	2.6	B	2.4	B	2.2	B	2.6	B	2.5
Cadmium	165.0		137.0		144.0		142.0		147.0
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0
Chromium	247.0		209.0		227.0		219.0		225.5
Cobalt	4.5	B	3.6	B	4.3	B	3.9	B	4.1
Copper	169.0		144.0		164.0		168.0		161.3
Iron	27500.0		23500.0		25300.0		24100.0		25100.0
Lead	1610.0		1520.0		1620.0		1570.0		1630.0
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0
Manganese	171.0		155.0		168.0		175.0		167.3
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2
Nickel	127.0		105 0		113.0		141.0		121.5
Potassium	25300 0		21400 0		24200.0		23900.0		23700.0
Selenium	10.7		10.4		15.2		13.9		12.6
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7
Sodium	228000		198000		219000		214000		214750.0
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5
Vanadium	79.9		71.4		78.4		75.6		76.3
Zinc	19800.0		17000 0		18000 0		17400.0		18050.0
PCBs									
Aroclor-1016	--		--		--		--		--
Aroclor-1221	--		--		--		--		--
Aroclor-1232	--		--		--		--		--
Aroclor-1242	7	C	12	CP	21	C	4	YP	11
Aroclor-1248	--		--		--		--		--
Aroclor-1254	--		1 6	YJP	0.89	J	--		0.22
Aroclor-1260	--		--		--		--		--
Total PCBs	7.0		14		22		4.0		11

	World Environmental BATCH #3 TCLP Method 1311							World Environmental BATCH #3 TCLP Cage Method							
FIELD ID #:	W3S1		W3S2		W3S3		W3	W3B1		W3B2		W3B3		W3
SAMPLE ID #:	DABA22		DABA23		DABA61		TCLP	DABA24		DABA44		DABA62		Cage
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		Average	18-Jan-96		18-Jan-96		18-Jan-96		Average
INORGANIC ANALYTES														
Aluminum	526.0		579.0		496.0		533.7	4790.0		3770.0		3840.0		4133.3
Antimony	2.0	B	2.0	B	1.8	U	1.9	6.9	B	5.7	B	15.6	B	9.4
Arsenic	4.0	B	25.2		3.0	U	10.7	3.1	B	3.4	B	5.1	B	3.9
Barium	271.0		302.0		412.0		328.3	703.0		256.0		886.0		615.0
Beryllium	0.6	B	0.4	B	0.4	B	0.5	1.4	B	1.2	B	1.8	B	1.5
Cadmium	0.2	U	0.2	U	0.2	U	0.2	33.5		28.6		88.7		50.3
Calcium	2030000		1920000		1030000		1660000.0	575000		564000		1410000		849666.7
Chromium	13.9		15.6		12.3		13.9	209.0		131.0		358.0		232.7
Cobalt	4.3	B	5.5	B	2.8	B	4.2	4.2	B	3.7	B	12.5	B	6.8
Copper	1580.0		1700.0		1210.0		1496.7	916.0		762.0		2040.0		1239.3
Iron	10.9	U	89.8	B	67.5	B	56.1	4890.0		3640.0		5930.0		4620.0
Lead	1.6	U	1.6	B	18.9		7.4	501.0		347.0		560.0		469.3
Magnesium	1020.0	B	580.0	B	37.3	B	545.8	11200.0		9750.0		31500.0		17483.3
Manganese	0.8	B	0.8	B	1.2	B	1.0	271.0		243.0		797.0		437.0
Mercury	0.2	U	0.2	U	0.2	U	0.2	0.2	U	0.2	U	1.0		0.5
Nickel	71.1		83.6		94.6		83.1	89.2		78.2		221.0		129.5
Potassium	52100 0		56800.0		70700.0		59866.7	23000.0		26700.0		39100.0		29600.0
Selenium	10.0		11.6		11.2		10.9	15.8		14.1		5.8		11.9
Silver	0.7	U	0.7	U	0.7	U	0.7	0.7	U	1.0	B	4.5	B	2.1
Sodium	257000		292000		1150000		566333.3	117000		134000		198000		149666.7
Thallium	3.5	U	9.5	U	3.5	U	5.5	3.5	U	3.5	U	3.5	U	3.5
Vanadium	48.0	B	38.0	B	5.0	B	30.3	18.2	B	12.3	B	17.2	B	15.9
Zinc	8.0	B	10.5	B	30.7		16.4	4310.0		3500.0		11200 0		6336 7
PCBs														
Aroclor-1016	--		--		--		--	--		--		--		--
Aroclor-1221	--		--		--		--	--		--		--		--
Aroclor-1232	--		--		--		--	--		--		--		--
Aroclor-1242	45	C	9.5		32	CP	28.8	33	Y	35	C	75	C	47 7
Aroclor-1248	--		--		--		--	--		--		--		--
Aroclor-1254	2.2	YZ	1.4	J	--		1.2	1.9	YJ	2.2	JP	4.6	YJ	2.9
Aroclor-1260	--		--		--		--	--		--		--		--
Total PCBs	47		11		32		30	35		37		80		51

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					MARCOR ENVIRONMENTAL BATCH #1 TCLP Method 1311				MARCOR ENVIRONMENTAL BATCH #1 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	M1S1	M1S2	M1S3	M1	M1B1	M1B2	M1B3	M1
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA05	DABA25	DABA45	TCLP	DABA06	DABA26	DABA46	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	3 J	--	--	1	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	35	35	25	31.7	30	43	38	37.0
1,4-Dichlorobenzene	140	66	110	94 D	102.5	120	130	130	126.7	100	190 D	140	143.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	1 J	--	0.33	2 J	--	--	0.67
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	3 J	1
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--		--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	4 J	3 J	3.7	3 J	4 J	5 J	4.0
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	12 J	12 J	11 J	11.7	23	--	--	7.7
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	7 JZ	6 ZJ	--	4.3	2 JZ	--	3 J	1.67
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

	UNTREATED HOT SPOT SEDIMENT										MARCOR ENVIRONMENTAL BATCH #1 TCLP Method 1311								MARCOR ENVIRONMENTAL BATCH #1 TCLP Cage Method							
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated		M1S1		M1S2		M1S3		M1		M1B1		M1B2		M1B3		M1	
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment		DABA05		DABA25		DABA45		TCLP		DABA06		DABA26		DABA46		Cage	
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average	
INORGANIC ANALYTES																										
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0		7980.0		6670.0		297.0		4982.3		6840.0		972.0		322.0		2711.3	
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6		18.5	B	15.4	B	26.4	B	20.1		16.0	B	19.2	B	23.0	B	19.4	
Arsenic	57.7		49.1		56.8		52.7		54.1		7.0	B	31.2		16.8		18.3		32.5		16.9		17.1		22.2	
Barium	709.0		253.0		712.0		797.0		617.8		731.0		682.0		278.0		563.7		687.0		793.0		609.0		696.3	
Beryllium	2.6	B	2.4	B	2.2	B	2.8	B	2.5		5.4		4.8	B	0.6	B	3.6		5.0	B	1.5	B	1.0	B	2.5	
Cadmium	165.0		137.0		144.0		142.0		147.0		260.0		128.0	U	4.3	B	130.8		121.0		56.3	U	6.9		61.4	
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0		1110000		982000		690000		927333.3		917000.0		937000		669000		841000.0	
Chromium	247.0		209.0		227.0		219.0		225.5		326.0		285.0		11.0		207.3		294.0		76.6		19.1		129.9	
Cobalt	4.5	B	3.6	B	4.3	B	3.9	B	4.1		46.4	B	30.6	B	7.5	B	28.2		30.3	B	33.6	B	13.8	B	25.9	
Copper	169.0		144.0		164.0		168.0		161.3		1820.0		163.0		134.0		705.7		76.9		218.0		116.0		137.0	
Iron	27500.0		23500.0		25300.0		24100.0		25100.0		6610.0		16500.0		10.9	U	7707.0		22600.0		2510.0		64.3	B	8391.4	
Lead	1810.0		1520.0		1620.0		1570.0		1630.0		1300.0		1580.0		11.0		963.7		1460.0		246.0		24.5		576.8	
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0		160000.0		143000.0		77100.0		126700.0		133000.0		129000.0		73100.0		111700.0	
Manganese	171.0		155.0		168.0		175.0		167.3		33300.0		30400.0		13400.0		25700.0		24200.0		24100.0		15300.0		21200.0	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2		1.5		0.4		0.2	U	0.7	
Nickel	127.0		105.0		113.0		141.0		121.5		429.0		251.0		50.5		243.5		278.0		339.0		88.2		235.1	
Potassium	25300.0		21400.0		24200.0		23900.0		23700.0		50100.0		44000.0		57100.0		50400.0		40600.0		41900.0		54200.0		45566.7	
Selenium	10.7		10.4		15.2		13.9		12.6		22.8		15.1		13.4		17.1		12.9		9.7		13.7		12.1	
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	0.7	U	0.7		0.7	U	1.1	B	0.7	U	0.8	
Sodium	228000		198000		219000		214000		214750.0		309000		274000		1140000		574333.3		258000		278000		1160000		565333.3	
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5	
Vanadium	79.9		71.4		78.4		75.6		76.3		24.5	B	36.6	B	31.6	B	30.9		36.3	B	23.2	B	28.5	B	29.3	
Zinc	19800.0		17000.0		18000.0		17400.0		18050.0		35200.0		18700.0		1020.0		18306.7		17600.0		18200.0		2880.0		12893.3	
PCBs																										
Aroclor-1016	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1221	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1232	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1242	7	C	12	CP	21	C	4	YP	11		47	C	50	Y	45	C	47.3		33	C	32	P	28	C	31.0	
Aroclor-1248	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1254	--		1.6	YJP	0.89	J	--		0.22		2.4	YJ	--		2.5	YJ	1.6		1.6	YJ	1.7	YJ	7.7	YP	3.7	
Aroclor-1260	--		--		--		--		--		--		--		--		--		--		--		--		--	
Total PCBs	7.0		14		22		4.0		11		49		50		48		49		35		34		36		35	

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					MARCOR ENVIRONMENTAL BATCH #2 TCLP Method 1311				MARCOR ENVIRONMENTAL BATCH #2 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	M2S1	M2S2	M2S3	M2	M2B1	M2B2	M2B3	M2
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA07	DABA27	DABA47	TCLP	DABA08	DABA28	DABA48	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	3 J	5 J	--	2.7	6 J	--	--	2.0
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	5 J	--	--	1.7
1,3-Dichlorobenzene	48	16 J	29	68	40.25	34	6 J	20 J	20.0	18 J	34	37	29.7
1,4-Dichlorobenzene	140	66	110	94 D	102.5	120	26	100	82.0	82	130	140	117.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	--	--	--	1 J	--	--	0.3
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	4 J	3 J	2.3
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	4 J	--	--	1.3
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	--	3 J	2.3	6 J	4 J	5 J	5.0
Naphthalene	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	5 J	--	--	1.7
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	2 J	--	--	0.7
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	5 J	--	--	1.7
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	3 J	--	--	1.0
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	3 J	--	--	1.0
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	3 J	--	--	1.0
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	3 J	--	--	1.0
Diethylphthalate	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
Fluorene	--	--	--	--	--	--	--	--	--	3 J	--	--	1.0
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	3 J	--	--	1.0
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	3 J	--	--	1.0
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	36	4 J	11 J	17.0	4 J	--	3 J	2.3
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	6 J	--	--	2.0
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	5 JZ	6 J	--	3.7	6 J	47	--	17.7
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	7 J	--	--	2.3
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	5 J	--	--	1.7
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	4 J	--	--	1.3
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	5 J	--	--	1.7

ord Harbor Superfund Site - Hot Spot Sediments
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	UNTREATED HOT SPOT SEDIMENT										MAR ENVIRONMENTAL BATCH #2 TCLP Method 1311								MARCOR ENVIRONMENTAL BATCH #2 TCLP Cage Method							
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated		M2S1		M2S2		M2S3		M2		M2B1		M2B2		M2B3		M2	
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment		DABA07		DABA27		DABA47		TCLP		DABA08		DABA28		DABA48		Cage	
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average	
INORGANIC ANALYTES																										
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0		2630.0		538.0		3430.0		2199.3		7540.0		2620.0		3140.0		4433.3	
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6		22.8	B	23.0	B	20.0	B	21.9		18.2	B	14.3	B	15.8	B	16.1	
Arsenic	57.7		49.1		56.8		52.7		54.1		7.4	B	6.5	B	6.1	B	6.7		12.9		16.3		9.1	B	12.8	
Barium	709.0		253.0		712.0		797.0		617.8		705.0		574.0		727.0		668.7		860.0		861.0		938.0		886.3	
Beryllium	2.6	B	2.4	B	2.2	B	2.8	B	2.5		3.2	B	1.5	B	4.2	B	3.0		5.4		3.3	B	3.9	B	4.2	
Cadmium	165.0		137.0		144.0		142.0		147.0		133.0		55.6		211.0		133.2		122.0		53.4		154.0	U	109.8	
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0		1300000		1880000		1450000		1543333.3		1130000		1280000		1240000		1216666.7	
Chromium	247.0		209.0		227.0		219.0		225.5		180.0		72.4		223.0		158.5		381.0		209.0		199.0		263.0	
Cobalt	4.5	B	3.6	B	4.3	B	3.9	B	4.1		53.2		56.8		60.0		56.7		39.3	B	43.2	B	50.3		44.3	
Copper	169.0		144.0		184.0		168.0		161.3		921.0		453.0		1020.0		798.0		468.0		138.0		897.0		501.0	
Iron	27500.0		23500.0		25300.0		24100.0		25100.0		4280.0		235.0		2900.0		2471.7		22300.0		12100.0		4900.0		13100.0	
Lead	1810.0		1520.0		1620.0		1570.0		1630.0		478.0		78.1		624.0		393.4		962.0		428.0		552.0		647.3	
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0		177000.0		216000.0		195000.0		196000.0		145000.0		165000.0		170000.0		160000.0	
Manganese	171.0		155.0		168.0		175.0		167.3		40600.0		54500.0		44500.0		46533.3		35300.0		38000.0		39200.0		37500.0	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2		5.7		0.2	U	1.8		2.6		2.4		0.2		6.1		2.9	
Nickel	127.0		105.0		113.0		141.0		121.5		394.0		350.0		411.0		385.0		318.0		316.0		380.0		338.0	
Potassium	25300.0		21400.0		24200.0		23900.0		23700.0		52100.0		63800.0		57200.0		57700.0		45100.0		50000.0		49700.0		48266.7	
Selenium	10.7		10.4		15.2		13.9		12.6		26.4		24.8		26.8		26.0		19.1		17.6		19.0		18.6	
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7		5.2	B	0.7	U	0.7	U	2.2		2.8	B	0.7	U	5.1	B	2.9	
Sodium	228000		198000		219000		214000		214750.0		291000		322000		318000		310333.3		267000		285000		288000		280000.0	
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5	
Vanadium	79.9		71.4		78.4		75.6		76.3		20.2	B	15.4	B	19.7	B	18.4		27.9	B	20.6	B	17.4	B	22.0	
Zinc	19800.0		17000.0		18000.0		17400.0		18050.0		21900.0		15300.0		25600.0		20933.3		18300.0		16800.0		21300.0		18800.0	
PCBs																										
Aroclor-1016	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1221	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1232	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1242	7	C	12	CP	21	C	4	YP	11		24	YP	51	C	31	CP	35.3		34	C	34	C	38	C	35.3	
Aroclor-1248	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1254	--		1.6	YJP	0.89	J	--		0.22		1.9	YJ	7.2	Y	--		3.0		3	YJ	2.2	JY	10	C	5.1	
Aroclor-1260	--		--		--		--		--		--		--		--		--		--		--		--		--	
Total PCBs	7.0		14		22		4.0		11		26		58		31		38		37		36		48		40	

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					MARCOR ENVIRONMENTAL BATCH #3 TCLP Method 1311				MARCOR ENVIRONMENTAL BATCH #3 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	M3S1	M3S2	M3S3	M3	M3B1	M3B2	M3B3	M3
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA09	DABA29	DABA49	TCLP	DABA10	DABA30	DABA50	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	5 J	8 J	--	4.3	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	30	15 J	22 J	22.3	14 J	22	--	12.0
1,4-Dichlorobenzene	140	66	110	94 D	102.5	110	62	110	94.0	64	87	--	50.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	2 J	1 J	--	1.0	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	2 J	--	0.7	--	3 J	--	1.0
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	3 J	6 J	4.3	--	4 J	--	1.3
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	17 J	10 J	18 J	15.0	12 J	3 J	--	5.0
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	17 J	5.7
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	12 J	4.0
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	8 ZJ	7 JZ	--	5.0	--	2 J	23 J	8.3
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	18 J	6.0
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	14 J	4.7
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	12 J	4.0
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	14 J	4.7

	UNTREATED HOT SPOT SEDIMENT					MARCOR ENVIRONMENTAL BATCH #3 TCLP Method 1311				MARCOR ENVIRONMENTAL BATCH #3 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	M3S1	M3S2	M3S3	M3	M3B1	M3B2	M3B3	M3
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA09	DABA29	DABA49	TCLP	DABA10	DABA30	DABA50	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
INORGANIC ANALYTES													
Aluminum	7520.0	6400.0	7050.0	6910.0	6970.0	511.0	514.0	288.0	437.7	1480.0	416.0	404.0	766.7
Antimony	11.4 B	12.7 B	13.0 B	9.4 B	11.6	15.0 B	15.9 B	7.9 B	12.9	17.3 B	19.7 B	11.9 B	16.3
Arsenic	57.7	49.1	56.8	52.7	54.1	9.3 B	6.3 B	10.0	8.5	6.9 B	5.0 B	3.0 U	5.0
Barium	709.0	253.0	712.0	797.0	617.8	592.0	571.0	439.0	534.0	658.0	323.0	736.0	572.3
Beryllium	2.6 B	2.4 B	2.2 B	2.6 B	2.5	1.5 B	1.1 B	0.3 U	1.0	2.5 B	1.0 B	1.1 B	1.5
Cadmium	165.0	137.0	144.0	142.0	147.0	35.3	68.4	0.2 U	34.6	36.5	4.0 B	19.4	20.0
Calcium	109000.0	106000.0	116000.0	117000.0	112000.0	1770000	1710000	742000	1407333.3	1520000	694000	1550000	1254666.7
Chromium	247.0	209.0	227.0	219.0	225.5	78.2	79.5	19.9	59.2	145.0	15.7	33.8	64.8
Cobalt	4.5 B	3.6 B	4.3 B	3.9 B	4.1	60.7	55.2	5.8 B	40.6	59.9	11.7 B	39.9 B	37.2
Copper	169.0	144.0	164.0	168.0	161.3	721.0	538.0	805.0	688.0	532.0	208.0	436.0	392.0
Iron	27500.0	23500.0	25300.0	24100.0	25100.0	246.0	261.0	10.9 U	172.6	2240.0	10.9 U	65.5 B	772.1
Lead	1810.0	1520.0	1620.0	1570.0	1630.0	103.0	97.1	1.6 U	67.2	161.0	10.5	16.6	62.7
Magnesium	44300.0	38700.0	42300.0	41200.0	41625.0	215000.0	216000.0	47600.0	159533.3	193000.0	63900.0	174000.0	143633.3
Manganese	171.0	155.0	168.0	175.0	167.3	54600.0	50900.0	203.0	35234.3	39000.0	12900.0	39600.0	30500.0
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2	2.9	0.2	0.2 U	1.1	0.2 U	0.2 U	0.2 U	0.2
Nickel	127.0	105.0	113.0	141.0	121.5	317.0	331.0	25.2 B	224.4	346.0	73.5	207.0	208.8
Potassium	25300.0	21400.0	24200.0	23900.0	23700.0	59700.0	56000.0	65200.0	60300.0	52400.0	56000.0	46000.0	51466.7
Selenium	10.7	10.4	15.2	13.9	12.6	25.0	19.2	15.6	19.9	25.7	19.9	17.5	21.0
Silver	0.7 U	0.7 U	0.7 U	0.7 U	0.7	4.1 B	0.7 U	0.7 U	1.8	1.6 B	0.7 U	0.7 U	1.0
Sodium	228000	198000	219000	214000	214750.0	303000	288000	1080000	557000.0	266000	1120000	227000	537666.7
Thallium	3.5 U	3.5 U	3.5 U	3.5 U	3.5	3.5 U	3.5 U	4.3 B	3.8	3.5 U	3.5 U	3.5 U	3.5
Vanadium	79.9	71.4	78.4	75.6	76.3	16.0 B	15.4 B	40.0 B	23.8	14.8 B	18.5 B	15.6 B	16.3
Zinc	19800.0	17000.0	18000.0	17400.0	18050.0	14400.0	18300.0	5.9 B	10235.3	16300.0	1190.0	5080.0	7523.3
PCBs													
Aroclor-1016	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1221	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1232	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1242	7 C	12 CP	21 C	4 YP	11	46 C	50 C	29 CP	41.7	36 C	32 C	32 C	33.3
Aroclor-1248	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1254	--	1.6 YJP	0.89 J	--	0.22	3.9 Y	3.7 YJ	4.5 Y	4.0	3.2 Y	5 Y	2.2 YJ	3.5
Aroclor-1260	--	--	--	--	--	--	--	--	--	--	--	--	--
Total PCBs	7.0	14	22	4.0	11	50	54	34	46	39	37	34	37

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					Foster Wheeler Environmental BATCH #1 TCLP Method 1311				Foster Wheeler Environmental BATCH #1 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	E1S1	E1S2	E1S3	FW1	E1B1	E1B2	E1B3	FW1
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA11	DABA31	DABA51	TCLP	DABA12	DABA32	DABA52	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	3 J	7 J	4 J	4.7	--	--	2 J	0.7
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	49	41	55	48.3	8 J	4 J	20 J	10.7
1,4-Dichlorobenzene	140	66	110	94 D	102.5	200 D	160	160 D	173.3	39	15 J	84	46.0
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	3 J	3 J	3 J	3.0	--	--	1 J	0.3
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	6 J	13 J	6 J	8.3	--	5 J	4 J	3.0
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	4 J	5 J	4.3	--	--	2 J	0.7
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	3 J	--	1.0	--	2 J	--	0.7
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	--	5 J	3 J	2.7	--	16 J	--	5.3
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	16 JZ	14 ZJ	4 ZJ	11.3	3 ZJ	--	15 J	6.0
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

ord Harbor Superfund Site - Hot Spot Sediments
ale Treatability Study

	UNTREATED HOT SPOT SEDIMENT										Foster Wheeler Environmental BATCH #1 TCLP Method 1311								Foster Wheeler Environmental BATCH #1 TCLP Cage Method							
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated		E1S1		E1S2		E1S3		FW1		E1B1		E1B2		E1B3		FW1	
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment		DABA11		DABA31		DABA51		TCLP		DABA12		DABA32		DABA52		Cage	
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average	
INORGANIC ANALYTES																										
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0		947.0		843.0		1050.0		946.7		4100.0		4560.0		1270.0		3310.0	
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6		2.0	B	1.8	U	3.2	B	2.3		3.8	B	7.1	B	7.1	B	6.0	
Arsenic	57.7		49.1		56.8		52.7		54.1		3.0	U	3.0	U	3.0	U	3.0		3.0	U	3.0	U	3.2	B	3.1	
Barium	709.0		253.0		712.0		797.0		617.8		1220.0		1170.0		1260.0		1216.7		715.0		1200.0		1660.0		1191.7	
Beryllium	2.6	B	2.4	B	2.2	B	2.6	B	2.5		0.3	U	0.5	B	0.7	B	0.5		0.9	B	0.9	B	1.5	B	1.1	
Cadmium	165.0		137.0		144.0		142.0		147.0		0.2	U	0.2	U	0.2	U	0.2		10.5		19.0		72.3		33.9	
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0		1910000		2040000		2010000		1986666.7		471000.0		506000		1630000		869000.0	
Chromium	247.0		209.0		227.0		219.0		225.5		17.1		19.4		19.4		18.6		69.8		92.7		56.7		73.1	
Cobalt	4.5	B	3.6	B	4.3	B	3.9	B	4.1		8.0	B	7.8	B	7.6	B	7.8		2.9	B	5.5	B	21.7	B	10.0	
Copper	169.0		144.0		164.0		168.0		161.3		730.0		693.0		770.0		731.0		156.0		469.0		396.0		340.3	
Iron	27500.0		23500.0		25300.0		24100.0		25100.0		13.8	B	24.6	B	31.0	B	23.1		3900.0		4220.0		894.0		3004.7	
Lead	1810.0		1520.0		1620.0		1570.0		1630.0		2.2	B	1.6	U	1.6	U	1.8		146.0		179.0		63.6		129.5	
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0		674.0	B	1130.0	B	643.0	B	815.7		9560.0		11200.0		49000.0		23253.3	
Manganese	171.0		155.0		168.0		175.0		167.3		12.0	B	10.1	B	1.0	B	7.7		227.0		286.0		1120.0		544.3	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.4		0.5		0.3	
Nickel	127.0		105.0		113.0		141.0		121.5		89.3		83.0		84.9		85.7		39.7	B	67.1		220.0		108.9	
Potassium	25300.0		21400.0		24200.0		23900.0		23700.0		98100.0		99900.0		103000.0		100333.3		55100.0		57900.0		83500.0		65500.0	
Selenium	10.7		10.4		15.2		13.9		12.6		18.8		16.2		15.7		16.9		12.9		11.4		10.9		11.7	
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	B	2.2	B	1.2	
Sodium	228000		198000		219000		214000		214750.0		236000		245000		241000		240666.7		137000		149000		199000		161666.7	
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5		3.5	U	5.2	U	3.5	U	4.1	
Vanadium	79.9		71.4		78.4		75.6		76.3		46.0	B	60.7		45.1	B	50.6		16.2	B	10.1	B	15.2	B	13.8	
Zinc	19800.0		17000.0		18000.0		17400.0		18050.0		20.6		10.9	B	6.7	B	12.7		1410.0		2610.0		8740.0		4253.3	
PCBs																										
Aroclor-1016	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1221	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1232	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1242	7	C	12	CP	21	C	4	YP	11		5		28	YP	49	C	27.3		29	Y	38	C	88	Y	51.7	
Aroclor-1248	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1254	--		1.6	YJP	0.89	J	--		0.22		--		--		--		--		1	YJ	2.1	YJ	5.6	Y	2.9	
Aroclor-1260	--		--		--		--		--		--		--		--		--		--		--		--		--	
Total PCBs	7.0		14		22		4.0		11		5		28		49		27		30		40		94		55	

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					Foster Wheeler Environmental BATCH #2 TCLP Method 1311				Foster Wheeler Environmental BATCH #2 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	E2S1	E2S2	E2S3	FW2	E2B1	E2B2	E2B3	FW2
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA13	DABA33	DABA53	TCLP	DABA14	DABA15	DABA54	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	4 J	6 J	--	3.3	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	68	39	34	47.0	22	17 J	2 J	13.7
1,4-Dichlorobenzene	140	66	110	94 D	102.5	180 D	150	130	153.3	84	68	11 J	54.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	3 J	2 J	1.7	--	1 J	--	0.3
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	3 J	--	1.0
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	2 J	--	0.7	--	--	--	--
4-Methylphenol	--	--	--	--	--	6 J	11 J	--	5.7	4 J	--	--	1.3
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	3 J	1.0	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--		--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	4 J	4 J	4.0	3 J	2 J	--	1.7
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	2 J	0.7	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	8 J	2.7	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	3 J	4 J	4 J	3.7	4 J	17 J	10 J	10.3
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	7 ZJ	6 ZJ	4 ZJ	5.7	--	--	91	30.3
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

	UNTREATED HOT SPOT SEDIMENT										Foster Wheeler Environmental BATCH #2 TCLP Method 1311								Foster Wheeler Environmental BATCH #2 TCLP Cage Method							
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated		E2S1		E2S2		E2S3		FW2		E2B1		E2B2		E2B3		FW2	
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment		DABA13		DABA33		DABA53		TCLP		DABA14		DABA15		DABA54		Cage	
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average	
INORGANIC ANALYTES																										
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0		756.0		622.0		1620.0		999.3		4570.0		7240.0		4360.0		5390.0	
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6		2.1	B	1.9	B	2.1	B	2.0		5.5	B	5.9	B	2.8	B	4.7	
Arsenic	57.7		49.1		56.8		52.7		54.1		3.0	U	4.2	B	3.0	U	3.4		5.7	B	9.0	B	3.0	U	5.9	
Barium	709.0		253.0		712.0		797.0		617.8		1070.0		1060.0		1490.0		1206.7		1920.0		1880.0		728.0		1509.3	
Beryllium	2.6	B	2.4	B	2.2	B	2.6	B	2.5		0.8	B	0.8	B	0.3	U	0.6		2.4	B	2.5	B	1.0	B	2.0	
Cadmium	165.0		137.0		144.0		142.0		147.0		0.2	U	0.2	U	0.2	U	0.2		35.8		26.7		18.0		26.8	
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0		2010000		2090000		907000		1669000.0		1180000		1030000		498000		902666.7	
Chromium	247.0		209.0		227.0		219.0		225.5		19.3		20.8		21.7		20.6		175.0		308.0		86.1		189.7	
Cobalt	4.5	B	3.6	B	4.3	B	3.9	B	4.1		7.7	B	7.6	B	5.3	B	6.9		15.6	B	14.1	B	6.2	B	12.0	
Copper	169.0		144.0		164.0		168.0		161.3		543.0		700.0		934.0		725.7		60.7		43.4		438.0		180.7	
Iron	27500.0		23500.0		25300.0		24100.0		25100.0		29.4	B	28.0	B	49.7	B	35.7		10700.0		17200.0		4280.0		10726.7	
Lead	1810.0		1520.0		1620.0		1570.0		1630.0		1.7	B	3.0	B	6.1		3.6		206.0		276.0		159.0		213.7	
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0		1380.0	B	1900.0	B	43.6	B	1107.9		3320.0		29700.0		11100.0		14706.7	
Manganese	171.0		155.0		168.0		175.0		167.3		4.4	B	4.0	B	0.9	B	3.1		744.0		680.0		292.0		572.0	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.5		0.3	
Nickel	127.0		105.0		113.0		141.0		121.5		70.4		81.2		75.1		75.6		113.0		216.0		74.8		134.6	
Potassium	25300.0		21400.0		24200.0		23900.0		23700.0		95200.0		95600.0		125000.0		105266.7		67000.0		60500.0		53400.0		60300.0	
Selenium	10.7		10.4		15.2		13.9		12.6		18.9		18.6		8.4		15.3		17.0		14.7		6.4		12.7	
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	1.0	B	0.8	
Sodium	228000		198000		219000		214000		214750.0		229000		228000		1140000		532333.3		168000		153000		139000		153333.3	
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5	
Vanadium	79.9		71.4		78.4		75.6		76.3		77.6		86.0		10.1	B	57.9		23.0	B	33.8	B	9.4	B	22.1	
Zinc	19800.0		17000.0		18000.0		17400.0		18050.0		21.3		4.9	B	24.8		17.0		4640.0		4110.0		2270.0		3673.3	
PCBs																										
Aroclor-1016	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1221	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1232	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1242	7	C	12	CP	21	C	4	YP	11		2.6		53	YP	43	C	32.9		28	PC	8.6	PY	20	Y	18.9	
Aroclor-1248	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1254	--		1.6	YJP	0.89	J	--		0.22		--		--		--		--		8.8	PY	0.42	JP	1.1	JY	3.4	
Aroclor-1260	--		--		--		--		--		--		--		--		--		--		--		--		--	
Total PCBs	7.0		14		22		4.0		11		3		53		43		33		37		9		21		22	

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					Foster Wheeler Environmental BATCH #3 TCLP Method 1311				Foster Wheeler Environmental BATCH #3 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	E3S1	E3S2	E3S3	FW3	E3B1	E3B2	E3B3	FW3
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA16	DABA35	DABA55	TCLP	DABA17	DABA36	DABA56	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	4 J	5 J	--	3.0	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	34	37	36 J	35.7	24	44	7 J	25 0
1,4-Dichlorobenzene	140	66	110	94 D	102.5	120	3 J	140	87.7	90	150	34	91.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	11 J	3 J	4.7	2 J	4 J	--	2 0
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	6 J	--	12 J	6.0	2 J	--	3 J	1 7
N-Nitroso-di-n-propylamine	--	--	--	3 J	0 75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	3 J	--	1 0	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--		--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3 75	4 J	4 J	4 J	4 0	2 J	5 J	--	2 3
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1 25	--	--	--	--	--	3 J	--	1 0
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0 75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	--	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	.8 J	--	2.7	2 ZJ	3 J	4 J	3.0
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

	UNTREATED HOT SPOT SEDIMENT										Foster Wheeler Environmental BATCH #3 TCLP Method 1311								Foster Wheeler Environmental BATCH #3 TCLP Cage Method							
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated		E3S1		E3S2		E3S3		FW3		E3B1		E3B2		E3B3		FW3	
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment		DABA16		DABA35		DABA55		TCLP		DABA17		DABA36		DABA56		Cage	
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average	
INORGANIC ANALYTES																										
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0		1260.0		1270.0		1400.0		1310.0		1040.0		1080.0		8680.0		3600.0	
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6		1.8	U	1.8	U	1.8	U	1.8		1.8	U	1.8	U	6.1	B	3.2	
Arsenic	57.7		49.1		56.8		52.7		54.1		3.0	U	3.0	U	3.0	U	3.0		3.0	U	3.0	U	3.0	U	3.0	
Barium	709.0		253.0		712.0		797.0		617.8		1520.0		1500.0		2260.0		1760.0		1360.0		1170.0		1580.0		1370.0	
Beryllium	2.6	B	2.4	B	2.2	B	2.8	B	2.5		0.4	B	0.3	U	0.5	B	0.4		0.5	B	0.9	B	2.0	B	1.1	
Cadmium	165.0		137.0		144.0		142.0		147.0		0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	29.8		10.1	
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0		1890000		1890000		930000		1570000.0		1850000		1250000		812000		1304000.0	
Chromium	247.0		209.0		227.0		219.0		225.5		13.3		11.1		19.1		14.5		13.4		10.2		290.0		104.5	
Cobalt	4.5	B	3.6	B	4.3	B	3.9	B	4.1		6.9	B	6.8	B	5.3	B	6.3		6.8	B	7.0	B	13.4	B	9.1	
Copper	169.0		144.0		164.0		168.0		161.3		810.0		781.0		868.0		819.7		297.0		710.0		641.0		549.3	
Iron	27500.0		23500.0		25300.0		24100.0		25100.0		27.9	B	31.3	B	609.0		222.7		67.0	B	118.0		10100.0		3428.3	
Lead	1810.0		1520.0		1620.0		1570.0		1630.0		3.5		2.1	B	12.4		6.0		3.0	B	5.4		249.0		85.8	
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0		176.0	B	228.0	B	75.6	B	159.9		280.0	B	94.3	B	21300.0		7224.8	
Manganese	171.0		155.0		168.0		175.0		167.3		1.4	B	1.5	B	3.3	B	2.1		2.8	B	4.6	B	567.0		191.5	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2	
Nickel	127.0		105.0		113.0		141.0		121.5		70.7		68.6		69.9		69.7		64.2		97.1		213.0		124.8	
Potassium	25300.0		21400.0		24200.0		23900.0		23700.0		109000.0		109000.0		142000.0		120000.0		98900.0		90800.0		64400.0		84700.0	
Selenium	10.7		10.4		15.2		13.9		12.6		11.1		12.0		8.8		10.6		17.7		8.8		11.1		12.5	
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	0.7	U	0.7	
Sodium	228000		198000		219000		214000		214750.0		226000		230000		1120000		525333.3		212000		197000		143000		184000.0	
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5		4.6	U	3.5	U	4.0	B	4.0	
Vanadium	79.9		71.4		78.4		75.6		76.3		17.1	B	21.3	B	3.8	B	14.1		21.2	B	8.1	B	17.5	B	15.6	
Zinc	19800.0		17000.0		18000.0		17400.0		18050.0		6.5	B	5.6	B	170.0		60.8		15.7	B	13.1	B	3940.0		1322.9	
PCBs																										
Aroclor-1016	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1221	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1232	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1242	7	C	12	CP	21	C	4	YP	11		5.5	Y	76	C	32	C	37.8		28	Y	34	C	33	C	31.7	
Aroclor-1248	--		--		--		--		--		--		--		--		--		--		--		--		--	
Aroclor-1254	--		1.6	YJP	0.89	J	--		0.22		--		22	Y	--		7.3		1.2	YJ	5.8	C	1.9	YJ	3.0	
Aroclor-1260	--		--		--		--		--		--		--		--		--		--		--		--		--	
Total PCBs	7.0		14		22		4.0		11		5.5		98		32		45		29		40		35		35	

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					World Environmental BATCH #2 TCLP Method 1311				World Environmental BATCH #2 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	W2S1	W2S2	W2S3	W2	W2B1	W2B2	W2B3	W2
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA20	DABA40	DABA59	TCLP	DABA21	DABA41	DABA60	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	5 J	4 J	--	3.0	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	21	18 J	22	20.3	5 J	8 J	9 J	7.3
1,4-Dichlorobenzene	140	66	110	94 D	102.5	97	84	110	97.0	25	32	44	33.7
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	5 J	4 J	4 J	4.3	--	6 J	2 J	2.7
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--		--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	3 J	4 J	3.7	--	3 J	2 J	1.7
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	3 J	--	--	1.0	18 J	--	--	6.0
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	5 J	2 J	5 JZ	4.0	--	--	--	--
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

	UNTREATED HOT SPOT SEDIMENT					World Environmental BATCH #2 TCLP Method 1311				World Environmental BATCH #2 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	W2S1	W2S2	W2S3	W2	W2B1	W2B2	W2B3	W2
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA20	DABA40	DABA59	TCLP	DABA21	DABA41	DABA60	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
INORGANIC ANALYTES													
Aluminum	7520.0	6400.0	7050.0	6910.0	6970.0	683.0	662.0	674.0	673.0	4090.0	1690.0	2010.0	2596.7
Antimony	11.4 B	12.7 B	13.0 B	9.4 B	11.6	1.8 U	1.8 U	1.8 U	1.8	7.4 B	12.9 B	12.6 B	11.0
Arsenic	57.7	49.1	56.8	52.7	54.1	3.0 U	3.1 B	5.4 B	3.8	3.0 U	3.0 U	3.0 U	3.0
Barium	709.0	253.0	712.0	797.0	617.8	354.0	419.0	374.0	382.3	300.0	524.0	425.0	416.3
Beryllium	2.6 B	2.4 B	2.2 B	2.6 B	2.5	0.7 B	0.5 B	3.0 U	1.4	0.9 B	1.3 B	1.1 B	1.1
Cadmium	165.0	137.0	144.0	142.0	147.0	0.2 U	0.2 U	0.2 U	0.2	28.2	82.4 U	58.3	56.3
Calcium	109000.0	106000.0	116000.0	117000.0	112000.0	2220000	2130000	2070000	2140000.0	690000	1570000	1200000	1153333.3
Chromium	247.0	209.0	227.0	219.0	225.5	13.5	14.6	12.9	13.7	166.0	184.0	113.0	154.3
Cobalt	4.5 B	3.6 B	4.3 B	3.9 B	4.1	3.3 B	2.6 B	3.2 B	3.0	4.9 B	12.0 B	8.3 B	8.4
Copper	169.0	144.0	164.0	168.0	161.3	1400.0	1300.0	1320.0	1340.0	753.0	1650.0	1070.0	1157.7
Iron	27500.0	23500.0	25300.0	24100.0	25100.0	26.1 B	83.0 B	60.6 B	56.6	4520.0	2530.0	2370.0	3140.0
Lead	1810.0	1520.0	1620.0	1570.0	1630.0	2.8 B	1.6 U	1.6 U	2.0	375.0	318.0	172.0	288.3
Magnesium	44300.0	38700.0	42300.0	41200.0	41625.0	267.0 B	168.0 B	188.0 B	207.7	10700.0	31900.0	22600.0	21733.3
Manganese	171.0	155.0	168.0	175.0	167.3	0.6 B	2.0 B	0.4 B	1.0	735.0	731.0	539.0	668.3
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2	0.2 U	0.2 U	0.2 U	0.2	0.2 U	1.2	0.9	0.8
Nickel	127.0	105.0	113.0	141.0	121.5	63.8	72.0	67.6	67.8	132.0	182.0	137.0	150.3
Potassium	25300.0	21400.0	24200.0	23900.0	23700.0	61400.0	57500.0	59100.0	59333.3	26900.0	42100.0	37500.0	35500.0
Selenium	10.7	10.4	15.2	13.9	12.6	6.0	10.9	13.8	10.2	13.8	15.2	9.5	12.8
Silver	0.7 U	0.7 U	0.7 U	0.7 U	0.7	0.7 U	0.7 U	0.7 U	0.7	0.7 U	6.9 B	5.6 B	4.4
Sodium	228000	198000	219000	214000	214750.0	285000	256000	277000	272666.7	134000	187000	178000	166333.3
Thallium	3.5 U	3.5 U	3.5 U	3.5 U	3.5	3.7 B	3.8 B	3.5 U	3.7	3.8 B	4.6 B	3.5 U	4.0
Vanadium	79.9	71.4	78.4	75.6	76.3	20.2 B	11.6 B	14.8 B	15.5	16.0 B	14.1 B	12.1 B	14.1
Zinc	19800.0	17000.0	18000.0	17400.0	18050.0	5.7 B	12.0 B	9.0 B	8.9	3480.0	10200.0	7300.0	6993.3
PCBs													
Aroclor-1016	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1221	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1232	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1242	7 C	12 CP	21 C	4 YP	11	14 Y	18 CP	40 C	24.0	28 Y	28 C	72 C	42.7
Aroclor-1248	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1254	--	1.6 YJP	0.89 J	--	0.22	1.6 YJ	0.87 JP	--	0.8	1.9 YJ	1.2 JY	4.1 YJ	2.4
Aroclor-1260	--	--	--	--	--	--	--	--	--	--	--	--	--
Total PCBs	7.0	14	22	4.0	11	16	19	40	25	30	29	76	45

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					World Environmental BATCH #3 TCLP Method 1311				World Environmental BATCH #3 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	W3S1	W3S2	W3S3	W3	W3B1	W3B2	W3B3	W3
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA22	DABA23	DABA61	TCLP	DABA24	DABA44	DABA62	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	4 J	--	--	1.3	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	38	30	17 J	28.3	7 J	5 J	17 J	9.7
1,4-Dichlorobenzene	140	66	110	94 D	102.5	140	140	85	121.7	33	19 J	81	44.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	--	--	--	--	--	1 J	0.3
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	5 J	7 J	5 J	5.7	--	3 J	2 J	1.7
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	4 J	3 J	3.7	--	--	3 J	1.0
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	3 J	--	--	1.0	16 J	--	5 J	7.0
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	10 JZ	29	3 JZ	14.0	3 ZJ	--	5 J	2.7
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

	UNTREATED HOT SPOT SEDIMENT										World Environmental BATCH #1 TCLP Method 1311						World Environmental BATCH #1 TCLP Cage Method							
FIELD ID #:	Bucket #11		Bucket #11		Bucket #13		Bucket #15		Untreated		W1S1		W1S2		W1S3		W1		W1B1		W1B2		W1B3		W1
SAMPLE ID #:	DABA01		DABA02		DABA03		DABA04		Sediment		DABA18		DABA38		DABA57		TCLP		DABA19		DABA39		DABA58		Cage
DATE SAMPLED:	18-Jan-96		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average		18-Jan-96		18-Jan-96		18-Jan-96		Average
INORGANIC ANALYTES																									
Aluminum	7520.0		6400.0		7050.0		6910.0		6970.0		635.0		667.0		664.0		655.3		4080.0		6470.0		4320.0		4956.7
Antimony	11.4	B	12.7	B	13.0	B	9.4	B	11.6		1.8	U	1.8	U	1.8	U	1.8		14.5	B	9.6	B	7.0	B	10.4
Arsenic	57.7		49.1		56.8		52.7		54.1		3.0	U	4.2	B	3.0	U	3.4		3.7	B	3.0	B	3.2	B	3.3
Barium	709.0		253.0		712.0		797.0		617.8		344.0		335.0		609.0		429.3		503.0		701.0		340.0		514.7
Beryllium	2.6	B	2.4	B	2.2	B	2.6	B	2.5		0.3	B	0.3	U	0.6	B	0.4		1.3	B	1.3	B	1.6	B	1.4
Cadmium	165.0		137.0		144.0		142.0		147.0		0.2	U	0.2	U	0.2	U	0.2		76.6		40.0		31.9		49.5
Calcium	109000.0		106000.0		116000.0		117000.0		112000.0		2180000		2100000		2060000		2113333.3		1500000		819000		785000		1034666.7
Chromium	247.0		209.0		227.0		219.0		225.5		14.6		13.9		14.7		14.4		258.0		296.0		152.0		235.3
Cobalt	4 5	B	3.6	B	4.3	B	3.9	B	4.1		3.6	B	3.8	B	2.9	B	3.4		12.4	B	5.7	B	4.1	B	7.4
Copper	169.0		144.0		164.0		168.0		161.3		1390.0		1420.0		1250.0		1353.3		1580.0		1300.0		931.0		1270.3
Iron	27500.0		23500.0		25300.0		24100.0		25100.0		24.6	B	52.8	B	93.5	B	57.0		4790.0		6590.0		3840.0		5073.3
Lead	1810.0		1520.0		1620 0		1570.0		1630.0		2.3	B	4.1		2.2	B	2.9		367.0	B	572.0		398.0		445.7
Magnesium	44300.0		38700.0		42300.0		41200.0		41625.0		333.0	B	275.0	B	189.0	B	265.7		30700.0		15500.0		12200 0		19466.7
Manganese	171.0		155.0		168.0		175.0		167.3		0.6	B	2.6	B	1.2	B	1.5		736.0		380.0		295 0		470.3
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2		0.2	U	0.2	U	0.2	U	0.2
Nickel	127.0		105.0		113.0		141.0		121.5		72.9		68.4		71.4		70.9		217.0		112.0		79.2		136.1
Potassium	25300.0		21400.0		24200.0		23900.0		23700 0		58800.0		57300.0		56400.0		57500.0		35900.0		24800.0		31000 0		30566.7
Selenium	10.7		10.4		15.2		13.9		12.6		12.0		18.3		14.5		14.9		7.9		13.2		12.3		11.1
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7		0.7	U	0.7	U	0.7	U	0.7		6.8	B	0.7	U	1.1	B	2.9
Sodium	228000		198000		219000		214000		214750.0		285000		281000		268000		278000.0		171000		124000		157000		150666.7
Thallium	3.5	U	3.5	U	3.5	U	3.5	U	3.5		3.6	B	3.5	U	3.5	U	3.5		3.5	U	3.5	U	3.5	U	3.5
Vanadium	79.9		71.4		78.4		75.6		76.3		21.3	B	20.2	B	13.0	B	18.2		18.3	B	20.0	B	14.2	B	17.5
Zinc	19800.0		17000.0		18000.0		17400.0		18050.0		10.7	B	8.4	B	25.6		14.2		9680.0		5310.0		3980.0		6323.3
PCBs																									
Aroclor-1016	--		--		--		--		--		--		--		--		--		--		--		--		--
Aroclor-1221	--		--		--		--		--		--		--		--		--		--		--		--		--
Aroclor-1232	--		--		--		--		--		--		--		--		--		--		--		--		--
Aroclor-1242	7	C	12	CP	21	C	4	YP	11		43	C	41	C	36	C	40.0		83	C	43	Y	73	C	66.3
Aroclor-1248	--		--		--		--		--		--		--		--		--		--		--		--		--
Aroclor-1254	--		1.6	YJP	0.89	J	--		0.22		2.2	CJ	3.7	YJ	2.5	YJ	2.8		6.7	Y	2.5	YJ	6 1	YJ	5.1
Aroclor-1260	--		--		--		--		--		--		--		--		--		--		--		--		--
Total PCBs	7 0		14		22		4.0		11		45		45		39		43		90		46		79		71

New Bedford Harbor Superfund Site - Hot Spot Sediments
Bench Scale Treatability Study

	UNTREATED HOT SPOT SEDIMENT					World Environmental BATCH #1 TCLP Method 1311				World Environmental BATCH #1 TCLP Cage Method			
FIELD ID #:	Bucket #11	Bucket #11	Bucket #13	Bucket #15	Untreated	W1S1	W1S2	W1S3	W1	W1B1	W1B2	W1B3	W1
SAMPLE ID #:	DABA01	DABA02	DABA03	DABA04	Sediment	DABA18	DABA38	DABA57	TCLP	DABA19	DABA39	DABA58	Cage
DATE SAMPLED:	18-Jan-96	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average	18-Jan-96	18-Jan-96	18-Jan-96	Average
COMPOUND													
Phenol	--	--	--	2 J	2	4 J	--	--	1.3	4 J	--	--	1.3
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	3 J	--	--	2 J	1.25	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	48	16 J	29	68	40.25	25	20 J	17 J	20.7	17 J	9 J	7 J	11.0
1,4-Dichlorobenzene	140	66	110	94 D	102.5	100	96	79	91.7	70	39	36	48.3
1,2-Dichlorobenzene	1 J	--	2 J	2 J	1.25	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-Oxybis (1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	4 J	3 J	4 J	3.7	3 J	--	--	1.0
N-Nitroso-di-n-propylamine	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	13 J	8 J	14 J	18 J	13.25	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	7 J	--	2 J	6 J	3.75	4 J	3 J	3 J	3.3	4 J	--	--	1.3
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	4 J	--	--	3 J	1.75	--	--	--	--	2 J	--	--	0.7
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	3 J	--	--	2 J	1.25	--	--	--	--	2 J	--	--	0.7
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	2 J	--	--	6 J	2	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	3 J	0.75	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	2 J	--	0.7	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	11 J	--	--	3.7
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	9 J	2.25	3 J	--	--	1.0	--	9 J	--	3.0
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	3 J	--	--	6 J	2.25	--	--	--	--	2 J	--	--	0.7
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	12 JZ	3 J	2 J	5.7	--	3 ZJ	7 J	3.3
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--

APPENDIX B

Alternative HS-1:
No Further Action

ARARs TABLES

Table B-1-1
Chemical-Specific ARARs and TBCs, Alternative HS-1

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-1-2
Location-Specific ARARs and TBCs - Alternative HS-1

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats) (Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions, including operation and maintenance, within filled tidelands and adjacent to flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-1-3
Action-Specific ARARs and TBCs, Alternative HS-1

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements- PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will adequately protect health and the environment.	Permanent storage of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA Chemical Waste Landfill Standards	40 CFR 761.75	Relevant and Appropriate	Standards for the construction, operation, and monitoring of facilities used to dispose of PCBs, unless a waiver is granted under Sec. 761.75(c)(4).	The facility will be operated and maintained to satisfy the substantive requirements of these standards. Waivers will be required for specific requirements regarding hydrologic conditions, flood protection, and leachate collection upon a finding by the Regional Administrator that the operation of the facility will not present an unreasonable risk of injury to health or the environment.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.

Table B-1-3
Action-Specific ARARs and TBCs, Alternative HS-1

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when in evaluating PCB issues associated with in-place disposal of contaminated sediment.
Massachusetts				
Hazardous Waste Management Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establish standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges from the facility from monitoring, operations and/or maintenance.
Hazardous Waste Management Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.

Table B-1-3
Action-Specific ARARs and TBCs, Alternative HS-1

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air levels for contaminants including PCBs and particulates.	Emissions from the CDF will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.

Table B-1-3
Action-Specific ARARs and TBCs, Alternative HS-1

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
MADEP - Assessment and Control of Dioxin in Massachusetts		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions. (To be used to convert to a toxic equivalent concentration of 2,3 7,8-TCDD and compared to the Massachusetts standard).	Alternatives with on-site sediment containment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions and will consider using the Massachusetts dioxin air guidance.

Alternative HS-2A: Solvent Extraction and Solid Phase Chemical Destruction

ARARs TABLES

Table B-2A-1
Chemical-Specific ARARs and TBCs, Alternative HS-2A

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Tabl 2A-2
Location-Specific ARARs a..d TBCs - Alternative HS-2A

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats) (Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Extraction and treatment facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions, including operation and maintenance, within filled tidelands and adjacent to flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-2A-3
Action-Specific ARARs and TBCs, Alternative 2A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	On-site separation and destruction of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.

Table B-2A-3
Action-Specific ARARs and TBCs, Alternative 2A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of contaminated dewatered sediment and treated material.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the separation and treatment facility will be protective of health and the environment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(e) (1-5,7)	Relevant and Appropriate	Describes the substantive requirements of closure plans for commercial PCB storage facilities, including groundwater monitoring, run-on and run-off control, and facility security. The facility must be closed so as to prevent post-closure releases of PCBs.	The site will be closed consistent with this section. No PCB contaminated material is to be left on site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the separation/treatment facilities.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.

Table B-2A-3
Action-Specific ARARs and TBCs, Alternative 2A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will bc carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with storage and treatment of contaminated sediment.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Applicable	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the treated sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or process wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.

Table B-2A-3
Action-Specific ARARs and TBCs, Alternative 2A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.

Table B-2A-3
Action-Specific ARARs and TBCs, Alternative 2A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the separation/treatment facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the separation/treatment facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment, separation and treatment technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment treatment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-2B: Solvent Extraction and Gas Phase Chemical Destruction

ARARs TABLES

Table B-2B-1
Chemical-Specific ARARs and TBCs, Alternative HS-2B

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-2B-2
Location-Specific ARARs and TBCs - Alternative HS-2B

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Extraction and treatment facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table 11-2B-3
Action-Specific ARARs and TBCs, Alternative 2B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	On-site separation and destruction of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.

Table H-2B-3
Action-Specific ARARs and TBCs, Alternative 2B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of contaminated dewatered sediment and treated material.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the separation and treatment facility will be protective of health and the environment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(e) (1-5,7)	Relevant and Appropriate	Describes the substantive requirements of closure plans for commercial PCB storage facilities, including groundwater monitoring, run-on and run-off control, and facility security. The facility must be closed so as to prevent post-closure releases of PCBs.	The site will be closed consistent with this section. No PCB contaminated material is to be left on site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the separation/treatment facilities.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.

Table ..-2B-3
Action-Specific ARARs and TBCs, Alternative 2B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with storage and treatment of contaminated sediment.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Applicable	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the treated sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establish standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or process wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.

Table ..-2B-3
Action-Specific ARARs and TBCs, Alternative 2B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are Classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the separation/treatment facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the separation/treatment facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment, separation and treatment technologies having air emissions will consider the TELs and AALs.

Table 11-2B-3
Action-Specific ARARs and TBCs, Alternative 2B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment treatment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-2C: Solvent Extraction and Off-Site Incineration

ARARs TABLES

Table B-2C-1
Chemical-Specific ARARs and TBCs, Alternative HS-2C

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-2C-2
Location-Specific ARARs and TBCs - Alternative HS-2C

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100 foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Extraction facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.

Table B-2C-2
Location-Specific ARARs and TBCs - Alternative HS-2C

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-2C-3
Action-Specific ARARs and TBCs, Alternative 2C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	On-site separation and off-site incineration of the contaminated dredge spoil at the CDF complies with these regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Separated PCB contaminated material (oily wastes) will be stored, if necessary, prior to off-site destruction, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Separated PCB contaminated material will be stored, if necessary, prior to off-site destruction to satisfy this requirement.

Table B-2C-3
Action-Specific ARARs and TBCs, Alternative 2C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of separated PCB contaminated material, if necessary, prior to off-site destruction.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the separation facility will be protective of health and the environment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(e) (1-5,7)	Relevant and Appropriate	Describes the substantive requirements of closure plans for commercial PCB storage facilities, including groundwater monitoring, run-on and run-off control, and facility security. The facility must be closed so as to prevent post-closure releases of PCBs.	The site will be closed consistent with this section. No PCB contaminated material is to be left on site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the separation/storage facilities.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (AWQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.

Table B-2C-3
Action-Specific ARARs and TBCs, Alternative 2C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when in evaluating PCB issues associated with separation and storage of contaminated material.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Applicable	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the treated sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establish standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or process wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.

Table B-2C-3
Action-Specific ARARs and TBCs, Alternative 2C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the separation facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the separation facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment and separation technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.

Table B-2C-3
Action-Specific ARARs and TBCs, Alternative 2C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment separation technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-3A: Thermal Desorption and Solid Phase Chemical Destruction

ARARs TABLES

Table B-3A-1
Chemical-Specific ARARs and TBCs, Alternative HS-3A

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-3A-2
Location-Specific ARARs and TBCs - Alternative HS-3A

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARS
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Separation and treatment facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.

Table B-3A-2
Location-Specific ARARs and TBCs - Alternative HS-3A

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARS
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-3A-3
Action-Specific ARARs and TBCs, Alternative 3A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and environment.	On-site separation and destruction of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.

Table B-3A-3
Action-Specific ARARs and TBCs, Alternative 3A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of contaminated dewatered sediment and separated material.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the separation and treatment facility will be protective of health and the environment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(e) (1 5,7)	Relevant and Appropriate	Describes the substantive requirements of closure plans for commercial PCB storage facilities, including groundwater monitoring, run-on and run-off control, and facility security. The facility must be closed so as to prevent post-closure releases of PCBs.	The site will be closed consistent with this section. No PCB contaminated material is to be left on site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the treatment facilities.

Table B-3A-3
Action-Specific ARARs and TBCs, Alternative 3A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Lead (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with storage and treatment of contaminated sediment.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Applicable	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the treated sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or process wastes from the facility.

Table _ -3A-3
Action-Specific ARARs and TBCs, Alternative 3A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments or any process or dewatering discharge will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.

Table B-3A-3
Action-Specific ARARs and TBCs, Alternative 3A

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the treatment facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the separation/treatment facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment, separation and treatment technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment treatment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-3B: Thermal Desorption and Gas Phase Chemical Destruction

ARARs TABLES

Table B-3B-1
Chemical-Specific ARARs and TBCs, Alternative HS-3B

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-3B-2
Location-Specific ARARs and TBCs - Alternative HS-3B

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Separation and treatment facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.

Table B-3B-2
Location-Specific ARARs and TBCs - Alternative HS-3B

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-3B-3
Action-Specific ARARs and TBCs, Alternative 3B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements- PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	On-site separation and destruction of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.

Table B-3B-3
Action-Specific ARARs and TBCs, Alternative 3B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of contaminated dewatered sediment and separated material.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the separation and treatment facility will be protective of health and the environment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(e) (1 5,7)	Relevant and Appropriate	Describes the substantive requirements of closure plans for commercial PCB storage facilities, including groundwater monitoring, run-on and run-off control, and facility security. The facility must be closed so as to prevent post-closure releases of PCBs.	The site will be closed consistent with this section. No PCB contaminated material is to be left on site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the separation/treatment facilities.

Table B-3B-3
Action-Specific ARARs and TBCs, Alternative 3B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with storage and treatment of contaminated sediment.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Applicable	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the treated sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or process wastes from the facility.

Table B-3B-3
Action-Specific ARARs and TBCs, Alternative 3B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.

Table B-3B-3
Action-Specific ARARs and TBCs, Alternative 3B

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the separation/treatment facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the separation/treatment facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment, separation and treatment technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment treatment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-3C: Thermal Desorption and Off-Site Incineration

ARARs TABLES

Table B-3C-1
Chemical-Specific ARARs and TBCs, Alternative HS-3C

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table _-3C-2
Location-Specific ARARs and TBCs - Alternative HS-3C

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Separation facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-3C-3
Action-Specific ARARs and TBCs, Alternative 3C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	On-site separation and off-site incineration of the contaminated dredge spoil at the CDF complies with these regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Separated PCB contaminated material will be stored, if necessary, prior to off-site destruction, to satisfy this requirement.

Table B-3C-3
Action-Specific ARARs and TBCs, Alternative 3C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Separated PCB contaminated material will be stored, if necessary, prior to off-site destruction to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Separated PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of separated PCB contaminated material, if necessary, prior to offsite destruction.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the separation facility will be protective of health and the environment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(e) (1-5,7)	Relevant and Appropriate	Describes the substantive requirements of closure plans for commercial PCB storage facilities, including groundwater monitoring, run-on and run-off control, and facility security. The facility must be closed so as to prevent post-closure releases of PCBs.	The site will be closed consistent with this section. No PCB contaminated material is to be left on site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the separation/storage facilities.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.

Table B-3C-3
Action-Specific ARARs and TBCs, Alternative 3C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emission from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with separation and storage of contaminated material.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Applicable	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the treated sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or process wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.

Table B-3C-3
Action-Specific ARARs and TBCs, Alternative 3C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.

Table B-3C-3
Action-Specific ARARs and TBCs, Alternative 3C

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the separation facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the separation facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment and separation technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment separation technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-4:
Staged Vitrification

ARARs TABLES

Table B-4-1
Chemical-Specific ARARs and TBCs, Alternative HS-4

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-4-2
Location-Specific ARARs and TBCs - Alternative HS-4

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Dewatering and treatment facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-4-3
Action-Specific ARARs and TBCs, Alternative 4

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements- PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	On-site dewatering and destruction of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection proces, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs. PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners. Dewatered PCB contaminated material will be stored, if necessary, to satisfy this requirement.

Table B-4-3
Action-Specific ARARs and TBCs, Alternative 4

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable. Dewatered PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1) (v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. Dewatered PCB contaminated material will be stored, if necessary, to satisfy this requirement.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments. Sufficient space will be developed for storage of contaminated dewatered sediment prior to treatment.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2) (vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The operation of the dewatering and treatment facility will be protective of health and the environment.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF or the treatment facilities.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.

Table B-4-3
Action-Specific ARARs and TBCs, Alternative 4

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emissions from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with storage and treatment of contaminated sediment.
Massachusetts				
Solid Waste Management	21A MGL 2 and 8; 310 CMR 19.00	Relevant and Appropriate	This regulation establishes rules and requirements for solid waste facilities; including cover systems; surface water and ground water protection; monitoring and post-closure.	Disposal of the vitrified sediment containing less than 50 ppm of PCBs will meet the substantive requirements of these provisions.
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or dewatering wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.

Table B-4-3
Action-Specific ARARs and TBCs, Alternative 4

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air levels for contaminants including PCBs and particulates.	Emissions from the CDF and the dewatering/treatment facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the dewatering/treatment facility will comply with the substantive requirements of these provisions.

Table B-4-3
Action-Specific ARARs and TBCs, Alternative 4

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment, dewatering and treatment technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment dewatering and treatment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-5:
In-Place Capping

ARARs TABLES

Table B-5-1
Chemical-Specific ARARs and TBCs, Alternative HS-5

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-5-2
Location-Specific ARARs and TBCs - Alternative HS-5

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec.10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.

Table B-5-2
Location-Specific ARARs and TBCs - Alternative HS-5

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions, including operation and maintenance, within filled tidelands and adjacent flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-5-3
Action-Specific ARARs and TBCs, Alternative 5

Medium Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will adequately protect health and the environment.	Permanent storage of the contaminated dredge spoil at the CDF must be approved by the Regional Administrator under the terms of the regulations.
TSCA Chemical Waste Landfill Standards	40 CFR 761.75	Relevant and Appropriate	Standards for the construction, operation, and monitoring of facilities used to dispose of PCBs, unless a waiver is granted under Sec. 761.75(c)(4).	The facility will be operated and maintained to satisfy the substantive requirements of these standards. Waivers will be required for specific requirements regarding hydrologic conditions, flood protection, and leachate collection upon a finding by the Regional Administrator that the operation of the facility will not present an unreasonable risk of injury to health or the environment.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emissions from the facility will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

Table B-5-3
Action-Specific ARARs and TBCs, Alternative 5

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with in-place capping of contaminated sediment.
Massachusetts				
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges and process wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities·	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper,	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.

Table B-5-3
Action-Specific ARARs and TBCs, Alternative 5

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MADEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions. (To be used to convert to a toxic equivalent concentration of 2,3 7,8-TCDD and compared to the Massachusetts standards.	Alternatives with on-site sediment containment technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions and will consider using the Massachusetts dioxin air guidance.

Alternative HS-6:
Off-Site Landfilling

ARARs TABLES

Table B-6-1
Chemical-Specific ARARs and TBCs, Alternative HS-6

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-6-2
Location-Specific ARARs and TBCs - Alternative HS-6

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards. Dewatering and loading facilities will be protected from flooding.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore substantive coastal zone management requirements will be met.

Table B-6-2
Location-Specific ARARs and TBCs - Alternative HS-6

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-6-3
Action-Specific ARARs and TBCs, Alternative 6

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements- PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	Sediments will be disposed of in a permitted TSCA facility.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners.

Table B-6-3
Action-Specific ARARs and TBCs, Alternative 6

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. The dewatering facility will be located above the 100-foot flood elevation.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(ii)	Relevant and Appropriate	CDF facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The cover for Cell #1 would have to be extended to overlap the cell walls to prevent persons from falling in. Air, groundwater, and surface water monitoring in the vicinity of the CDF will be continued to verify protectiveness of controls until all of the sediments are removed off-site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.

Table B-6-3
Action-Specific ARARs and TBCs, Alternative 6

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emissions from the facility, including from the dewatering process, will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with removal, dewatering, and offsite disposal of contaminated sediment.
Massachusetts				
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establishes standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or dewatering wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.

Table B-6-3
Action-Specific ARARs and TBCs, Alternative 6

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments and the water from dewatering will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the dewatering facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the dewatering facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment and dewatering technologies having air emissions will consider the TELs and AALs.

Table B-6-3
Action-Specific ARARs and TBCs, Alternative 6

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment dewatering technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.

Alternative HS-7:
Off-Site Incineration

ARARs TABLES

Table B-7-1
Chemical-Specific ARARs and TBCs, Alternative HS-7

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Reference Doses (RfDs)		To Be Considered	These are guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Operation and maintenance of the facility will minimize exposure to potential receptors.
Massachusetts				
			There are no state chemical-specific ARARs.	

Table B-7-2
Location-Specific ARARs and TBCs - Alternative HS-7

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Federal				
Floodplain Management - Executive Order 11988	40 CFR Part 6, Appendix A	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	The facility lies within the 100-year coastal floodplain. The potential effects of any action must be evaluated to ensure that the planning and decision making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural and beneficial values, wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.; 40 CFR 6.302	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss.	Appropriate agencies will be consulted prior to implementation to find ways to minimize adverse effects to fish and wildlife from facility operation and maintenance.
Coastal Zone Management Act	16 USC Parts 1451 et seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.
Massachusetts				
Wetlands Protection Act	131 MGL 40; 310 CMR 10.00	Applicable	These standards regulate the dredging, filling, altering, or polluting of coastal and inland wetland resource areas. Protected resource areas within and adjacent to the site include: Land Subject to Coastal Storm Flowage (Sec. 10.02(1)(d)), Land Under Ocean (Sec. 10.25), Designated Port Area (Sec. 10.26), Coastal Beaches (including tidal flats)(Sec. 10.27), Coastal Bank (Sec. 10.30), and Land Containing Shellfish (Sec. 10.34). There is a 100-foot buffer zone landward of the Coastal Bank.	Operation and maintenance of the facility within the 100-year floodplain and the 100-foot buffer zone to the coastal bank will comply with the substantive requirements of the standards.
Coastal Zone Management	301 CMR 21.00	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore applicable coastal zone management requirements will be met.

Table B-7-2
Location-Specific ARARs and TBCs - Alternative HS-7

Requirement	Citation	Status	Requirement Synopsis	Actions To Be Taken To Attain ARARs
Waterways	310 CMR 9.00	Applicable	Sets forth criteria for work within flowed and filled tidelands. Waterways concerns focus on the long term viability of marine uses and protecting public rights in tidelands, including fishing and access.	Actions within filled and flowed tidelands at the site will comply with the regulation's environmental standards.

Table B-7-3
Action-Specific ARARs and TBCs, Alternative 7

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Federal				
Toxic Substances Control Act (TSCA), Disposal Requirements-PCBs Contaminated Dredged Spoil	15 USC 2601-2692; 40 CFR 761.60(a)(5)	Applicable	Dredged materials with PCBs at concentrations greater than 50 ppm must be disposed of either in an incinerator, or in a chemical waste landfill, or, when the first 2 options are not reasonable and appropriate, by a disposal method which will protect health and the environment.	Sediments will be removed and incinerated in a permitted TSCA facility.
TSCA PCB Storage Regulations	40 CFR 761.65(a)	Applicable	PCBs stored for disposal must be properly disposed of within one year of being placed in storage.	A waiver will be required from this requirement since it is technically impracticable from an engineering perspective to complete the proposed remedy in less than one year, requiring storage of PCB contaminated material for more than one year on site.
Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules	59 Fed. Reg. 62866	To Be Considered	Proposed rules would permit additional extensions to the one year PCB storage rule.	If the rule is promulgated prior to completing the remedy selection process, it will be possible to extend the period of PCB storage beyond a year, without a waiver, until the completion of the remedial action.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(i)	Applicable	Storage facilities must have adequate roof and walls to prevent rainwater from reaching the stored PCBs.	Present cover, if properly maintained, does prevent rainwater from reaching the stored PCBs. Rainwater that falls directly on Cell #1 may require treatment if contamination occurs.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(ii)	Applicable	Storage facilities cannot have floor drains or openings that would allow liquids to flow from the storage area.	Cell #1 has two continuous, impermeable bottom liners.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(iv)	Applicable	Storage facilities must have floors and curbs made of smooth impervious material to prevent PCB penetration.	Cell #1 has two liners made of HDPE which is smooth and impermeable.
TSCA PCB Storage Regulations	40 CFR 761.65(b)(1)(v)	Applicable	Storage facilities must not be located below the 100-year floodwater elevation.	The top-of-berm elevation is 2 feet higher than the 100-year flood elevation. The dewatering facility will be located above the 100-foot flood elevation.

Table B-7-3
Action-Specific ARARs and TBCs, Alternative 7

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(ii)	Relevant and Appropriate	Commercial facilities must possess the capacity to handle the maximum quantity of PCB waste that will be handled at any one time.	The CDF has the capacity to contain all of the dredged hot spot sediments.
TSCA PCB Commercial Storage Regulations	40 CFR 761.65(d)(2)(vi)	Relevant and Appropriate	The operation of a commercial storage facility must not pose an unreasonable risk of injury to health or the environment.	The cover for Cell #1 would have to be extended to overlap the cell walls to prevent persons from falling in. Air, groundwater, and surface water monitoring in the vicinity of the CDF will be continued to verify protectiveness of controls until all of the sediments are removed off-site.
TSCA PCB Spill Cleanup Policy	40 CFR 761.120 - .135	Relevant and Appropriate	Establishes criteria to determine adequacy of the cleanup of spills (occurring after 5/4/87) from the release of materials with > 50 ppm PCBs.	Although this policy is directed at electrical equipment-type spills, it will be considered to address any PCB leakage or spillage from the CDF.
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Due to the degraded nature of New Bedford Harbor waters, regulated discharges into the waterway must meet ambient water quality criteria (WQC) at the discharge point.	Any drainage off the site which becomes contaminated by the stored sediments and any process or dewatering discharge will be treated by the on-site treatment plant and discharged. Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
CWA, Section 402, NPDES, Prohibitions	40 CFR 122.4(i)	Applicable	Prohibition on new discharges into waters that do not meet applicable water quality criteria (WQC) unless certain conditions are met.	A waiver will be sought for this provision since compliance would prevent cleanup of the site until Harbor waters either reach water quality standards or until the other conditions in the regulation are met. Neither of which can be accomplished in a reasonable time frame.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7401 et seq.; 40 CFR Part 61	Applicable	NESHAPS are a set of emissions standards for specific chemicals, including PCBs, from specific production activities.	Monitoring of air emissions from the facility, including from the dewatering process, will be used to assess compliance with these standards. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

Table B-7-3
Action-Specific ARARs and TBCs, Alternative 7

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive)		To Be Considered	Describes the recommended approach for evaluating and remediating CERCLA sites with PCB contamination.	This guidance will be considered when evaluating PCB issues associated with removal, dewatering, and off-site treatment of contaminated sediment.
Massachusetts				
Hazardous Waste Management - Identification and Listing	21C MGL 4 and 6; 310 CMR 30.100	Relevant and Appropriate	Establish standards for identifying and listing hazardous waste.	Monitoring will assess whether hazardous wastes are present in discharges or dewatering wastes from the facility.
Hazardous Waste Management - Requirements for Generators of Hazardous Waste	21C MGL 4 and 6; 310 CMR 30.300	Relevant and Appropriate	Establishes standards for various classes of generators.	Any hazardous waste generated from the facility will be managed in accordance with the substantive requirements of these regulations.
Hazardous Waste Management - Management Standards for all Hazardous Waste Facilities	21C MGL 4 and 6, 310 CMR 30.500	Relevant and Appropriate	Establishes standards for treatment, storage, and disposal of hazardous waste, and establishes standards for closure, post closure and ground water monitoring. Sec. 30.501(3)(a) exempts facilities which treat, dispose or store hazardous waste containing 50 ppm or more of PCBs if they are adequately regulated under TSCA, 40 CFR 761.	Any non-PCB hazardous waste which is treated, stored or disposed of at this facility as part of the remedy will be managed in accordance with the substantive requirements of this section.
Supplemental Requirements for Hazardous Waste Management Facilities	21 MGL 27(12), 34 and 43; 314 CMR 8.00	Relevant and Appropriate	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulation.	The substantive requirements of these provisions will be met.
Surface Water Discharge	21 MGL 23(12) and 34; 314 CMR 1.00-7.00	Applicable	This section outlines the requirements for obtaining a National Pollutant Discharge Elimination System (NPDES) permit in Massachusetts. The waters of New Bedford Harbor adjacent to the site are classified as SB.	Any drainage off the site which becomes contaminated by the stored sediments and the water from dewatering will be treated by the on-site treatment plant and discharged in accordance with the substantive provisions of the regulations.

Table B-7-3
Action-Specific ARARs and TBCs, Alternative 7

Medium/Authority	Citation	Status	Requirement Synopsis	Actions to be Taken to Attain ARARs
Surface Water Quality Standards	27 MGL 27; 314 CMR 4.00	Applicable	MADEP surface water quality standards incorporate the federal AWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, copper, and lead.	Ambient water quality criteria, particularly for copper, will be addressed through a phased Total Maximum Daily Load (TMDL) approach.
Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth	21 MGL 26-53; 314 CMR 15.000	Applicable	Regulates the discharge of oil or sewage, industrial waste or other material containing oil into waters of the Commonwealth.	The remedy will comply with the substantive requirements of the provisions.
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters (2/23/90)		To Be Considered	Recommends surface water quality standards for specified contaminants and implementation to achieve standards.	This implementation policy and appropriate standards will be considered for alternatives which impact surface water quality.
Ambient Air Quality Standards	111 MGL 142D; 310 CMR 6.00	Applicable	Establishes ambient air level for contaminants including PCBs and particulates.	Emissions from the CDF and the dewatering facility will comply with these standards. Dust suppression will be used to reduce particulate emissions.
Air Pollution Control	111 MGL 142A-J, 310 CMR 7.00	Applicable	Standards for sources of emissions. Pollution abatement controls may be required.	Operation and maintenance of the CDF and the dewatering facility will comply with the substantive requirements of these provisions.
MADEP - Recommended Threshold Effect Exposure Limits (TELs) and Allowable Ambient Limits (AALs)		To Be Considered	Establishes exposure concentrations for air contaminants developed and recommended by the Office of Research and Standards to protect public health.	On-site containment and dewatering technologies having air emissions will consider the TELs and AALs.
DAQC Policy (90.001): Allowable Sound Emissions (2/1/90)		To Be Considered	Establishes guidelines where the source of new noise should not emit more than 10 decibels above the existing (background) level.	Site operations noise level will be minimized and will follow the suggested noise limit to the extent practicable.
MA DEP - Assessment and Control of Dioxin in Massachusetts (10/31/91)		To Be Considered	Recommends revisions to Toxicity Equivalence Factors (TEFs) for polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in air/emissions.	Alternatives with on-site sediment dewatering technologies that potentially include air emissions of PCDDs and PCDFs will consider the revised TEFs for evaluating the toxicity of these air emissions.