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Engineering Evaluation Cost Analysis (EE/CA)

for

IR Site 57
Former Drum Loading Area
Building 292
Indian Head Division
Naval Surface Warfare Center

Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Northern Division Contract Number N62472-90-D-1298

Contract Task Order 0209

June 1998

Brown & Root Environmental

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ENGINEERING EVALUATION COST ANALYSIS (EE/CA) FOR IR SITE 57 FORMER DRUM LOADING AREA BUILDING 292

INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

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FOREWORD

The purpose of this Engineering Evaluation and Cost Analysis (EE/CA) is to support the need for an Interim Removal Action of the TCE contaminated soils and groundwater at Installation Restoration (IR) Site 57, the Former Drum Loading Area.

This EE/CA provides removal action alternatives and evaluates each alternative for the following:

1. protection of human health and the environment,
2. implementability,
3. cost efficiency, and
4. ability to achieve the removal action objectives, is consistant with the final remedial goals, and complies with applicable or relevant and appropriate requirements (ARARs).

A removal action alternative for the interim removal action will be chosen based on the results of the above evaluations. This action will be undertaken under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

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LIST OF ACRONYMS/ABBREVIATIONS

AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
CTO	Contract Task Order
cy	cubic yards
DCA	Dichloroethane
DCE	Dichloroethene
DNAPL	Dense Nonaqueous Phase Liquids
DO	Dissolved Oxygen
DRE	Destruction and Removal Efficiency
EBCT	Empty Bed Contact Time
EE/CA	Engineering Evaluation/Cost Analysis
FS	Feasibility Study
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
GAC	Activated Carbon
GAC	Granular Activated Carbon
HCL	Hydrochloric Acid
HDPE	High Density Polyethylene
HTTD	High Temperature Thermal Desorption
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
IR	Installation Restoration
LDR	Land Disposal Restriction
LTTD	Low Temperature Thermal Desorption
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDE	Maryland Department of the Environment
mg/L	milligrams per Liter

MH	Manhole
NCP	National Oil and Hazardous Substances Contingency Plan
nM	nanoMolar
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration/Act
OSWER	Office of Solid Waste and Emergency Response
PCE	Tetrachloroethene
ppb	Parts per billion
PPE	Personal Protection Equipment
PVC	Polyvinylchloride
RBC	Risk-Based Criteria
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPM	Remedial Project Manager
SACM	Superfund Accelerated Cleanup Model
SARA	Superfund Amendments and Reauthorization Act
SG	Sample Group
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
TBC	To be considered
TCA	Trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet
VC	Vinyl Chloride
VOC	Volatile Organic Compound

AUTHORITY AND PURPOSE

The Northern Division of the Naval Facilities Engineering Command has issued Contract Task Order Number 0209 (CTO 209) to Brown & Root Environmental (B&R Environmental), under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. CTO 209 is for environmental work to support a potential removal action at Installation Restoration (IR) Site 57, the Former Drum Loading Area near Building 292 at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland. This Engineering Evaluation/Cost Analysis (EE/CA) has been produced under CTO 209 in support of the Navy.

The Navy is submitting this EE/CA under the authority granted the Navy as the lead agency in the National Contingency Plan, Title 40 of the Code of Federal Regulations (CFR) Section 300 Subpart B. The lead agency is given the authority to conduct removal actions in 40 CFR 300.130. This EE/CA is required for non-time critical removal actions as specified in 40 CFR 300.415. The pattern of the report follows the Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA, U.S. EPA Publication Number PB93-963402, August 1993. State and local participation are in accordance with 40 CFR 300 Subpart F, State Involvement in Hazardous Substance Response, and the Maryland Superfund Memorandum of Agreement.

An Administrative Record (AR) has been established at the IHDIV-NSWC and the Engineering Field Activity Chesapeake, per 40 CFR 300 Subpart I. In addition, Information Repositories containing all pertinent documentation from the AR have been established at the IHDIV-NSWC General Library, Building D-40, and the Charles County Public Library in La Plata, Maryland.

EXECUTIVE SUMMARY

Installation Restoration (IR) Site 57, the Former Drum Loading Area, is located immediately south of Building 292, a facility that used trichloroethene (TCE) as a degreasing agent from the mid-1960s to 1989. In 1994, TCE was detected at the industrial wastewater/stormwater outfall designated IW-80. As a result of this detection, a field investigation was conducted on September 26, 1995 and the results of this investigation demonstrated the presence of TCE and other volatile organic compounds (VOCs) in the soil, groundwater and stormwater (B&R Environmental, 1996a). Based on the available information, contaminated groundwater is believed to have infiltrated into a storm sewer system that is located below Site 57. This storm sewer system ultimately discharges to IW-80 and is the likely cause of the detection of the TCE at IW-80.

As the lead agency, the Navy has determined that the Removal Action under CERCLA (Comprehensive Environmental Response Compensation and Liability Act) is appropriate for IR Site 57. This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared to develop, evaluate, and select a non-time critical removal action to eliminate/reduce the release of TCE into the Mattawoman Creek.

IDENTIFICATION, ANALYSIS, AND COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES FOR SOIL

U.S. EPA has established presumptive remedy guidance (OSWER Directive No. 9355.0-47FS) for streamlining site investigations and remediating sites. The presumptive remedies for VOCs in soil in order of preference are: soil vapor extraction (SVE), thermal desorption, and incineration. The OSWER Directive indicates that primary consideration should be given to SVE. If site conditions are not conducive to SVE (i.e., low permeable soils) then thermal desorption should be evaluated, followed by incineration. In accordance with presumptive remedy guidance, the following removal action alternatives were developed.

- Alternative 1: No-Action
- Alternative 2: In-situ Soil Vapor Extraction
- Alternative 3A: Excavate Soil Exceeding U.S. EPA Soil Screening Levels; Onsite Thermal Desorption; Backfilling; Restoration
- Alternative 3B: Excavate Soil "Hot Spots"; Onsite Thermal Desorption; Backfilling; Restoration

- Alternative 4A: Excavate Soil Exceeding U.S. EPA Soil Screening Levels; Offsite Incineration; Backfilling; Restoration
- Alternative 4B: Excavate Soil "Hot Spots"; Offsite Incineration; Backfilling; Restoration

An analysis of these removal alternatives was conducted. Alternative 2 is not technically feasible as a pilot-scale SVE study conducted in April 1997 at Site 57 (B&R Environmental, 1997) concluded that the subsurface soil conditions at Site 57 are not well suited to the application of the SVE technology. Alternatives 3 and 4 are technically feasible. The present worth cost associated with these alternatives are as follows: Alternative 1 - no cost, Alternative 2 - no cost analysis performed because the alternative is not implementable, Alternative 3A - $2,970,000, Alternative 3B - $997,000, Alternative 4A - $20,600,000, and Alternative 4B - $1,910,000.

IDENTIFICATION, ANALYSIS, AND COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES FOR GROUNDWATER

The selection of removal action alternatives for groundwater differed from the approach taken for soil. Initially, a preliminary screening of groundwater technologies was conducted to eliminate process options not suited for use at Site 57. The remedial technologies and process options that passed the preliminary screening were evaluated in detail based on the criteria of effectiveness, implementability, and cost. Based on this approach, the following removal action alternatives for groundwater were developed:

- Alternative 1: No Action
- Alternative 2: Storm Sewer System Rehabilitation
- Alternative 3: In Situ Air Sparging with Offgas Treatment
- Alternative 4: Groundwater Extraction/Treatment (air stripping with offgas treatment or enhanced oxidation)/Discharge

As with soils, a comparative analysis was conducted to evaluate these alternatives in order to select a recommended removal action alternative. The present worth cost associated with these alternatives are as follows: Alternative 1 - no cost, Alternative 2 - $668,297, Alternative 3 - $1,895,773, Alternative 4 - $1,128,031 for the air stripping/offgas treatment option or $1,491,235 for the enhanced oxidation option.

RECOMMENDATIONS

Based on the identification and comparative analysis of removal action alternatives for soil and groundwater, recommendations for a removal action are as follows.

- At this time, conduct no further action for site soil until the nature and extent of soil contamination is more clearly defined in the RI phase.

- Perform storm sewer system rehabilitation. This action will mitigate the infiltration of contaminated groundwater into the storm sewer and eliminate VOC discharge at IW-80. Conduct no further action for site groundwater until the nature and extent of groundwater contamination is more clearly defined in the RI phase.

The Navy plans to initiate a remedial investigation within six months. This investigation will serve to better define the nature and extent of contamination at the site. Based on this new information, the remedial alternatives may be re-evaluated and other feasible alternatives added.

1.0 ACTIVITY AND SITE DESCRIPTION

This section contains a description of the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), including information on topographic setting, history, climate, geology, hydrology, and additional features (EE/CA, 1995). Additionally, this section contains background information concerning Site 57 including summaries of past investigations.

1.1 TOPOGRAPHIC SETTING

The IHDIV-NSWC is located in Indian Head, Maryland, approximately 25 miles south of Washington, DC, at the southern terminus of Maryland Route 210. The mainside of the IHDIV-NSWC occupies approximately 2,400 acres of land and is situated on a peninsula formed at the confluence of the Potomac River to the northwest, and the Mattawoman Creek to the south-southeast, in the west-central portion of Charles County, Maryland (Figure 1-1).

1.2 HISTORY AND BACKGROUND

The principal mission of the IHDIV-NSWC is research, development, and production of propellants and explosives for the United States Navy. The scope of operations ranges from laboratory research to full-scale production and testing. The IHDIV-NSWC is the largest employer in Charles County, Maryland, and, since operations began in 1892, has consistently proven to be a vital economic force in Southern Maryland.

1.3 CLIMATE

IHDIV-NSWC is located in the Atlantic Coastal Plain on the east bank of the Potomac River, lying midway between the rigorous climate of the north and the mild climate of the south. Since IHDIV-NSWC is located in the middle latitudes where the general atmospheric flow is from west to east across North America, it has a continental-type climate with four well-defined seasons. However, the proximity of the Potomac River and its tributaries have a considerable moderating effect on the climate, especially with regards to extreme temperatures.

Generally, the coldest period of the year is late January and early February when the early morning temperature averages 21°F. The warmest period is late July when the afternoon maximum temperature averages 89°F. The highest temperature on record in the county is 108°F, recorded at Newburg in July 1930, while the lowest was -12°F at La Plata in January 1913. Precipitation is evenly distributed through

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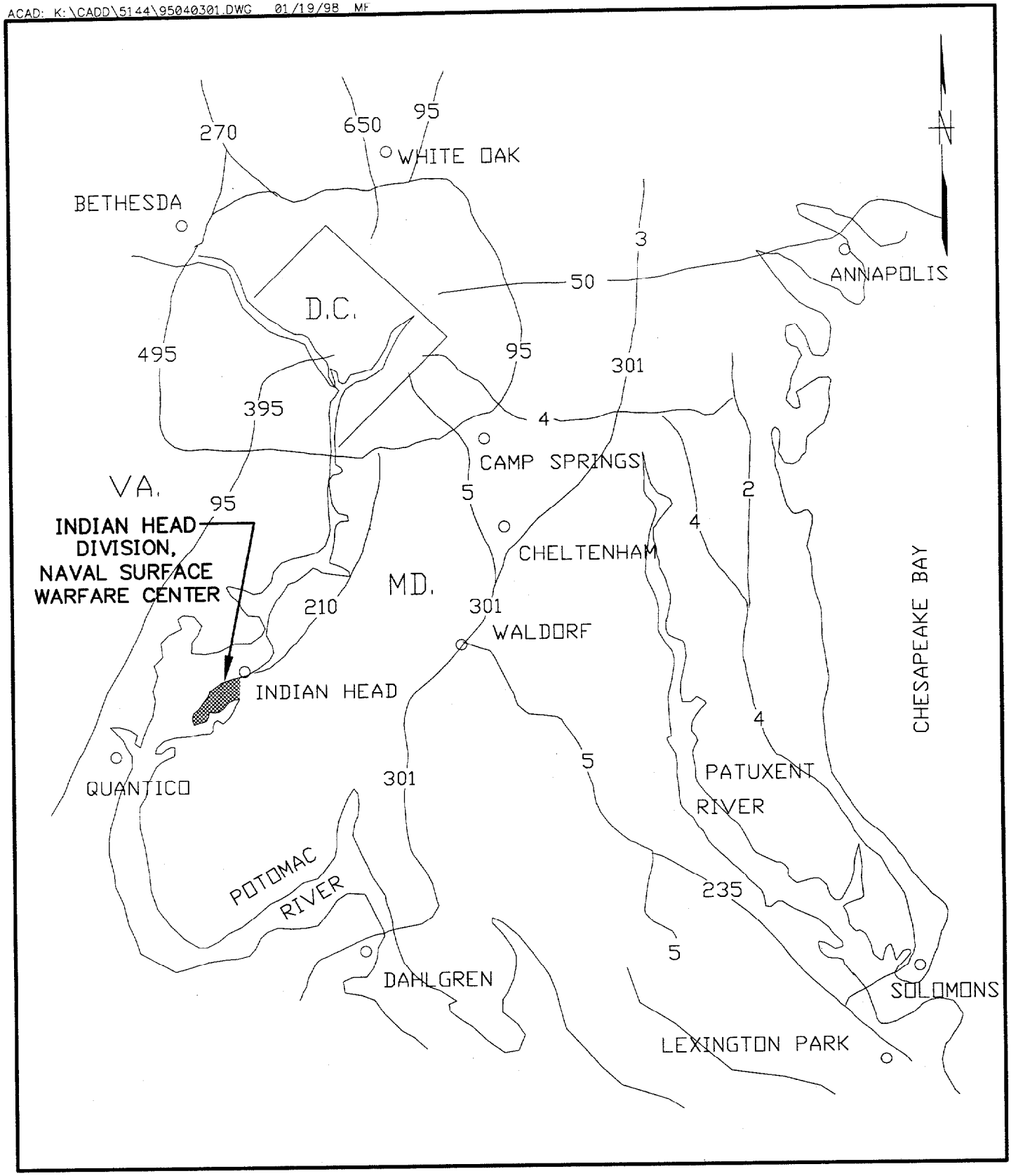

VICINITY MAP
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
NOT TO SCALE

FIGURE 1-1

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the year with either July or August being the wettest month, and February or October the driest. The heaviest precipitation during the colder half of the year is generally the result of low pressure systems moving northeastward along the Atlantic coast; in summer it occurs as thunderstorms. The highest official one day precipitation on record is 6.45 inches, which occurred at Waldorf in August 1955. Thunderstorms occur on an average of 35 days per year, mostly from May through August.

Prevailing surface winds are from the west-northwest to northwest except during the warm months of the year when they become more southerly. The most windy period is late winter and early spring. The growing season is approximately 187 days long.

1.4 GEOLOGY

The surficial geology is comprised of Cretaceous fluviodeltic, Tertiary marine, and Quaternary fluvial deposits, which include the Cretaceous Upper Patapsco Formation, the Tertiary Aquia Formation, and the Quaternary deposits of the Potomac River System.

The upland is an erosional remnant of the Upper Patapsco Formation capped by a thin layer of Tertiary Aquia Formation. The Quaternary sediments make up the majority of the surficial exposures and are generally thickest in the lower relief area.

The USGS reports that the early Potomac River cut paleochannels across the Indian Head Peninsula during the Quaternary. A paleochannel is evident where Quaternary deposits form a belt along the northeast end and the southeastern part of the facility. The southern section of the paleochannel extends across the entire southern region of the facility. Portions of these units subsequently have been eroded by the current Potomac River and Mattawoman Creek systems.

1.5 HYDROLOGY

The shallow, water-bearing zones (water table aquifer) of IHDIV-NSWC are controlled by the shallow soil deposits. In general, the water table appears to be between 7 and 10 feet below the ground surface within the Quaternary sediment belt. Lithologies of the water-bearing zones were usually restricted to silty and sandy clay zones.

A thin layer of the Tertiary deposits overlay the Upper Patapsco confining unit along the upland in the northwest. Soils in this area are very stiff, with lithologies ranging from silt to silty clays. A marked bed on top of the Upper Patapsco Formation, an iron-cemented reddish sand unit, was encountered during the

Site Inspection in the upland area at depths ranging from 30 to 40 feet. The upper-most aquifer is the Patapsco aquifer, which is estimated to be more than 100 feet below ground surface in the upland area.

Data collected during the Site Inspection generally indicate that the inorganic quality of the water table aquifer is poor. Analytical results of groundwater samples indicate elevated concentrations of total dissolved solids in the water table aquifer suggesting that water from the surficial zones is not suitable as a potable water source. This unit is not used as a potable water source on the peninsula.

Potable water wells at IHDIV-NSWC are screened in one or more sand zones in either the Patapsco or Patuxent Formations to an average depth of 200-300 feet. These potable water wells serve an approximate population of 3,350 people, including civilian and enlisted Navy employees, as well as contractor employees. None of these wells supply reserves or residences beyond the facility boundaries.

1.6 ADDITIONAL FEATURES

IHDIV-NSWC contains archeological sites which contain Native American artifacts dating back 12,000 years. In addition, the Mattawoman Creek is a popular fishing location and is frequently used for national bass fishing tournaments. Numerous bird species, including the bald eagle, great blue heron, a variety of waterfowl, and several neotropical migratory species feed in the approximately 300 acres of tidal and nontidal wetlands present.

1.7 SITE 57 BACKGROUND INFORMATION

Installation Restoration (IR) Site 57, also known as the Former Drum Loading Area, encompasses the area which is located south-east of Building 292 at the main operational facility of the IHDIV-NSWC. Previous operations at the building involved vapor degreasing of metal parts using trichloroethene (TCE). It is believed that these operations may have resulted in the contamination of the soil and groundwater near the building.

Building 292 operations reportedly included the following activities:

- Mid-1960s until 1989 - used 1,900-gallon TCE vapor degreaser.
- Mid-1970s until 1989 - large solvent dip tanks used for general cleaning.
- Spent TCE piped to drums outside Building 292 via a ball valve through the wall of the building. Drums were reportedly stored on a grass-covered area near the ball valve and near MH-1.

The use of TCE at the facility was reportedly stopped in 1989. The Building 292 area is believed to be one potential source of the TCE detected in the storm sewer. Figure 1-2 illustrates the location of the storm sewer system in relationship to Site 57. No other obvious sources of TCE are located in the vicinity.

TCE degrades in the environment to form cis-1,2-dichloroethene, trans-1,2-dichloroethene (1,2-DCE), and 1,1-dichloroethene (1,1-DCE). These compounds can subsequently degrade to form vinyl chloride and chloroethane. The presence of vinyl chloride is usually indicative of an older TCE discharge.

Technical-grade TCE contains 0.035 percent 1,1,1-TCA, as well as chloroform, carbon tetrachloride, and other priority pollutants. 1,1,1-TCA degrades in the environment to form 1,1-DCE, 1,1-dichloroethane (1,1-DCA), which subsequently degrade to form vinyl chloride and chloroethane. Impurities in commercial-grade 1,1,1-TCA are normally below a concentration of 250 mg/L. Presence of 1,1,1-TCA in samples can probably be attributed to its presence as an impurity in technical-grade TCE rather than an indication of a spill.

1.8 INITIAL INVESTIGATION

TCE was first detected in February 1994 at 53 micrograms per liter (µg/L, equivalent to parts per billion, ppb) at the industrial wastewater/stormwater outfall designated IW-80 which is located approximately 1,000 feet south of Building 292, and serves the drainage basin that includes Building 292 (Figure 1-2). This initial sampling was conducted because of an odor reported at IW-80. A sample collected from the same outfall in May 1994 detected 60.2 µg/L TCE. The Navy notified the Maryland Department of the Environment (MDE) of the TCE discharge and submitted a revised National Pollutant Discharge Elimination System (NPDES) permit application on November 4, 1994 to MDE requesting approval of a 100 µg/L TCE discharge limit.

Since May 1994, the Navy has conducted several rounds of storm sewer sampling for TCE in an attempt to locate the source of this chemical. The results of the sampling efforts are summarized below. Sampling points referenced below, in association with these sampling efforts, are shown on Figure 1-3.

- July 12, 1994 - Sample results did <u>not</u> detect TCE or any other volatile organic priority pollutants at three sampling points upstream from Building 292. (Sampling Points 1, 2, and 3)

- July 27, 1994 - Sample results did not detect TCE upstream of Building 292 (Sampling Point 3) but did detect TCE at MH-1 (62 µg/L) immediately downstream from the building (Sampling Point 4) and

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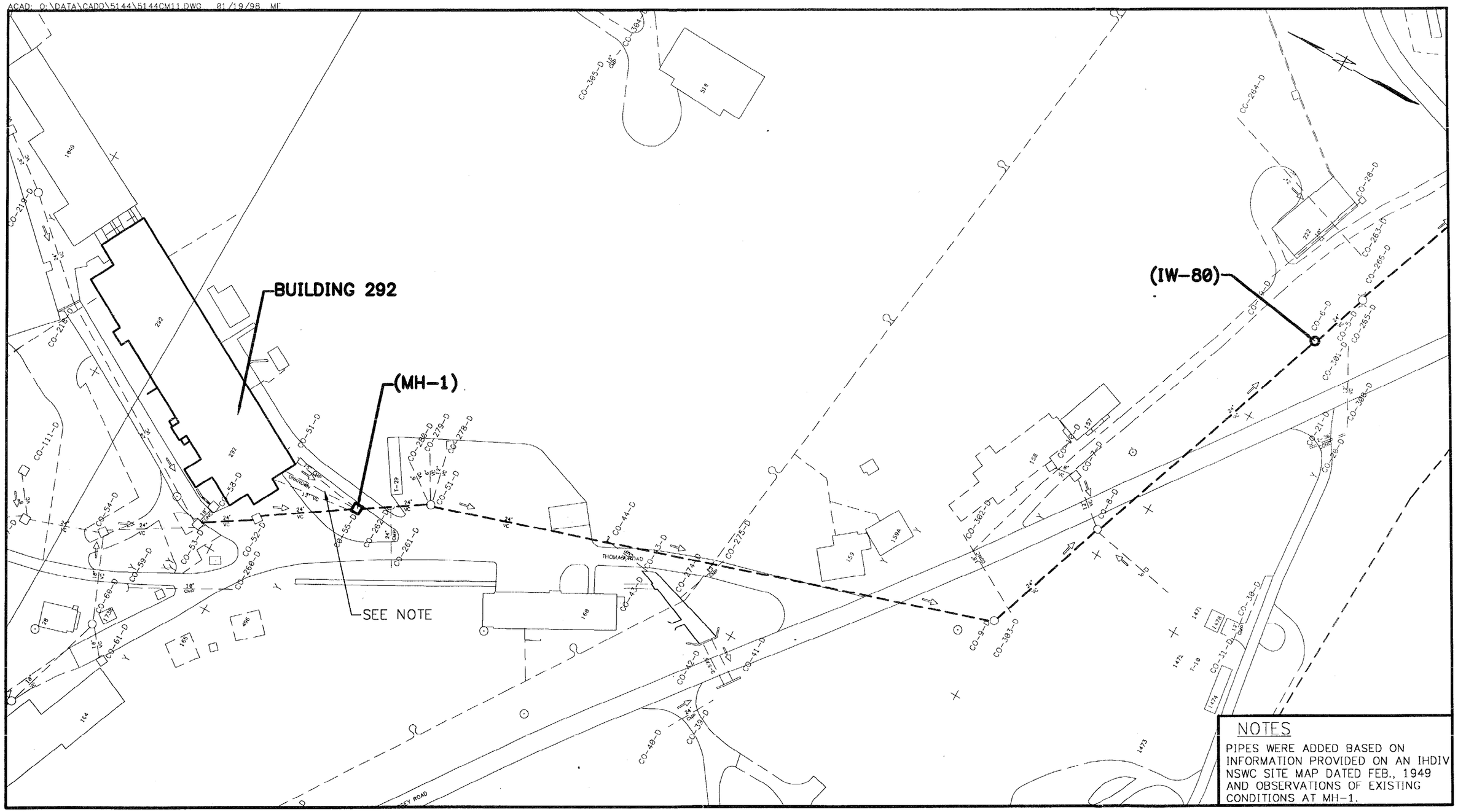

SITE LAYOUT
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

0 100 200
SCALE IN FEET

FIGURE 1-2

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CTO 0209

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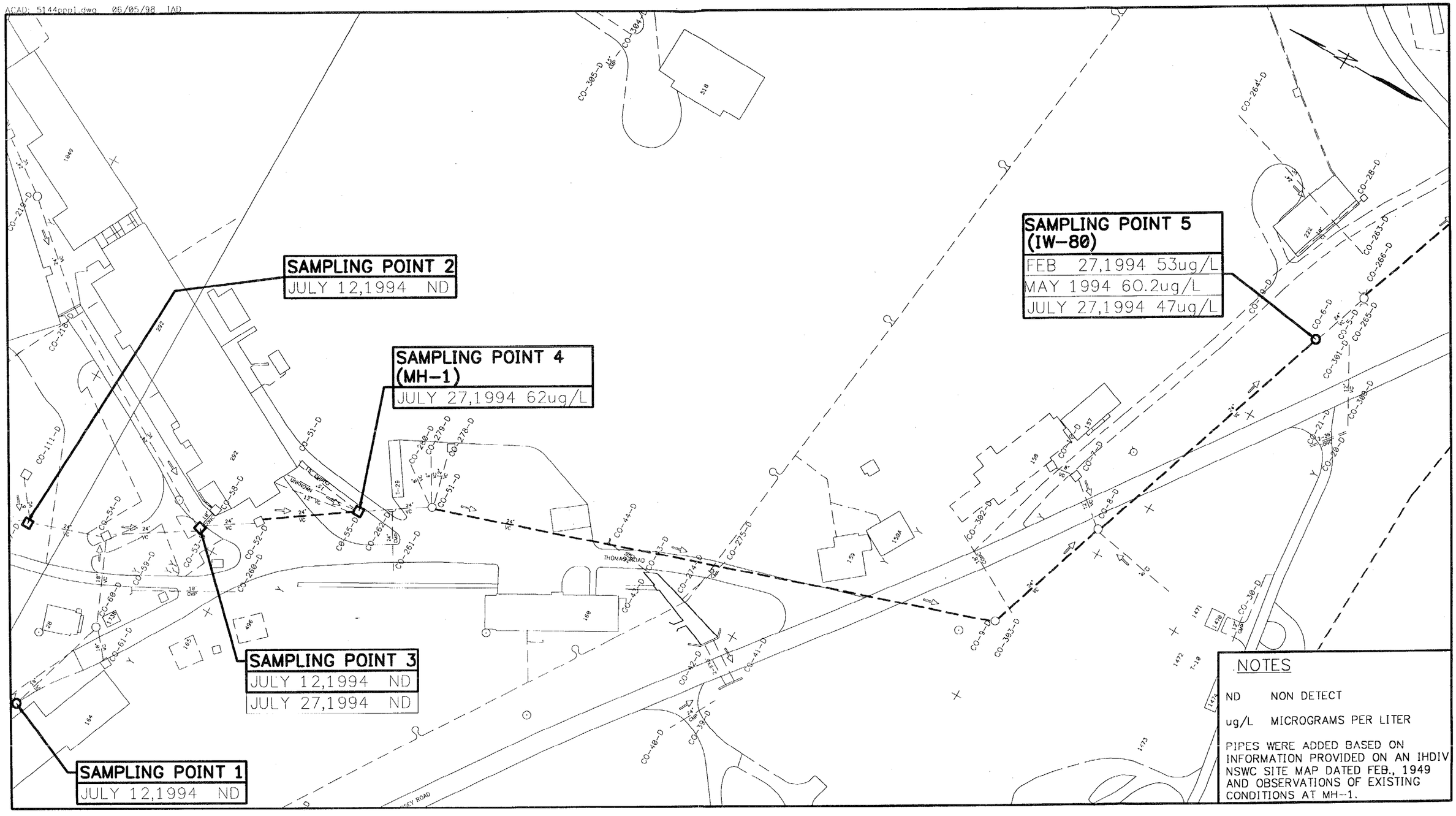

PAST INVESTIGATION SAMPLING POINTS AND ANALYTICAL RESULTS FOR TCE
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

0 100 200
SCALE IN FEET

FIGURE 1-3

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CTO 0209

099607/P

more than 1,000 feet downstream from Building 292 at IW-80 (47 µg/L) (Sampling Point 5). No other volatile organic priority pollutant was detected.

On November 2, 1994, Halliburton NUS (now B&R Environmental) conducted an extensive site visit of the Building 292 area. The results of the physical observation and detailed description of the site is provided in the Abbreviated Field Sampling Plan (HNUS, 1995).

1.9 SUBSURFACE INVESTIGATION

This section discusses the analytical results from the samples collected during the subsurface field investigation conducted on September 26, 1995, and subsequent report entitled Data Report (B&R Environmental, 1996).

1.9.1 Soil-Gas Analytical Results

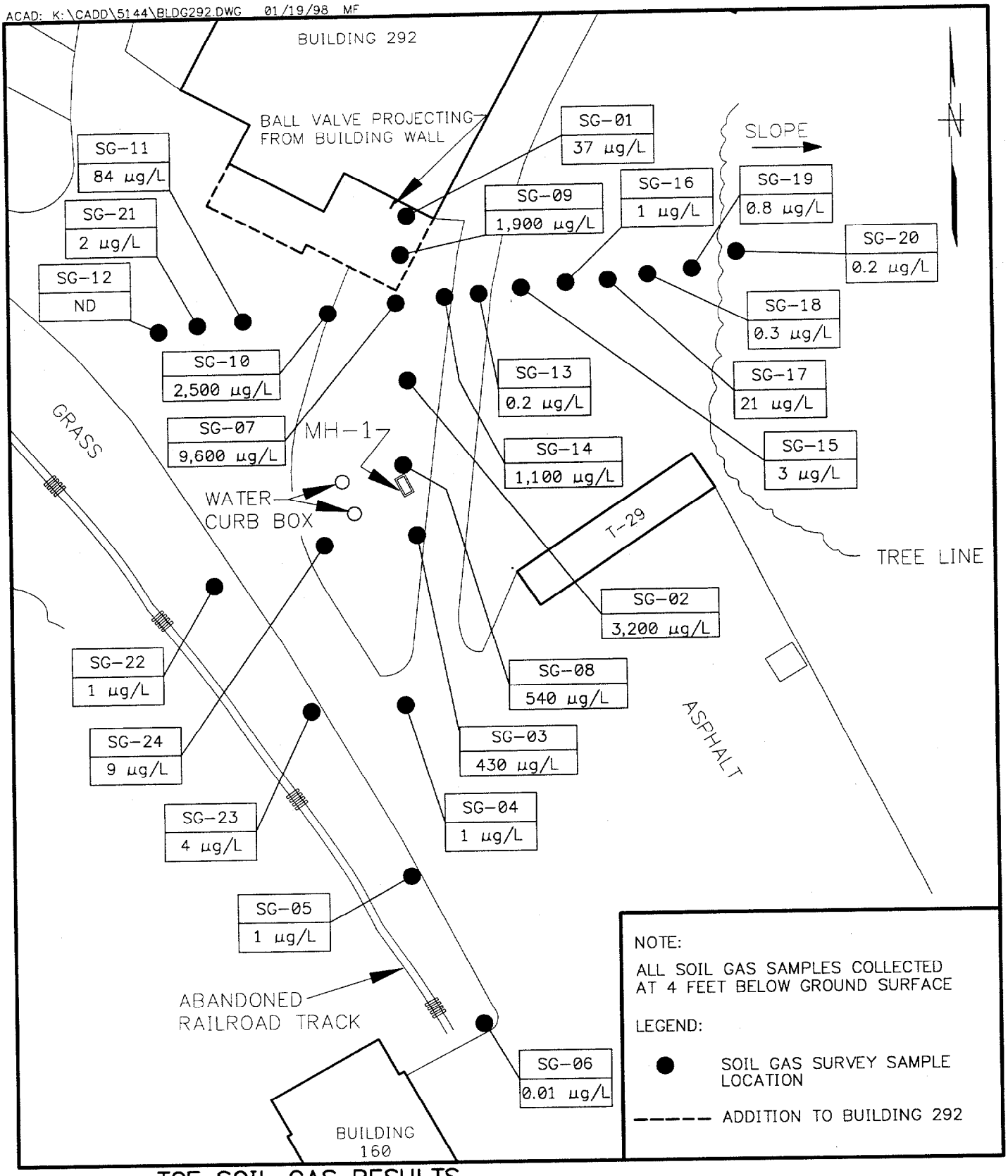
Soil-gas sampling locations and the field TCE analytical results are shown on Figure 1-4. The soil gas data confirm the presence of TCE in the vadose zone, with the point of apparent highest concentration located approximately 30 feet southwest of the southern corner of Building 292 (SG-07 on Figure 1-4).

There are four soil-gas sampling points immediately adjacent to SG-07 which exhibit high TCE concentrations. They are SG-02 to the south (3,200 µg/L), SG-10 to the west (2,500 µg/L), SG-09 to the north (1,900 µg/L), and SG-14 to the east (1,100 µg/L). Soil-gas levels decrease dramatically after these points. The first non-detect soil-gas sample along the north-south axis, as reported in the field, was to the south at SG-06. The soil gas results were used to select soil sample locations. A direct relationship between TCE levels in soil-gas and soil is not apparent from the available data.

1.9.2 Soil Data

Nine subsurface soil samples were collected at four different sampling locations. The soil samples were collected close to the soil-gas sampling points so as to be essentially the same locations. Table 1-1 displays the soil data, but limits the presentation to detected soil contaminants. This table also presents the U.S. EPA Region III Risk-Based Concentrations (RBCs). Figure 1-5 illustrates the location of the samples containing the detected concentrations.

Concerning regulatory compliance, emphasis is placed on the U.S. EPA Region III Soil Screening Level (SSL) for TCE concentrations in soil that may result in sufficient contaminant migration to groundwater. From the soil data analytical results, the U.S. EPA SSL of 20 µg/kg TCE concentration is exceeded in all



TCE SOIL GAS RESULTS
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WAREFARE CENTER
INDIAN HEAD, MARYLAND

FIGURE 1-4

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TABLE 1-1

SOIL ANALYTICAL RESULTS AND REGULATORY CRITERIA AND GUIDANCE
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

SOIL ANALYTICAL RESULTS										REGULATORY CRITERIA AND GUIDANCE			
Sample Number	SO-01-2/4	SO-05-10/12	SO-06-2/4	SO-07-2/4	SO-08-10/12	SO-09-2/4	SO-10-10/12	SO-12-2/4	SO-13-10/12	U.S. EPA Region III (1)			
Corresponding Soil-Gas Sample	(SG-06)	(SG-06)	(SG-06)	(SG-02)	(SG-02)	(SG-07)	(SG-07)	(SG-10)	(SG-10)	Risk Based Concentrations (RBCs) Soil Ingestion		Soil Screening Levels (SSL) - Transfers from Soil to:	
Depth Below Grade (Feet)	(2 to 4)	(10 to 12)	(2 to 4)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	Residential	Industrial	Air	Groundwater
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
ACETONE	160 J	99 J	150 J	85 J	82 J	B	ND	B	B	7,800,000	200,000,000	62,000,000	8,000
1,2-DICHLOROETHENE (TOTAL)	18	ND	14	37,000	ND	36	15	10 J	ND	700,000	18,000,000		
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	10	4	5 J	ND	2,700,000	72,000,000	980,000	900
TRICHLOROETHENE	140	3 J	220	840,000	4 J	9,300 J	150	120	ND	58,000	520,000	3,000	20

NOTES:

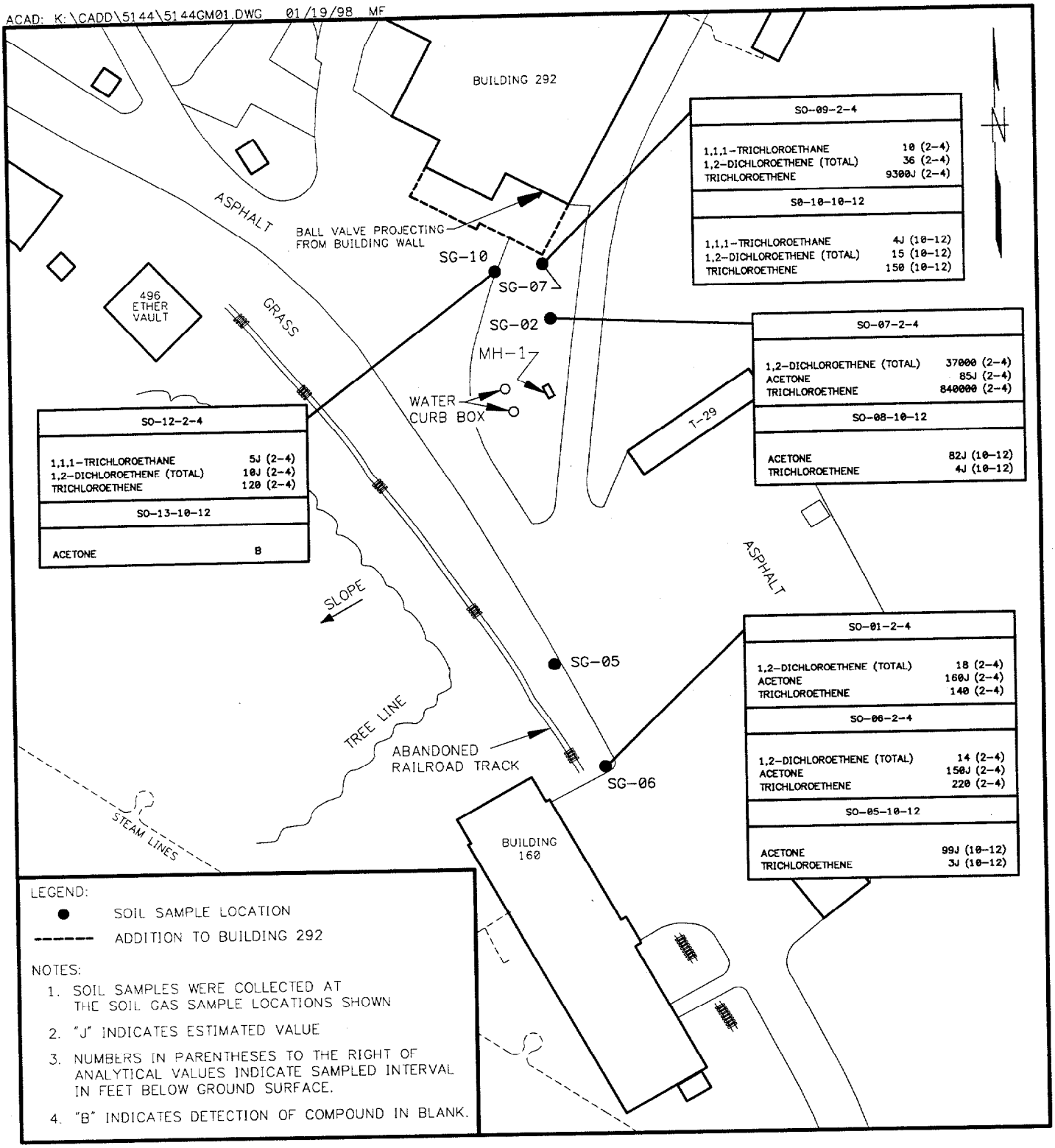
J = Estimated value.

B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.

ND = Not Detected

(1) US EPA Region III, 1996, Communication from Roy L. Smith, Senior Toxicologist, to RBC Table Mailing List.

NOTE: Shaded Soil Analytical Results exceed one or more Regulatory Criteria and Guidance values.



DETECTED SOIL CONTAMINANTS (ug/kg)
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

0 60 120
SCALE IN FEET

FIGURE 1-5

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of the shallow subsurface soil (2 to 4 feet) samples collected, but in only one of the deep soil samples, sample SO-10-10/12 (150 µg/kg), which was collected at SG-07. This corresponds with the location exhibiting the greatest TCE concentration in soil gas (9,600 µg/L) and the second highest in shallow subsurface soil (9,300 µg/kg).

Data from the deeper soil samples (10 to 12 feet below ground surface) indicates that TCE contamination in deeper soil may be very localized. The TCE concentration in the deep soil sample collected at location SG-07 (SO-10-10/12) exceeded the SSL for protection of groundwater, but the same criteria was not exceeded by the deep soil samples from locations SG-02 (SG-08-10/12) and SG-10 (SO-13-10/12), which are approximately 25 feet west and 20 feet south, respectively, from SG-07. This indicates that deep soil with TCE concentrations exceeding the SSLs for protection of groundwater may be limited to a radius of less than 25 feet around location SG-07.

The fact that the shallow soil TCE concentrations are consistently higher than the groundwater protection SSL while the deep soil TCE concentrations are not as high, as evidenced by the current analytical data, seems to indicate that the potential migration of TCE to the deeper soil is occurring at a very slow rate.

Shallow subsurface soil samples SO-09-2/4 and SO-07-2/4 collected from locations SG-07 and SG-02, respectively, also exceeded the TCE SSL for transfer from soil to air. The SSL for transfer of contaminants from soil to air is provided solely for the purpose of providing a point of comparison for the shallow subsurface soil data. In its strictest sense, this SSL is for screening contaminant levels present in surface soil samples. This criteria is being included here as a conservative approach which provides some measure of the severity of shallow subsurface soil contamination. Strict comparison of existing sample results to this level is inaccurate and exceedance of this criteria by all of the shallow sample results is not necessarily indicative of an immediate human health risk. Soil contamination will be subjected to a more thorough evaluation as part of a human health risk assessment in the ensuing remedial investigation.

Only one of the shallow subsurface soil samples, SO-07-2/4, at location SG-02, exhibited a TCE concentration in excess of the RBCs for soil ingestion for an industrial site, as shown in Table 1-1.

1.9.3 Groundwater Data

Data was collected at Site 57 for both groundwater and stormwater. The full set of data is presented and evaluated in the Data Report (B&R Environmental, 1996). Table 1-2 summarizes analytical results for detected contaminants. The table also presents the U.S. EPA Region III RBCs for tap water, along with

TABLE 1-2

WATER ANALYTICAL RESULTS AND REGULATORY CRITERIA AND GUIDANCE
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

GROUNDWATER AND STORM WATER ANALYTICAL RESULTS					REGULATORY CRITERIA AND GUIDANCE						
Sample Number	GW-11-11	GW-14-13	SW-01-04	SW-02-09	U.S. EPA Region III (2) Risk Based Concentrations (RBCs) Tap Water	EPA - Ambient Water Quality Criteria (3) (AWQCs)	National Primary Drinking Water Standard				State of Maryland
Corresponding Soil-Gas Sample	SG-07	SG-05	MH #1	MH #1			Maximum Contaminant Level (MCL) (4)		Maximum Contaminant Level Goal (MCLG) (5)		Maximum Contaminant Level (MCL) (6)
Depth Below Grade (Feet)	11	13	N/A (1)	N/A							
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	Status	ug/L	Status	ug/L
VINYL CHLORIDE	2,000	ND (7)	ND	ND	0.019	2	2	F (8)	0	F	2
CHLOROETHANE	6	ND	ND	ND	8,600			L (9)		L	
1,1-DICHLOROETHENE	140	ND	ND	ND	0.044	0.057	7	F	7	F	7
1,1-DICHLOROETHANE	65	ND	ND	ND	810						
1,2-DICHLOROETHENE (TOTAL)	52,000	ND	7	ND	55		70 (11)	F	70 (11)	F	70 (11)
1,2-DICHLOROETHANE	5	ND	ND	ND	0.12	0.38	5	F	0	F	5
1,1,1-TRICHLOROETHANE	260	ND	B (10)	ND	790		200	F	200	F	200
TRICHLOROETHENE	370,000	3	39	2	1.6	2.7	5	F	0	F	5
1,1,2-TRICHLOROETHANE	108	ND	ND	ND	0.19	0.6	5	F	3	F	5
TETRACHLOROETHENE	61	ND	ND	ND	1.1	0.8	5	F	0	F	5

NOTES:

(1) N/A = Not Applicable. Sample collected in a manhole.

(2) US EPA Region III, 1996, Communication from Roy L. Smith, Senior Toxicologist, to RBC Table Mailing List.

(3) 40 CFR 131.36

(4) 40 CFR 141.61

(5) 40 CFR 141.50

(6) Code of Maryland Regulation 26.04.01.07

(7) ND = Not Detected

(8) F = Final promulgated standard

(9) L = Listed for regulation

(10) B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.

(11) Value shown is applicable to the CIS isomer only.

NOTE: Shaded Groundwater and Storm Water Analytical Results exceed one or more Regulatory Criteria and Guidance values.

the U.S. EPA Ambient Water Quality Criteria (AWQCs), the Federal Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) under the National Primary Drinking Water Standard, and the State of Maryland Maximum Contaminant Levels (MCLs). Figure 1-6 illustrates the locations that were the sources of the samples containing the detected concentrations. As with the soil sample collection points, the groundwater sample collection points were intentionally placed close to the soil-gas sampling points so as to be essentially the same locations.

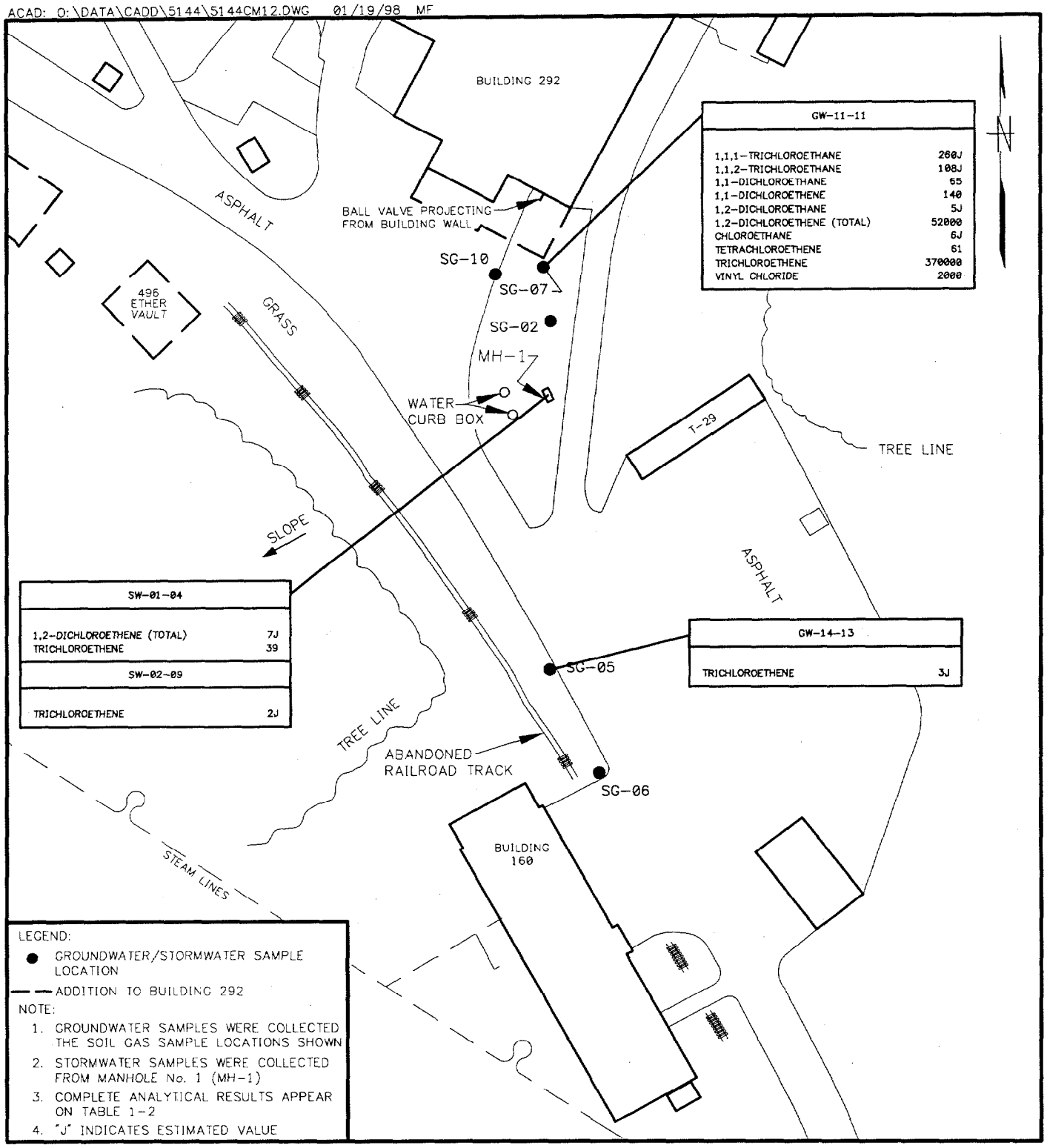
Two groundwater samples were collected from Site 57 during the soil gas investigation. One (GW-11-11) was collected at location SG-07 (the location exhibiting the greatest TCE concentration in soil gas (9,600 μg/L) and the second highest in soil (9,300 μg/L). GW-14-13 was collected from the second location, SG-05, located approximately 50 feet north of the point of lowest TCE concentration in soil gas (SG-06). As described in the Data Report (B&R Environmental, 1996), attempts to secure a groundwater sample from SG-06 were unsuccessful.

Of the contaminants detected in GW-11-11 (see Table 1-2), only chloroethane and 1,1-DCA do not exceed regulatory criteria. At 260 μg/L in GW-11-11, 1,1,1-TCA does not exceed either the U.S. EPA's RBC or the AWQC, but it does exceed the Federal MCL and MCLG as well as the State of Maryland MCL, all of which are set at 200 μg/L. Other contaminants detected in GW-11-11 all exceed the regulatory criteria, especially TCE, with a concentration of 370,000 μg/L.

The only detection in GW-14-13 consists of 3 μg/L of TCE. None of the other contaminants detected in GW-11-11 were found in GW-14-13. The 3 μg/L TCE concentration exceeds the U.S. EPA's RBC, the AWQC and the National Primary Drinking Water Standard MCLG, but not the Federal or the State MCLs.

1.9.4 Stormwater Data

Table 1-2 also shows analytical results for the two stormwater samples collected from manhole MH-1. One sample (SW-01-04) was collected from the upper pipe in this manhole and the other (SW-02-09) was collected from the lower pipe. Sample SW-01-04 contained 7 μg/L of 1,2-DCE (total) and 39 μg/L of TCE. The latter concentration exceeds all of the regulatory criteria shown in Table 1-2. The TCE detected in SW-02-09 was 2 μg/L which exceeds the U.S. EPA RBC for tap water and the Federal MCLG.



DETECTED GROUNDWATER AND STORMWATER CONTAMINANTS (µg/L)
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

0 50 100
SCALE IN FEET

FIGURE 1-6

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1.10 DATA ASSESSMENT SUMMARY

1.10.1 Soil Data Assessment Summary

TCE contamination is present in the Site 57 soil. At the 10- to 12-foot depth, TCE contamination appears very localized near soil gas survey location SG-07 approximately 100 ft. south of the southeast corner of Building 292. Current data indicate that deep soil contamination may be limited to within a 25-foot radius of SG-07. Shallow, 2- to 4-foot deep soils show evidence of contamination over a wider area, possibly extending to SG-06 (approximately 240 feet south of Building 292 along the north-south axis). However, the east-west extent of the contaminated soil area is less certain as only soil-gas data are available for estimating this area.

The extent of TCE contamination in soil is an estimate and it should be noted that several factors affect this estimate. First, other than SG-07, there is not a strong correlation between the soil gas data and the analytical data from the soil samples; however, soil gas was used to determine a potentially impacted area. Second, the direction of the field study axis was set based on visual observation of the local surface topography, and on the assumption that the groundwater downgradient direction coincided with the topographic down-slope direction. However, the true local groundwater flow direction may vary from the topographic down-slope direction, and the axis of the groundwater contaminant plume will more closely follow the groundwater flow direction. Thus, an axis selected on the basis of topography may not coincide with the contaminant plume's axis.

The 20 μg/kg U.S. EPA SSL for protection of groundwater is key to determining the size of the area requiring soil remediation. As an example, the next most stringent regulatory TCE criteria shown in Table 1-1 is the 3,000 μg/kg U.S. EPA SSL for protection of air. Based on the existing data and applying this SSL of 3,000 μg/kg, only shallow soil at SG-02 and SG-07 would be in need of remediation.

The available data tend to support a view that the TCE migration from shallow soil to groundwater occurs at a relatively slow rate. Thus a TCE concentration in soil that is higher than the Region III SSL may be permitted while retaining groundwater protectiveness. Site-specific data regarding TCE leachability, soil permeability, and total organic carbon in the soil, which will be obtained during RI field work, would allow a site-specific determination of the concentration of TCE in soil that will maintain protection of groundwater.

1.10.2 Groundwater and Stormwater Data Assessment Summary

The most consistently detected compound in the groundwater and stormwater samples was TCE. This chemical was detected in all water samples, but at a much higher concentration in GW-11-11

(370,000 μg/L) near soil-gas survey location SG-07. GW-11-11 was generally the more contaminated of the two groundwater samples. In addition to TCE, it also contained vinyl chloride at 2,000 μg/L and 1,2-DCA at 52,000 μg/L. Of the two stormwater samples, the sample collected from the uppermost pipe in MH-1 (SW 10-04) exhibited the highest concentration of TCE (39 μg/L). Other contaminants were found in the groundwater and stormwater samples, but at lower concentrations.

Analysis of the two groundwater samples collected verify the presence of TCE in the groundwater. However, sample analyses further indicate the possibility that groundwater contamination requiring remediation (as determined by comparison with the MCLs for the National Primary Drinking Water Standards and the State of Maryland) is not widespread. For instance, comparing GW-14-13 with the MCLs, the groundwater TCE plume may not extend beyond SG-05.

Storm-water samples show the presence of TCE, but the potential source of the TCE in the stormwater is in question. Previous storm-water system sampling conducted in an effort to identify the source of the TCE detected at location IW-80 (located approximately 1,300 feet downgradient from Building 292) found no TCE present in the upstream storm-water collection system (See Figure 1-3). The source of the TCE found in MH-1 may be groundwater infiltration either directly into the manhole or via joints in the pipes discharging into the manhole.

2.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

Removal action objectives are developed to determine guidance for the removal action and ensure the action complies with regulatory requirements. This section provides a streamlined risk assessment, an evaluation of applicable or relevant and appropriate requirements (ARARs), the removal action objectives, statutory limits, and estimated quantities.

2.1 STREAMLINED RISK ASSESSMENT

The purpose of the streamlined risk assessment is to provide a general assessment of the risks posed by contaminants present in Site 57 soils, and the potential of site soils to act as a source of contaminants to other media. This will be accomplished partly through a description of the use of the site and the activities which may result in exposure of humans to contaminated soil. U.S. EPA Region III RBCs will be relied upon as estimates of the concentrations of chemicals above which adverse human health effects may occur. These RBCs assume that exposure to a contaminated medium will occur through a standard exposure scenario, which may differ from that which would occur at a specific site. The assessment of the potential for transfers of soil contaminants to other media will be based on site data and on U.S. EPA SSLs. The SSLs are chemical concentrations in soil which could result in hazardous concentrations of chemicals in air or groundwater through the transfer of chemicals from soil. The SSLs are calculated based on an assumed residential exposure scenario. Consequently, they consist of contaminant levels that are more stringent than necessary for an industrial exposure scenario. Additionally, SSLs are based on standard assumptions regarding soil properties and meteorological factors which affect contaminant transfers from soil.

Site 57, the Drum Loading Area for Building 292, previously housed operations employing large quantities of TCE. The site was initially investigated because it was located upstream of a stormwater discharge point that was found to contain TCE. Soil, stormwater, and groundwater from the site were analyzed for Target Compound List (TCL) Volatile Organic Compounds (VOCs). However, TCE was the chemical consistently found at the highest concentrations in the sampled media, and, with the exception of tetrachloroethene in one groundwater sample, only TCE or one of its degradation products was found at concentrations in excess of any standards, criteria, or RBCs. In soils, TCE was the only contaminant found at concentrations exceeding U.S. EPA Region III RBCs or SSLs.

Site 57 is immediately adjacent to Building 292, one of several buildings in the area used in research, development, testing, and production of propellants and explosives. Access to the area is strictly controlled. Thus, potential human exposure to TCE at the site is limited to workers at the site or nearby

buildings. There are no sensitive ecological habitats, such as streams or wetlands, in the immediate vicinity of the site.

A typical worker at the area would generally be exposed only to surface soils. Because data are not available for surface soils, the risk to typical workers cannot be evaluated directly. However, because the source of the TCE in shallow subsurface soil (2-4 foot depth) is presumed to have resulted from past spills to the surface, rather than an underground source such as a pipeline or underground tank, surface soils may have significant concentrations of TCE. A typical worker at the site could be exposed to TCE in surface soils through incidental ingestion of soil transferred from the hand to an article of food or a cigarette, through dermal contact, and through inhalation, as TCE is a volatile compound. If one assumes the shallow subsurface data on TCE is representative of surface soil concentrations, the RBC for exposure to TCE through incidental ingestion of soil under an industrial scenario is exceeded at one location, and the SSL for transfer to air is exceeded at two locations (Table 2-1). These exceedances indicate that TCE in soils at the site may pose a risk to typical workers in the area. However, this analysis will not represent the actual risk if TCE concentrations in surface soils are not similar to those in the shallow subsurface soil and site-specific factors affecting exposure differ from those assumed in the calculation of the RBCs and SSLs.

A construction worker or other worker involved in excavation activities at Site 57 could be exposed directly to TCE in subsurface soils through incidental ingestion, dermal contact, and inhalation. The exposure of a construction worker to contaminants in soil would be expected to occur over a shorter overall time period than a typical worker, as exposure would be limited to the duration of the construction project. However, within this time period a construction worker's exposure to soil contaminants may be greater than that of the typical worker because construction work often requires working in close contact with soil for most or all of the workday. Exceedances of the RBC developed for the typical worker and the SSL for transfer to air by TCE concentrations in soil at the site suggest that exposure to site soils may represent a risk to construction workers.

The TCE in soil at the site also represents a potential source of TCE to other environmental media. As discussed above, the evaporation of TCE from soil to air could serve as an exposure pathway for workers at the site. In addition, TCE may migrate from the shallow subsurface, where the data indicates it is present in the highest concentrations, to deeper layers of soil and groundwater. The concentration of TCE in the soil designed to be protective of groundwater quality is 20 µg/kg, the SSL for the transfer from soil to groundwater.

TABLE 2-1

FEDERAL ARARs AND TBCs
IR SITE 57, NSWC
INDIAN HEAD, MARYLAND

ARAR/TBC	Requirement	Synopsis	Comments
RBC Screening Levels	20 µg/kg TCE	USEPA Region III Risk-Based Concentrations (RBCs) Screening Levels	Screening level for transfer from soil to groundwater. Selected for protection of groundwater.
Clean Air Act (CAA)	Air emission limitations on selected parameters	Emission limitations related to attainment of National Ambient Air Quality Standards and Emission Standards for Hazardous Air Pollutants	Potential removal actions may involve air emissions. However emissions are not likely to be affected by CAA due to 1. Small quantities of pollutants emitted and/or 2. Source not included in a regulated category
Safe Drinking Water Act	TCE 5 µg/L Vinyl chloride 2 µg/L 1,1-DCE 7 µg/L 1,2-DCE 70 µg/L 1,1,1-TCA 200 µg/L 1,1,2-TCA 5 µg/L PCE 5 µg/L	Sets drinking water standards for public water supply	Not currently applicable as site groundwater is not a public water supply. However, protection of groundwater for future potential drinking water use is an objective of the potential removal actions

This soil concentration was exceeded by the TCE concentrations in all shallow subsurface soil samples. The SSL for transfer to groundwater was only exceeded by the TCE concentration in one of the deeper soil samples (10-12 feet), suggesting the downward migration of TCE may be proceeding slowly. However, TCE was detected in one groundwater sample in the upper aquifer at a concentration of 370,000 µg/L, well above the Safe Drinking Water Act MCL of 5 µg/L (B&R Environmental, 1996).

Currently, there are no drinking water wells believed to be located downgradient of the site and high concentrations of total dissolved solids may limit the use of the upper aquifer as a drinking water supply. In addition, future residential land use is not considered likely. However, the presence of vinyl chloride, 1,1-DCE, 1,2-DCE, 1,1,1-TCA, 1,1,2-TCA, PCE, and TCE in the groundwater at concentrations exceeding the Safe Drinking Water Act MCLs suggests that a hypothetical future domestic user of groundwater could be at risk from TCE concentrations present.

The soil at Site 57 may also be acting as a source of TCE to stormwater. TCE has been detected in a pipe entering MH-1 located on the site. The TCE stormwater from the pipe presumably originates from either infiltration of water which has been in contact with TCE contaminated soils or from the upstream source of stormwater to the pipe. The stormwater ultimately discharges to Mattawoman Creek near its confluence with the Potomac River. Mattawoman Creek is used for recreational fishing and boating. Although the TCE concentration in stormwater exceeds AWQC, the large dilution by Mattawoman Creek is expected to mitigate any risks from TCE in stormwater.

In conclusion, the available data indicate that TCE concentrations in soil may represent a risk to workers involved in excavation activities at Site 57. Typical workers at the site may also be at risk if the concentrations of TCE in surface soil are similar to those found in the shallow subsurface soil. Transfers of TCE from soil at the site may result in hazardous concentrations of TCE in groundwater and/or the air. However, the risks from groundwater may not be realized as future use of the upper aquifer for drinking water is not likely. It is also possible that soil contaminated with TCE is acting as a source of TCE in stormwater flowing to Mattawoman Creek, although the large dilution volume associated with the stormwater discharge is expected to mitigate the potential risks associated with TCE in stormwater.

2.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or Relevant and Appropriate Requirements (ARARs) are used to develop criteria by which removal action objectives and removal action technologies can be established. The term ARARs is defined in the National Oil and Hazardous Substances Contingency Plan (NCP) as follows:

- Applicable requirements are generally defined as the remediation standards, standards of control, or other substantive requirements promulgated under Federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, or location. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be considered as applicable requirements.

- Relevant and appropriate requirements are defined as those remedial standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal or state environmental or facility siting laws that are not directly applicable to a hazardous substance, pollutant, contaminant, remedial action, or location. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may by considered as relevant and appropriate requirements.

- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

ARARs are classified into three broad categories, based on the manner in which they are applied during a removal action. These categories are as follows:

- Contaminant-Specific. Contaminant-specific ARARs were developed to provide health or risk-based concentration limits for environmental media. These limits are specific for an individual chemical or group of chemicals. Often, these ARARs are used to determine the extent of site remediation. Contaminant-specific ARARs may be concentration-based cleanup goals or may provide the basis for calculating such levels. In cases where no chemical-specific ARAR exists, chemical advisories may be used to develop remedial objectives.

- Location-Specific. Location-specific ARARs are considered in view of natural or man-made site features. These ARARs are intended to limit activities within designated areas.

- Action-Specific. Action-specific ARARs pertain to the implementation of a given remedy. These ARARs control or restrict hazardous substance- or pollutant-related activities. These controls are considered when specific remedial activities are planned for a site.

The presumptive remedies for soil contaminated with VOCs have been developed on the Federal level and the OSWER directive is national in scope; therefore it does not take into account State ARARs. For this reason State ARARs, relating to the presumptive remedies, should be considered on a site-specific basis.

Contaminant-, location-, and action-specific ARARs for IR Site 57 are discussed in the subsections that follow. In addition to ARARs, other regulations and guidances may be classified as guidance "To Be Considered" (TBC). TBCs are also identified in this section to aid in the evaluation of the removal actions and in establishing the cleanup levels of contamination. Table 2-1 provides a summary of ARARs and TBC requirements. The State of Maryland provided a list of potential state ARARs. Those Maryland ARARs which are applicable to the current site and the potential removal actions are shown in Table 2-2.

2.2.1 Contaminant-Specific ARARs

Data indicate that TCE is present at the IR Site 57 area soils in concentrations which exceed the U.S. EPA Region III RBCs and SSLs for TCE.

The most stringent risk-based soil concentration for TCE is 20 μg/kg under the SSL for transfer from soil to groundwater. Clean-up goals can be established based on risk assessment methods; however, the conservative goal represented by the SSL for transfer to groundwater will be utilized as the removal goal in the event a soil removal alternative is selected under this removal action. This SSL also provides a measure of the appropriateness of a removal action alternative.

Data also indicate that in addition to TCE, vinyl chloride, 1,1-DCE, 1,2-DCE, 1,1,1-TCA, 1,1,2-TCA, and PCE are present in the Site 57 groundwater at concentrations that exceed U.S. EPA and Maryland MCLs (See Table 1-2). Of these additional contaminants, 1,2-DCE and 1,1,1-TCA were also detected in soil, but not in concentrations which exceed any of the regulatory criteria and guidance.

2.2.2 Action-Specific ARARs

Action-specific ARARs will be identified or defined by the specific removal actions proposed. Several action-specific ARARs are listed in Table 2-2. Activities which may be a part of the potential removal actions and subject to an ARAR include the potential generation and transportation of hazardous waste, earth disturbance, and emission of air pollutants.

TABLE 2-2

STATE OF MARYLAND ARARS
SITE 57, EE/CA
INDIAN HEAD, MARYLAND
PAGE 1 OF 4

Citation (COMAR)	Type of ARAR	Title	Requirement Synopsis	Comments
26.02.03	Action	Control of Noise Pollution.	Provides limits on the maximum allowable levels of noise at the site boundaries during site remediation work to protect the health, general welfare, and property of the people of the State.	State regulation Potential removal actions may involve use of heavy machinery.
26.04.01	Action/Chemical	Quality of Drinking Water in Maryland	Provides for maximum contaminant levels (MCLs) of contaminants in drinking water.	State regulation Not directly applicable as groundwater is not used as a source of drinking water. However, protection of groundwater quality is one reason for potential removal action.
26.04.04	Action	Well Construction	Provides specifications for well construction and abandonment. Any wells installed, decommissioned, and/or abandoned in Maryland are subject to these requirements.	State regulation Structures similar to wells will be installed for one potential removal action.

TABLE 2-2

STATE OF MARYLAND ARARS
SITE 57, EE/CA
INDIAN HEAD, MARYLAND
PAGE 2 OF 4

Citation (COMAR)	Type of ARAR	Title	Requirement Synopsis	Evidence of Enforceability
26.04.07	Action/Chemical	Solid Waste Management	Provides for proper closure and post closure monitoring and maintenance of landfills. Remedial alternatives involving landfill capping and incinerators are dependent upon these regulations.	State regulation Incineration is a potential removal action.
26.05.01	Action	Board of Well Drillers	Provides licensing requirements for persons drilling and installing wells in the State. Assures that monitoring wells are installed by qualified well drillers.	State regulation Structures similar to wells will be installed for one potential removal action.
26.08.01 26.08.02 Title 26, Subtitle 23 26.08.04	Action/Chemical Chemical Chemical Chemical	Water Pollution: General Water Quality Discharge Limitation Permits	Protects and maintains the quality of surface water in the State. Establishes criteria and standards for discharge limitations and policy for antidegradation of waters of the State. Any contaminated groundwater entering the surface water must meet ambient water quality criteria. Discharge of treated groundwater must meet State NPDES limits.	State regulations Potential removal actions do not discharge to surface water. In addition, removal action is designed to protect groundwater which may discharge to surface water.

TABLE 2-2

STATE OF MARYLAND ARARS
SITE 57, EE/CA
INDIAN HEAD, MARYLAND
PAGE 3 OF 4

Citation (COMAR)	Type of ARAR	Title	Requirement Synopsis	Evidence of Enforceability
Title 26, Subtitle 17 Title 26, Subtitle 17	Action Action/Location	Erosion and Sediment Control Stormwater Management	Any land-clearing, grading, other earth disturbances require an erosion and sediment control plan. This plan must be approved before construction activities begin. Stormwater must be managed to prevent offsite sedimentation and maintain current site conditions. The primary goal is to maintain after development, as nearly as possible, the pre-development runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and local flooding.	State regulations Potential removal actions may involve significant earth disturbance.
26.11	Action/Chemical	Air Quality	Provides ambient air quality standards, general emissions standards, and restrictions for air emissions from construction activities, vents, and treatment technologies such as incinerators. Also includes nuisance and odor control. Construction activities will emit particulate matter into the ambient air. Remedial activities must follow regulations.	State regulation Potential removal actions may involve air emissions.

TABLE 2-2

STATE OF MARYLAND ARARS
SITE 57, EE/CA
INDIAN HEAD, MARYLAND
PAGE 4 OF 4

Citation (COMAR)	Type of ARAR	Title	Requirement Synopsis	Evidence of Enforceability
26.13.01 26.13.02	Action/Chemical Chemical	Hazardous Waste Management System; General Identification and Listing of Hazardous Waste	Provides criteria to identify hazardous waste and listed waste, including Maximum Concentration of Contaminants for the Toxicity Characteristic.	State regulation Potential removal actions may generate hazardous waste.
26.13.03	Chemical/Action	Standards Applicable to Generators of Hazardous Waste	Establishes standards for generators of hazardous waste.	State regulation Potential removal actions may generate hazardous waste.
26.13.04	Chemical	Standards Applicable to Transporters of Hazardous Waste	Provides regulations for the transport of hazardous waste. Any hazardous waste found during site remediation must be disposed of according to regulation. Any residues or by-products from treatment systems which are hazardous must be disposed of properly.	State regulation Potential removal actions may generate hazardous waste.
08.05.03	Action	Construction on Nontidal Waters and Floodplains	Establishes criteria to govern construction, reconstruction, repair, or alteration of a dam, reservoir or waterway obstruction or any change of the course, current, or cross section of a stream or body of water within the State including any changes to the 100-year frequency floodplain or free-flowing waters.	State regulation Site of potential removal actions may lie within 100-year flood plain.

2.2.3 Location-Specific ARARs

The removal actions being evaluated are expected to cause significant disturbance. Nothing from the background search indicates that a significant wetland area or ecologically sensitive area is in the immediate area of IR Site 57, nor is the site located in a 100-year flood plain.

2.3 REMOVAL ACTION OBJECTIVES

As the lead agency, the Navy has determined that soil and groundwater are the media to be considered under this non-time critical removal action. The primary objective is to mitigate the escape of TCE contaminated groundwater at IW-80 apparently as a result of the infiltration of contaminated groundwater in the area of Site 57 into the stormwater collection system. Secondarily, the TCE contaminated soil in the Site 57 area may be contributing contamination to the groundwater as a result of leaching in addition to the possibility of risks to personnel who work in the area.

The development of site-specific remediation goals would require the availability of sufficient analytical data to conduct a formal human health and environmental risk assessment, as well as physical parameters (e.g., soil lithology, porosity, bulk density, moisture content and possibly partition coefficients) for estimating the rate of contaminant leachability from soil to the groundwater and plume migration rates. In the absence of that data, the following criteria for TCE are applied in this document:

- 450 µg/L for groundwater, in situ, for protection of surface water in Mattawoman Creek, based on the 100 µg/L limit for stormwater discharge at outfall IW-80, details of which are presented in Appendix A. In the absence of a more complete database, the 450 µ/L criterion was developed for the purposes of this document only. The matter of groundwater concentrations necessary for the protection of surface water needs to be reconsidered during the remedial investigation. It is expected that a more comprehensive database will be available at that time and will permit a more thorough consideration of the issue.

- 5 µg/L for groundwater, in situ, based on the State of Maryland MCL.

- 20 µg/kg for soil at the site, based on the U.S. EPA Region III SSLs for the transfer of contamination to groundwater from soil subjected to the leaching of stormwater.

The 20 μg/kg is likely more conservative than site-specific conditions would require to protect groundwater, and should be reevaluated as part of a more complete Remedial Investigation. At that time, data can be collected to permit the estimation of a more site-specific soil contaminant concentration protective of groundwater.

In addition to TCE, the criteria applied to other COCs are based on the State of Maryland MCLs and are as follows:

- Vinyl chloride 2 μg/L
- 1,1-DCE 7 μg/L
- 1,2-DCE 70 μg/L
- 1,1,1-TCA 200 μg/L
- 1,1,2-TCA 5 μg/L
- PCE 5 mg/L

2.4 STATUTORY LIMITS ON REMOVAL ACTIONS

The statutory limits for fund-financed removal actions are presented in section 104(c)(1) of CERCLA. These limits are not applicable because the action at Site 57 is not financed by the Superfund.

2.5 ESTIMATED EXTENT OF SOIL CONTAMINATION

Based on the results of the subsurface investigation (B&R Environmental, 1996) and using the U.S. EPA Region III SSL for the transfer of contamination from soil to groundwater for TCE of 20 μg/kg, an estimate of the extent of TCE contamination can be determined. Figure 2-1 provides an estimate of the area to be considered during this removal action.

The estimated values scaled from Figure 2-1 are as follows:

Planimeter Reading: 7.78 in^2 (1"=60'):

Area = 28,008 ft^2 @ 7 ft below ground surface

Volume @ 7 ft = 7,261 cubic yards

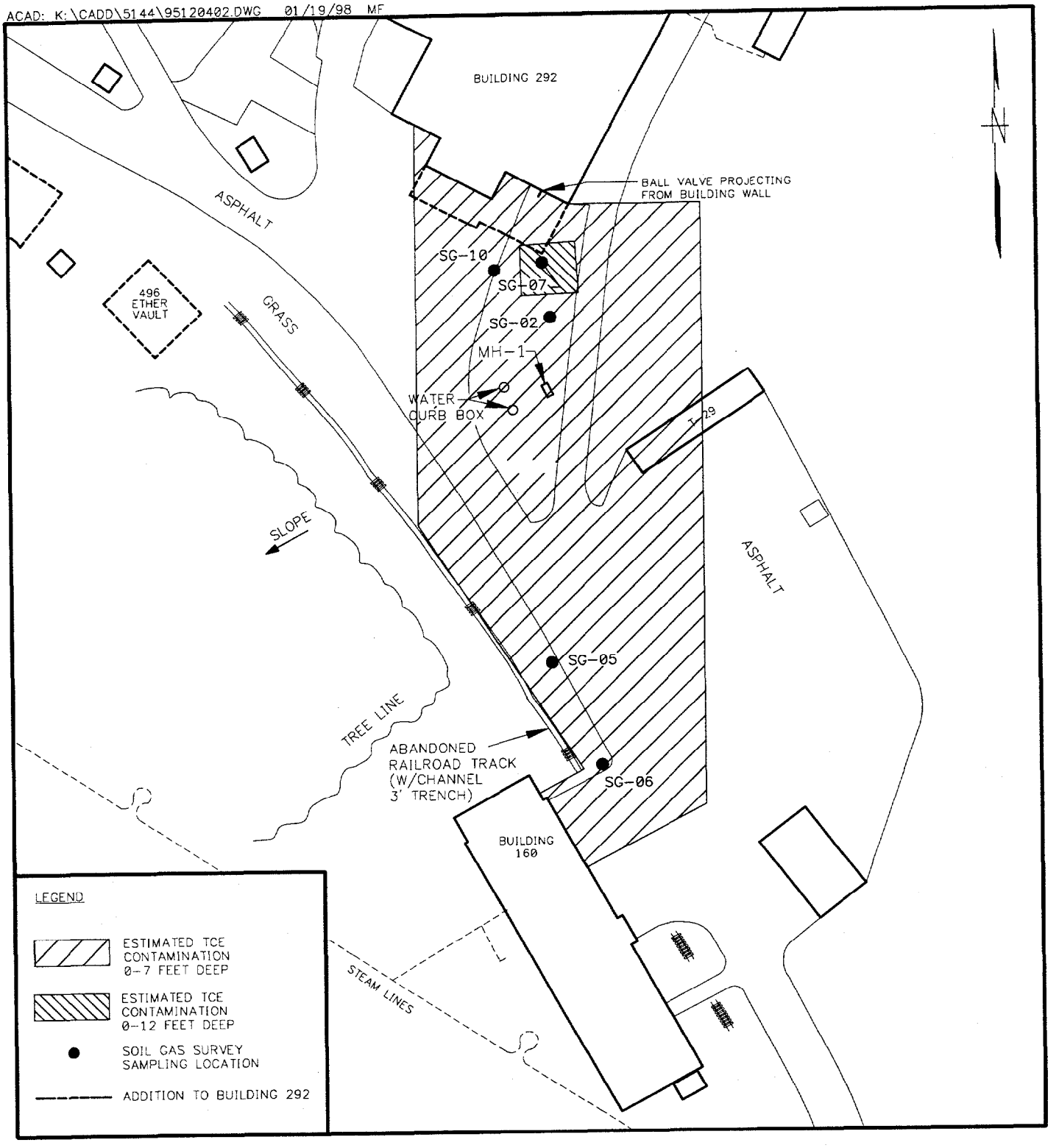
Deep contamination observed in 20 ft x 20 ft area to depth of 12 ft

Volume @ 7 ft - 12 ft = 74 cubic yards

Total Contaminated Soil Volume = 7,335 cubic yards

Area covered by Asphalt:

Planimeter Reading = 4.26 in^2 ~ 1,704 square yards



LATERAL EXTENT OF SOIL CONTAMINATION (ESTIMATED)
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

0 60 120
SCALE IN FEET

FIGURE 2-1

Brown & Root Environmental

These volumes will be used to conduct a cost estimate of the Removal Action Alternatives.

2.6 ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION

Based on the results of the subsurface investigation (B&R Environmental, 1996), an estimate of the extent of groundwater contamination was determined. Figure 2-2 provides an estimate of the area to be considered during this removal action. Assumptions and calculations made for this estimate are provided in Appendix A. It should be noted that this is an assumed plume delineation and that further characterization of the extent of the plume is required before implementation of a removal action. This delineation of the plume is presented for the purposes of providing a framework for the preliminary conceptual design of alternatives and development of cost estimations.

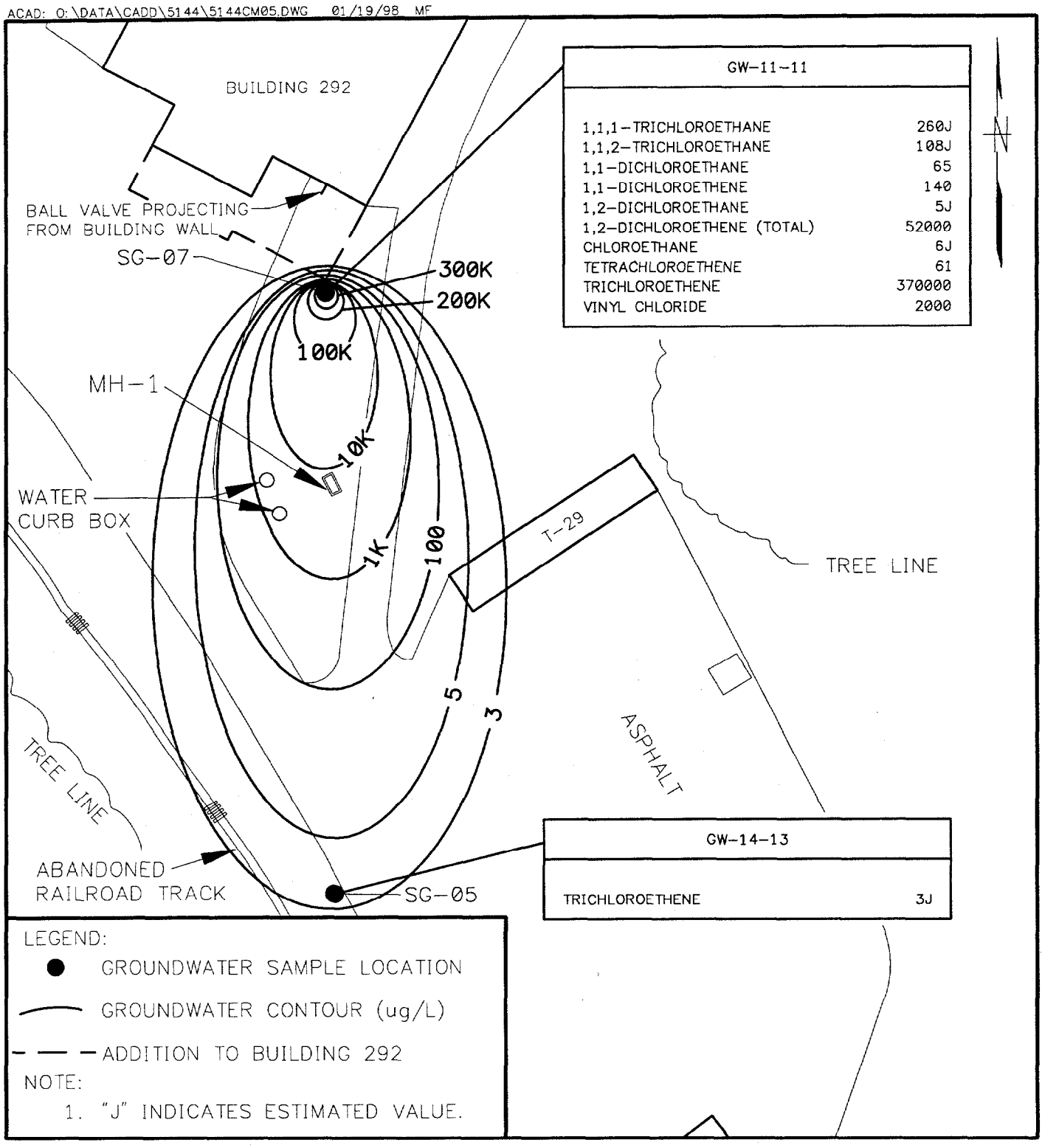
The isoconcentration contours are theoretical delineations of the plume that were developed to estimate the average concentration of TCE for preliminary conceptual design purposes. The area-weighted average concentration of TCE within the 3 µg/L plume is estimated to be approximately 10,000 µg/L, details of which are presented in Appendix A.

The shape, size and orientation of the plume have been assumed based on two well point data at SG-07 and SG-05 as depicted in Figure 2-2, using the soil gas plume as a guidance for the extent of the plume.

The estimated groundwater flow rate through the plume is approximately 12 gpm. This flow rate is an estimated hydraulic conductivity derived from limited grain-size distribution data, an assumed plume width and an estimated aquifer thickness. Details of the estimated of flow rate are also presented in Appendix A.

It should also be noted that despite the estimated high hydraulic conductivity of the lower surficial aquifer (estimated to be in the order of 10^{-3} feet/second - see Appendix A for calculations), soil gas survey, groundwater, and soil data indicate that the contaminant plume appears to be localized in the vicinity of the suspected TCE spill location. Possible explanations for this occurrence include dilution of contaminants by the relatively high groundwater flow, adsorption of contaminants to soil particles, and chemical/microbial degradation of contaminants.

Prior to removal action design, additional investigation is required to confirm or possibly modify these parameters of the plume and the aquifer. At that time, the design of the alternatives must be re-evaluated.



ASSUMED GROUNDWATER
TCE ISOCONCENTRATION CONTOURS
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

0 40 80
SCALE IN FEET

FIGURE 2-2

Brown & Root Environmental

2.7 DETERMINATION OF REMOVAL ACTION SCHEDULE

The removal action at IR Site 57 was determined by the U.S. Navy, as the lead agency, to be a non time-critical removal action, because a planning period of six months was available before the implementation of the removal action. Implementation of the selected removal action could commence within 6 to 12 months of the finalization of the EE/CA. It is recommended that the removal action be conducted during the summer months when precipitation is expected to be at the lowest annual levels and temperatures for field actions are most favorable.

3.0 SCREENING OF TECHNOLOGIES AND SELECTION OF REPRESENTATIVE PROCESS OPTIONS

This section screens technologies and selects representative process options for treating the contaminated soil and groundwater. The technologies and process options discussed herein are primarily for the treatment of chlorinated VOCs (the primary contaminants of concern). Based on available information, only the most qualified technologies will be selected as an alternative for a removal action for soil and groundwater. Section 3.1 presents the screening of soil technologies for use at Site 57. Section 3.2 presents the preliminary screening of groundwater technologies and Section 3.3 presents the detailed screening of groundwater technologies. Section 3.4 presents the representative technology components that will be carried through the removal action alternative analysis.

3.1 SCREENING OF SOIL TECHNOLOGIES

Under the Superfund Accelerated Cleanup Model (SACM), U.S. EPA has established a set of "presumptive remedies" for categories of sites that exhibit similar characteristics (U.S. EPA, 1993b). Given the TCE contamination of the Site 57 soil, the presumptive remedy entitled "Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with VOCs in Soils" is applicable to the site. Under this presumptive remedy, the following removal technologies are recommended in order of preference: 1) soil vapor extraction (SVE), 2) thermal desorption, and 3) incineration.

- Soil vapor extraction (SVE) is an in-situ or ex-situ process which physically removes contaminants from soils by inducing air flow through the soil matrix. The flowing air strips volatile compounds from the solids and carries them to extraction wells. The recovered vapors may require further treatment.

- Thermal Desorption is an ex-situ process that uses direct or indirect heat exchange to vaporize organic contaminants from soil, sediment, sludge or other solid and semisolid matrices. The vapors are then condensed or otherwise collected for further treatment.

- Incineration is an ex-situ engineered process that employs thermal decomposition via oxidation at temperatures usually greater than 900°C to destroy the organic fraction of the waste.

As discussed in the U.S. EPA's Office of Solid Waste and Emergency Response (OSWER) (U.S. EPA, 1993b), published guidelines, "U.S. EPA has determined that, when using presumptive remedies at VOC-contaminated sites, site-specific identification and screening of alternatives is not necessary." The guidance further indicates, "Under this presumptive remedy approach, the detailed analysis can be limited

to the three presumptive remedies (in addition to the no-action alternative)," because, "One of these presumptive remedies is expected to be used for all VOC sites except under unusual circumstances." Accordingly, this EE/CA document does not attempt to identify and evaluate a range of technologies for the treatment of the TCE-contaminated soils at Site 57. This document proceeds directly to the identification and analysis of soil removal action alternatives utilizing the presumptive remedy technologies set forth in the guidance document.

The OSWER Directive identifies SVE as the primary presumptive remedy. SVE has in the past been selected most frequently to address VOC contamination at Superfund sites and initial performance data indicates that it effectively treats waste in place at a relatively low cost. As recommended in the OSWER Directive, a pilot-scale test to determine if in-situ SVE is applicable to site conditions will be conducted prior to final selection of a Removal Action Alternative. In cases where SVE will not work or where very high contamination exists, thermal desorption may be more appropriate. Ex-situ SVE was evaluated, but due to the large quantities of soil to be treated, 7,000 cubic yards (cy), it was not considered as a feasible alternative and has not been given further consideration.

Thermal desorption is considered the primary ex-situ presumptive remedy. However, if bench-scale testing indicates thermal desorption will not achieve described goals, incineration is the next alternative.

Two of the presumptive remedies, thermal desorption and incineration, are ex-situ and require the contaminated material be removed prior to treatment, thus they must include a removal technology in their evaluation. Therefore, prior to a discussion of the Removal Action Alternatives, an examination of removal technologies will be conducted.

Removal

The technologies typically considered under removal are excavation and dredging. Excavation can be performed by a variety of equipment, such as tractor shovels (front-end loaders), backhoes, grade-alls, etc. Dredging can be performed by clamshells, draglines, etc. These technologies are essentially identical, except for the type of equipment used for removal of contaminated material. The type of equipment selected must take into consideration several factors, such as the type of material to be removed, the load-bearing capacity of the ground surrounding the removal area, the depth and lateral extent of removal, the required rate of removal, and the location of the groundwater table with respect to the depth of excavation required. Excavation is the technology of choice for the removal of well consolidated material to a depth of up to 30 feet and from well-defined areas of ground with significant load bearing capacity (i.e., greater than 1,500 foot-pounds). Dredging is the technology of choice for the

removal of loosely consolidated material, such as sediment, to depths typically not in excess of 10 feet and from widespread and generally submerged areas of ground with low load bearing capacity. At Site 57, since removal will take place in a relatively small and well-defined area, the removal equipment will be operating on firm ground, and the majority of excavation will be above the water table, the removal technology of choice will be designated as excavation.

The logistics of excavation must take into account the available space for operating the equipment, loading/unloading to transport the removed material, location of the site, etc. Once excavation is completed, the location would be filled and graded with clean material or treated soils.

Effectiveness

Excavation is a well-proven and effective method of removing contaminated material from a site. The material present at IR Site 57 would be amenable to excavation. Properly designed excavation could remove virtually all of the soil exhibiting TCE contamination levels above Region III RBCs and the remaining soil would not pose an unacceptable risk to human health of the environment.

Verification sampling is typically required to verify the effectiveness of the removal action. Soil samples are collected from the walls, and as applicable, the bottom of the excavation. These samples are analyzed for contaminants of concern (COCs) to ensure that the remaining soil is not contaminated at unacceptable levels.

Implementability

Excavation equipment is readily available from multiple vendors. This technology is well proven and established in the construction/remediation industry. Compliance with site-specific health and safety procedures and OSHA regulations during excavation will ensure that the exposure of workers to COCs is minimized.

Cost

Excavation costs are typically low.

Conclusion

Excavation is retained for further consideration in the development of the removal alternatives.

3.2 PRELIMINARY SCREENING OF GROUNDWATER TECHNOLOGIES

This section presents the preliminary screening of groundwater technologies for use at Site 57. Technologies and process options under each general response action are screened at a preliminary level in Table 3-1. In order to aid in the focus for the detailed screening, process options not suited for use at Site 57 will be eliminated from further consideration.

3.3 DETAILED SCREENING OF GROUNDWATER TECHNOLOGIES

This section presents a detailed screening of those technologies that passed the preliminary screening conducted in Section 3.2. The remedial technologies and process options that passed the preliminary screening are evaluated in more detail based on the criteria of effectiveness, implementability, and cost. Of those technologies that are retained after this screening, process options are selected to represent each potential technology. A brief description of each evaluation criteria follows:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, and volume; and permanence of solution.
  - Ability of the technology to address the estimated areas or volumes of contaminated medium.
  - Ability of the technology to meet the goals identified in the removal action objectives.
  - Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.
- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term maintenance and operation requirements.
- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

TABLE 3-1

SCREENING OF GROUNDWATER TECHNOLOGIES
SITE 57, EE/CA
NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 3

General Response Action	Technology Type	Process Options	Brief Description	Screening Comment
No Action	None	Not Applicable	No action is taken	Retain as a baseline for comparison as required by the NCP.
Minimal Action	Institutional Controls	Fencing/Security/Posting of Notices/Deed Restrictions	Access/regulatory restrictions to prevent use of on-site groundwater or future down-gradient groundwater.	Potentially applicable. Retain for further consideration.
	Monitoring	Groundwater Sampling and Analysis	Monitoring wells for contaminants of concern in and around the site.	Potentially applicable. Retain for further consideration.
	Natural Attenuation	Chemical/Biological	Allowing naturally occurring chemical and microbial agents to degrade contaminants.	Do not retain. The removal objective requires a more immediate mitigation of contamination than what is possible utilizing natural attenuation.
Containment	Subsurface Barriers	Grout Curtains/Slurry Walls/Sheet Piling	Use of physical barriers to minimize migration of contaminated groundwater.	Do not retain. Not effective in the long term.
		Hydraulic Barrier	Use of extraction wells or trenches to restrict horizontal migration of plume.	Potentially applicable. Retain for further consideration.
Removal	Wells/Trenches	Extraction Wells	Use of wells screened within the contaminated saturated zone with pumps.	Potentially applicable. Retain for further consideration.
		Collection Trenches	Use of trenches backfilled with permeable material to collect and convey contaminated groundwater.	Potentially applicable. Retain for further consideration.
In-situ Treatment	Physical/ Chemical	Chemical Oxidation	Injection of oxidizing agents into the saturated zone to destroy organic contaminants.	Do not retain. Injection of aqueous oxidizing chemicals to ensure adequate disposal throughout the plume would be difficult to implement. Reaction rate without ultraviolet light catalyzers would be too slow for practical application in an interceptor trench. May be evaluated again for the FS.

TABLE 3-1

SCREENING OF GROUNDWATER TECHNOLOGIES
SITE 57, EE/CA
NSWC INDIAN HEAD, MARYLAND
PAGE 2 OF 3

General Response Action	Technology Type	Process Options	Brief Description	Screening Comment
In-situ Treatment (Continued)	Physical/ Chemical (Continued)	Permeable Treatment Walls	Downgradient trenches backfilled with reactive media to remove organic contaminants from the groundwater.	Do not retain. Based on the estimated high hydraulic conductivity and the residence times required to degrade TCE, a permeable treatment wall is not feasible (see Appendix A for calculations). However, it should be noted that the estimates of hydrologic and geochemical properties of the site are based on limited data. If further characterization of the site proves otherwise, this technology should be evaluated again for the FS.
	Biological	Biodegradation	Enhancement of natural aerobic and/or anaerobic processes by injecting nutrients and appropriate chemicals into the saturated zone.	Do not retain. Injection of aqueous nutrients and appropriate chemicals to ensure adequate disposal throughout the plume would be difficult to implement. Reaction rate would be too slow for practical use in an interceptor trench. Should be evaluated again for the FS.
	Physical/ Chemical	Air Sparging/Vapor Extraction	Air-injection in saturated zone to volatilize and enhance aerobic biodegradation, with vapor extraction in the unsaturated zone to remove volatilized contaminants and off gases.	Potentially applicable. Transfer of VOCs to vapor phase is relatively quick, and the process may be used in an interceptor trench with appropriate modification to the permeability of vadose zone for efficient capture of vapor. Impractical for application throughout the plume.
Ex-situ Treatment	Physical/ Chemical	Precipitation/Flocculation/ Clarification/Filtration Ion Exchange Reverse Osmosis	Use of one or more of these technologies for separation of suspended solids and removal of inorganics.	Do not retain. Not effective for treatment of primary COCs (i.e., halogenated alkenes/alkanes). However, these processes would be effective for inorganic COCs, or as a pre-treatment step to remove nuisance chemicals, if present. This technology should be considered again for the FS.
		Air Stripping/Steam Stripping/ Activated Carbon Adsorption/ Enhanced Oxidation	Use of one or more technologies to transfer contaminants from the groundwater to another phase in a more concentrated form or to break down the contaminants into more innocuous forms.	Potentially applicable. Retain for further consideration.

TABLE 3-1

SCREENING OF GROUNDWATER TECHNOLOGIES
SITE 57, EE/CA
NSWC INDIAN HEAD, MARYLAND
PAGE 3 OF 3

General Response Action	Technology Type	Process Options	Brief Description	Screening Comment
Prevention of Groundwater Infiltration into Storm Sewer	Storm Sewer System Rehabilitation	Pipe Grouting/ Pipe Lining/ Pipe Replacement	Repair of existing storm sewer pipe system to prevent the infiltration of contaminants.	Potentially applicable. Retain for further consideration.
	End of Pipe Treatment	Air Stripping/ Activated Carbon Adsorption/Enhanced Oxidation	Treatment of effluent discharged at IW-80.	Do not retain. Treatment of extracted groundwater at the source is more efficient than treatment of IW-80 discharge because of larger volumes of water.
Disposal	Surface Discharge	Local POTW	Discharge of the extracted groundwater to the base POTW with or without treatment.	Do not retain. A suitable POTW is not available.
		Surface Water	Discharge of the extracted groundwater to Mattawoman Creek directly or through storm sewer, following treatment	Potentially applicable. Retain for further consideration.
	Subsurface Discharge	Re injection Infiltration Basins	Return the extracted groundwater to the aquifer using forced injection or passive percolation	Potentially ineffective based on current knowledge of hydrogeology. Should be considered in the FS after an RI has been conducted.
Off-Gas Treatment	Physical	Activated Carbon Adsorption	Contaminated vapors pass through a bed of activated carbon. VOCs within the vapors are adsorbed onto the bed.	Potentially applicable. Retain for further consideration.
	Thermal/Chemical	Incineration/Catalytic Oxidation	VOCs are oxidized into relatively less toxic gasses.	Potentially applicable. Retain for further consideration.
	Biological Treatment	Biological Reactor	Microorganisms metabolize contaminants. VOCs are converted to cell mass, water vapor, and carbon dioxide.	Do not retain. Not applicable to COCs.

All of the items listed above may not apply directly to each technology and, therefore, will be addressed only as appropriate. Screening evaluations at this stage generally focus on effectiveness and implementability, with less emphasis on cost evaluations. Technologies whose use would be precluded by waste characteristics are screened and eliminated from further consideration. Each technology presented in this section is not necessarily intended to be implemented alone, as it may be combined with other technologies into remedial action alternatives.

3.3.1 No Action

No action does not involve any removal activity at the site.

Effectiveness. No action would allow the contamination in the groundwater to remain unchanged. In the long term, the concentrations of the chlorinated alkanes/alkenes will gradually reduce due to natural causes such as volatilization, oxidation, biodegradation, etc. The contaminant plume will continue to migrate off site.

Implementability. Implementability concerns are not applicable.

Cost. Cost concerns are not applicable.

Conclusion. Retain "no action" as a baseline for comparison to other technologies.

3.3.2 Minimal Action

3.3.2.1 Institutional Controls/Monitoring

Institutional controls are not directly related to any removal activity. They consist of access/deed restrictions, local regulations and monitoring.

Access restrictions such as those currently in place at the NSWC are required to prevent the public from coming in contact with the contaminated groundwater through one or more of the wells. In addition warning signs and notices that prohibit trespassing on the site may be used. Entries made in the NSWC Master Plan to restrict future development of the site may be used. Deeds, in the unlikely event of sale of the property, can restrict the use of onsite groundwater.

Monitoring of the groundwater would consist of periodically taking samples and analyzing for the contaminants of concern to human health and the environment. If monitoring indicates contamination of downgradient groundwater, local restrictions may be imposed on the use of groundwater at these locations.

Effectiveness. Institutional controls would essentially be as ineffective as no action in removing any contamination from the groundwater. Monitoring on a periodic basis would keep track of the migration of the contaminants off site towards potential exposure to ecological receptors that may be present in Mattawoman Creek.

Implementability. At present there are minimal implementability concerns associated with monitoring at Site 57. However, the Navy prefers not to impose deed restrictions as they may unduly encumber property.

Costs. Access to the site is currently restricted. The addition of any postings and signs would entail minimal extra costs. Periodic groundwater monitoring costs would be moderate.

Conclusion. Retain monitoring for further consideration. Institutional controls will not be retained for further consideration due to their ineffectiveness and inability to be implemented.

3.3.3 Containment

3.3.3.1 Extraction Wells

Extraction wells can be used to contain a contaminant plume to restrict horizontal movement of groundwater. This technology is discussed in the following section.

3.3.4 Removal

3.3.4.1 Extraction Wells

Wells are drilled into the aquifer and screened below the water table to access the groundwater. Pumping is used to extract the water collected in the wells and bring it to the surface. The process of extraction creates a hydraulic gradient which induces further flow of groundwater into the well. Extraction wells that are placed in the path of migration of a contaminant plume can also be used to intercept and contain the plume. Extraction wells that are placed within the contaminated plume can be used to clean the aquifer by removing the contaminated groundwater and flushing the saturated zone. The flushing action occurs when fresh water from upgradient (clean) areas replaces the extracted contaminated groundwater, and causes more contaminants to desorb from the saturated zone soils. Thus, theoretically, the saturated zone soils

progressively lose contaminants until the concentrations in the groundwater are at acceptable/background levels.

Extraction pumps typically used are submersible, electrically-operated centrifugal pumps and pneumatically-operated ejector pumps. For shallow groundwater extraction (depths of up to 10 feet), surface pumps may be used. For deeper groundwater extraction, submersible pumps must be used. Centrifugal pumps are not practicable for use at low extraction rates (less than 1 gpm), and therefore, in such cases, pneumatic ejector pumps are preferred.

Effectiveness. Extraction wells using submersible pumps or surface pumps can be effective in intercepting and containing the migration of a contaminant plume. The location and screening depth of the wells are important criteria that must be taken into consideration in achieving adequate capture of the contaminant plume. Extraction wells have been selected in the past for the remediation of several sites around the country. U.S. EPA currently acknowledges that restoration to drinking water quality criteria may not always be achievable due to limitations of available technologies (U.S. EPA, 1993c). There are technical limitations including slow desorption of contaminants from aquifer materials, hydrogeological factors such as the heterogeneity of soil or rock properties, and geological constraints such as complex fracturing of bedrock aquifer, which will critically limit the ability to restore an aquifer (U.S. EPA, 1993c). Ideally, extraction should result in a progressive decrease of concentrations until remedial action levels are attained. However, performance records of U.S. EPA cleanup projects suggest that, although concentrations may drop initially, this decline is followed by a leveling of concentrations with little or no further decrease (U.S. EPA 1989). It should be noted that the more severe problems that have been identified with complete aquifer restoration have occurred at sites where the groundwater contains dense nonaqueous phase liquids (DNAPLs). DNAPLs tend to sink to the bottom of an aquifer and act as an ongoing contaminant source. The limited data available does not indicate that DNAPL contamination is a problem or concern at Site 57. However, further investigation and confirmation of the presence or absence of DNAPL will be performed under the RI.

At this time, the effectiveness of an extraction well system in adequately capturing the plume at Site 57 is highly questionable because of the limited knowledge of the hydrogeology of the site. As mentioned above, the location and number of wells are critical to achieving adequate overlaps of the zones of influence of adjacent wells. Such an overlap would be required to adequately intercept the plume.

Implementability. Extraction wells are relatively easily installed and pumps are widely available for a variety of flow rates and aquifer conditions. Well screens require regular inspection and maintenance. Pumps also require regular preventive maintenance. Pneumatic pumps have an additional requirement of a source of compressed air and regular inspection of the pump mechanism as well as the air supply lines.

Cost. Capital costs of extraction wells are moderate to high, and O&M costs are low to moderate. Capital and O&M costs of pumps are moderate.

Conclusion. Because of a lack of adequate knowledge of hydrogeological conditions, extraction wells are being eliminated for further consideration in this EE/CA. Extraction wells may be considered again for the FS after an RI has been completed.

3.3.4.2 Collection Trench

Collection trenches are used to convey and collect aqueous discharges by gravity flow. They essentially function like a line of extraction wells by creating a continuous zone of influence. Groundwater within this zone flows toward the collection points. However, trenches cannot create as steep a hydraulic gradient as do extraction wells, and consequently, are less effective at depressing the water table. Since collection trenches function like a line of extraction wells, they can perform many of the same functions. They can be used to contain or remove the groundwater or to prevent contact of water with the waste material. They offer the advantage of collection of contaminated water in situations where the groundwater recharge rate is insufficient to sustain extraction well pumping. Further, they can also be used in circumferential configurations where the infiltration from upgradient groundwater is captured while the enclosed saturated zone is simultaneously dewatered.

A collection trench is formed by excavating a ditch a few feet wide to a depth where an impermeable base is encountered. A backhoe or clam shell is common equipment used for the excavation. This excavated trench is then backfilled with permeable material, such as gravel or crushed rock. Collection pipes and pumps are then placed in the trench to allow for water removal.

Effectiveness. Collection trenches are used for relatively shallow aquifers and have a practical depth limitation of 25-30 ft. However, the confining layer for the surficial aquifer is estimated to be 14 feet. Therefore, a collection trench may be suitable for use at Site 57.

Implementability. Collection trenches are readily implementable for shallow groundwater, and equipment and resources are readily available. Collection trenches would not be difficult to implement at Site 57 because the aquifer is relatively shallow. Replacement of excavated soil from the saturated zone with more permeable earthen material would result in the generation of excess contaminated soil that would need to be treated/disposed of appropriately.

Cost. Costs depend primarily on the depth of excavation, stability of soils, and groundwater flow rates. Capital costs are generally low to moderate and O&M costs low.

Conclusion. Retain collection trench for further consideration in conjunction with other suitable aboveground treatment technologies.

3.3.5 In-Situ Treatment

3.3.5.2 In-situ Air Sparging/Vapor Extraction

In-situ air sparging consists of the removal of VOCs from the groundwater by distributing air as a separate phase through the aquifer. The presence of air as a separate phase in the aquifer causes a transfer of the VOCs from the dissolved phase into the gas phase. The volatilized contaminants in the gas phase are then captured in the unsaturated zone, treated aboveground, and discharged.

This technology differs from aboveground air stripping in that the groundwater is treated for removal of VOCs within the aquifer itself without pumping. This is accomplished by forcing air through either a series of closely spaced vertical wells screened (or perforated) within the aquifer or by the use of submerged, horizontal wells screened throughout the length of each well. The air is released into the groundwater via the screens and is distributed as bubbles throughout the plume. As the bubbles traverse from the bottom of the saturated zone up towards the water table, VOCs are volatilized by the bubbles. These VOCs are then evacuated by the use of vapor extraction wells (vertical or horizontal) screened within the vadose zone and conveyed to an offgas treatment system.

This technology is not practical for groundwater remediation over the entire area of a plume unless the extent is limited to a small area such as a gas station. However, this technology may be more applicable to source area (hot spot) treatment or for plume migration control using interceptor trenches.

Effectiveness. This technology is potentially very effective for the removal of the VOCs of concern such as TCE, DCE and vinyl chloride, as discussed under Air Stripping (Section 3.3.6.1). Although this is a relatively novel technology in the remediation industry, it has been demonstrated to be successful in rapidly removing contaminants from the subsurface at several sites. This technology can be used for the removal of VOCs from both the saturated zone and the vadose zone assuming that there is adequate soil permeability to allow air flow. Typically, the permeability of the vadose zone and saturated zone are critical for the successful implementation of this alternative. Pilot-scale studies (B&R Environmental, May 1997) showed that the permeability of the vadose zone at Site 57 is inadequate for effective removal of VOCs from the vadose zone. Although this technology may still be effective for removal of VOCs from the

saturated zone, the material in the vadose zone would have to be replaced by more permeable material such as coarse sand or gravel to ensure adequate air flow for removal of the VOCs. Given this limitation, the application of this technology is envisioned only within an interceptor trench constructed using more permeable material to capture the migrating plume. Replacement of the entire vadose zone with more permeable material as a method for active remediation throughout the aquifer would not be practical.

Implementability. This is a relatively new technology, but the components of this technology (wells, blowers, vacuum pumps, etc.) are relatively common in the remediation industry. Contractors and consultants are available for the design, installation, and operation of the technology. The operation is not labor intensive and maintenance requirements are limited to those of commonly used rotating equipment. Off-gas treatment requirements would be additional concerns.

Cost. The capital and O&M costs of this technology are low to moderate. Costs of offgas treatment may be moderate to high depending on the requirements.

Conclusion. Retain for further consideration for groundwater treatment.

3.3.6 Ex-Situ Treatment

3.3.6.1 Air Stripping

Volatilization or air stripping technology is well suited for the removal of VOCs from contaminated groundwater. This aeration process encourages the transfer of VOCs found in site groundwater from the aqueous phase to the gas phase as defined by Henry's Law. In general, air stripping is used for VOCs with a Henry's Law constant greater than or equal to 3.0 atm-L/mole (Camp, Dresser and McKee Incorporated, 1985). Removal efficiencies of VOCs typically exceed 99 percent depending on the operating parameters as well as the physical properties of the organic contaminant(s).

The counter current packed tower is the most commonly used air stripping configuration. Water is distributed over the top of the unit while air is forced upward through the bottom. Loosely fitted packing material serves to increase the air/water interface area to provide maximum mass transfer. Key factors that influence performance of this process are: air-to-water flow ratio, height of packing and type of packing material, operating temperature, surface hydraulic loading, and contact time.

Another air stripping configuration that is gaining widespread use is the porous tray-type air stripper. In this system, the water is allowed to flow from the top of the unit through a series of trays until the bottom clearwell. In each tray the water comes into contact with numerous bubbles formed by crosscurrent air

flow through holes (typically 1/16-inch in diameter), while flowing across the tray in a thin layer aided by gravity. Because of the intimate contact between the water and air, the VOCs dissolved in the water are forced into the vapor-phase and eventually exit the system at the top of the air stripper. As the water flows across each tray, the dissolved concentrations of VOCs decrease, and the partially cleaned water flows down by gravity through a spout at one end of the tray to the next tray below it. Finally, the water with acceptable levels of residual VOCs is collected in the clearwell at the bottom of the air stripper and is discharged. The key factors that influence the performance of this process are: air-to-water flow ratio, number and size of trays, and operating temperature. Tray-type air strippers are typically more discreet because of a much smaller height than their packed tower counterparts. However, the air-to-water flow ratio may be up to an order of magnitude higher for tray-type air strippers to match the efficiency of their packed-tower counterparts.

Steam stripping uses steam to strip VOCs from water. This technology is very similar to air stripping, except that steam is used as a carrier gas and provides heat to enhance removal. Steam stripping is generally considered for product recovery and/or for removal of organic compounds that are only slightly more volatile than water.

Effectiveness. Air stripping is a well proven and reliable technology that would be effective for removing the primary VOCs from groundwater at IR Site 57. Removal efficiencies greater than 99 percent can theoretically be achieved for the contaminants of concern, namely TCE, TCA, DCE and vinyl chloride. Since air stripping only removes the contaminants from the water and transfers them to an offgas, the offgas may have to be treated by other means such as granular activated carbon adsorption, catalytic oxidation, or thermal destruction. The need and type of offgas treatment depends on the concentrations, loading rates, air discharge standards (federal or local), health-risk based criteria, etc. In order to make this determination, the following parameters must be defined: (1) groundwater plume boundaries, (2) location and pumping rates of extraction wells, and (3) treatment system discharge limits. Each of the above mentioned offgas treatment technologies should be effective for contaminants in the site groundwater, except for vinyl chloride. Granular activated carbon is typically selected as the representative offgas treatment process option for short-term remediation projects based on cost considerations. However, where vinyl chloride is present at significant levels, catalytic or thermal treatment may be the representative offgas treatment process option since vinyl chloride is a highly toxic compound that adsorbs extremely poorly on activated carbon.

Implementability. Air stripping would be readily implementable at the site. There are a significant number of subcontractors that provide air stripping equipment. In order to meet air discharge standards, control of offgas emissions may be required.

A maintenance problem associated with packed-tower type air strippers is the channeling of flow resulting from clogging in the packing material. Common causes of clogging include high oil and grease content, solids content, and iron concentrations, and the presence of slightly soluble salts such as calcium carbonate. Such maintenance problems are claimed to be less of a concern with the tray-type air strippers because the intense frothing action of the air-water contact has a scouring action on the plates. However, depending on the levels of these other constituents, pretreatment may be required. Therefore, additional parameters that must be analyzed for in groundwater samples are: oil and grease, total solids (suspended and dissolved), iron (total and dissolved), manganese (total and dissolved), calcium, magnesium, alkalinity, and hardness.

Cost. The capital costs are low and O&M costs range from low to moderate depending on influent contaminant concentrations, the degree of removal required, and the type of offgas treatment required. For the contaminants of concern at IR Site 57, steam stripping does not provide any advantage in effectiveness beyond that of air stripping. Therefore, steam stripping would not be cost effective for this application.

Conclusion. Air stripping is an effective and reliable technology for VOC removal of groundwater contamination at IR Site 57 and is retained as a representative process option for further consideration. Vapor-phase activated carbon or catalytic/thermal oxidation may be required depending on further evaluation of the removal system as described above.

3.3.6.2 Activated Carbon Adsorption

Activated carbon adsorption is a frequently applied technology for the removal of organic compounds from contaminated water. Activated carbon will adsorb many organic compounds to some extent but is most effective for the less polar and less soluble compounds. Removal efficiency exceeding 99 percent is possible depending on the type of organic solute and system operating parameters such as the retention time. The fundamental principle behind activated carbon treatment involves the physical attraction of organic solute molecules to exchange sites on the internal pore surface areas of the specially treated (activated) carbon grains. As water is filtered through the adsorbent, the organic molecules eventually occupy all of the surface sites on the carbon grains. The exhausted carbon must then be either regenerated or disposed of according to Federal (RCRA) or State of Maryland regulations.

Activated carbon adsorption systems may use granular or powdered activated carbon particles. Typical activated carbon adsorption treatment systems include gravity flow or pressure flow columns in series

and/or parallel configuration with backwashing capability. Common flow rates range from 0.5 to 5.0 gpm/ft^2. Factors such as pH and temperature of the influent, empty bed contact time (EBCT), surface area/volume ratio of the activated carbon, and solubility of the organic compound(s) will affect the activated carbon adsorption process.

Effectiveness. Activated carbon adsorption is a well proven, reliable technology that would be effective for removing most of the primary VOCs at IR Site 57, namely TCE, TCA, and DCE. Removal efficiencies exceeding 99 percent could potentially be achieved for all of these contaminants. However, treatment by activated carbon has limited effectiveness for vinyl chloride. Generally, the most effective application of activated carbon adsorption would be for the removal of low concentrations of organics, in order to result in a relatively low carbon consumption. Also, the use of activated carbon adsorption in the liquid-phase would be preferable in applications where a mixture of VOCs and semi-VOCs are present, particularly if the contaminants are not amenable to biodegradation. In applications where VOCs are the primary contaminants of concern such as at IR Site 57, the choice between the use of liquid-phase activated carbon adsorption and air stripping followed by vapor-phase activated carbon adsorption (as discussed in the previous section), would be determined by value engineering. Spent carbon containing the concentrated organic contaminants would have to be regenerated or disposed of in a hazardous waste landfill.

Implementability. Activated carbon adsorption would be readily implementable at the site under consideration. There are a sufficient number of vendors that provide carbon adsorption units. Pretreatment may be required if the influent has a suspended solids concentration greater than 50 mg/L, oil and grease concentrations greater than 10 mg/L, or calcium or magnesium concentrations greater than 500 mg/L to prevent clogging and high pressure drops. Therefore, at Site 57 additional parameters that must be analyzed for in groundwater samples are: oil and grease, total solids (suspended and dissolved), TDS, calcium, magnesium, alkalinity, and hardness.

Implementation factors include planning for disposal or regeneration of the spent carbon. Thermal, steam, and solvent treatments are the most common types of regeneration technologies, which are typically conducted offsite. Special handling of the periodically generated backwash liquids must also be taken into account.

Cost. Capital costs are low while O&M costs range from low to high, depending on the activated carbon usage rate, which is a function of influent contaminant concentrations and the groundwater flow rate.

Conclusion. Activated carbon adsorption is a viable technology for contaminants at IR Site 57 except for vinyl chloride, and is retained for further consideration.

3.3.6.3 Enhanced Oxidation

Enhanced oxidation processes use a controlled combination of ozone or hydrogen peroxide and ultraviolet (UV) light to induce photochemical oxidation of organic compounds. Ozone has been used extensively in Europe for purification, disinfection, and odor control of drinking water. Ozone by itself has the ability to break down some organic compounds, but its effectiveness is vastly enhanced with the use of UV light.

UV radiation is electromagnetic energy whose wavelengths fall between those of visible light and x-ray radiation on the electromagnetic spectrum. UV energy is capable of breaking down or rearranging a molecular structure, depending on the dissociation energies of the chemical bonds within the structure. The combination of UV radiation with ozone or hydrogen peroxide treatment results in the oxidation of organic contaminants at a rate many times faster than that obtained from applying UV light, hydrogen peroxide, or ozone alone.

A typical continuous-flow ozone/hydrogen peroxide/UV system consists of an oxygen or air source, an ozone generator or hydrogen peroxide feed system, a UV/oxidation reactor, and an ozone decomposer. Flow patterns and configurations are designed to maximize exposure of the ozone- or hydrogen peroxide-bearing wastewater to the UV radiation, which is supplied by an arrangement of UV lamps. Typical reactor designs range from mechanically agitated reactors to spray, packed, and tray-type towers.

Effectiveness. Enhanced oxidation is a relatively new, but demonstrated technology for the destruction of most volatile organics and some semivolatile organics in groundwater. This technology is unique in its ability to destroy chlorinated VOCs to form relatively innocuous compounds such as carbon dioxide and chlorides without transforming them to another phase. Destruction efficiencies in excess of 99 percent may be expected for various alkenes such as dichloroethenes and trichloroethenes. However, alkanes such as trichloroethanes and dichloroethanes are more difficult to remove through enhanced oxidation. This technology is likely to be effective for the groundwater contaminants at Site 57 because alkenes are the prevalent compounds.

Implementability. Enhanced oxidation technology should be implementable. Relatively few vendors currently offer this technology. Specialized labor would be required for installation. Operation and periodic maintenance would require training by the supplier. With ozone/hydrogen peroxide/UV treatment, no toxics are emitted to the atmosphere or adsorbed onto media that requires further treatment or disposal. Bench-

scale treatability studies may be needed to determine the actual effectiveness and cost of applying an enhanced oxidation process to the contaminants in the groundwater because other naturally-occurring constituents in the groundwater may impact its effectiveness. Pretreatment using clarification and/or filtration would typically be required for turbidity control to ensure the proper operation of the UV lamps used in this process.

Cost. Capital costs for enhanced oxidation are high, and O&M costs are moderate to high.

Conclusion. Retain enhanced oxidation for further consideration.

3.3.7 Prevention of Groundwater Infiltration into Storm Sewer

Storm Sewer System Rehabilitation

As discussed in previous sections, it is believed that contaminated groundwater is infiltrating into the storm sewer system passing through Site 57. This section provides a discussion of options for correcting leaking pipes. The technologies available for pipe rehabilitation include grouting/patching, lining, and replacement. Similar technologies are available for rehabilitating manholes. A separate discussion has not been included here.

Grouting is a method applicable to pipes with only isolated problem areas. The grout is typically cement or a cement/sand mixture used to fill holes or crevices. Plastic substitutes have also been used as a grout, especially in environments which would be corrosive to cement. For sewer rehabilitation, grouting is limited to sealing leaking pipe joints and manholes which are still structurally sound. During grouting operations, every joint in a line segment is pressure tested. If a joint fails, a grout packer is expanded and grout is applied to the defective joint. This is done for every joint in the line segment in an effort to prevent the migration of a leak from one joint to another.

Lining of pipes is another possible solution. Inversion lining is a process which utilizes a flexible felt tube with a polyurethane jacket to line the pipe. The felt is saturated with a thermosetting resin which will bind the tube to the pipe once installed. The tubing arrives on site polyurethane jacket side out. Water is used to force the tube through the pipe, inverting it and pressing the resin saturated felt against the existing pipe walls. Once installed, both ends of the pipe are sealed and the pipe is filled with heated water to activate the resin and cause it to cure. The pipe is drained to complete the installation. Inversion lining is a trenchless technology which utilizes existing manholes as access points for installation with no site disturbance.

Another lining method is slip lining, a process by which a rigid polyethylene or fiberglass pipe is pushed or pulled through the existing pipe and then grouted in place. Slip lining may require minimal site excavation to gain access to entrance and exit points when existing manholes are too narrow or deep to be used for the repair process.

Replacement of the piping system is another alternative. Replacement involves the excavation and removal of the existing pipe and the installation of new pipe. Replacement is most appropriate for easily accessible lines or in situations where pipes have lost their structural integrity, making grouting or lining unfeasible.

Similar technologies are available for rehabilitating manholes. The method selected is dependent upon the condition of the pipe, site accessibility, and the severity of the defects.

Effectiveness. Sewer pipe rehabilitation methodologies have been proven to minimize, even eliminate, the infiltration of groundwater. The proper rehabilitation of the pipes which pass through the contaminated area would minimize or eliminate infiltration of contaminated groundwater and prevent the discharge of contaminants to the adjacent surface water body.

Implementability. Prior to commencement of the removal action, further investigation of the pipes and assessment of their condition would be required in order to select the appropriate method. Pipes can be inspected through the use of a closed circuit television camera. Use of a television camera for inspection requires a pipe diameter in excess of eight inches, accessibility to both ends of the pipe length, a pipe which is straight and free of significant obstructions, and a water level in the pipe which is less than one third of the pipe diameter. At Site 57, the storm sewers are such that inspection via television cameras would be possible.

The inspection procedure would consist of cleaning a section of sewer using a water jet to scour the inside walls of the pipe and flush dirt and debris out of it. As analytical results from water samples obtained at the sewer discharge have indicated the presence of TCE contamination, debris and water scoured from the pipe interior during the cleaning process may also be contaminated. Means for collecting and containing the material generated during the cleaning process would have to be considered.

Available information indicates that the storm sewer pipes at Site 57 are either vitrified clay or corrugated metal construction. Both types can be rehabilitated by the methods discussed.

Based on the results of the inspection, the following limitations would determine the method(s) used.

- The use of grouting may not be applicable to pipes containing cracks and other defects. The pressure that is applied during joint testing has the potential of propagating existing cracks, further deteriorating the pipe.

- Pipes which are no longer structurally sound due to excessive damage or collapse cannot be repaired by a lining or grouting technology, unless point repairs are made.

- Replacement of pipes that are within the zone of contaminated soil and groundwater would expose workers to site contaminants and generate soil and groundwater which would require treatment or offsite disposal.

- Replacement would require the disturbance of much of the paved area adjacent to Building 292 and limit access to the building, particularly the loading dock. Groundwater may be encountered during replacement, dependent on pipe depths. Groundwater that is encountered has the potential to be contaminated, resulting in worker exposure.

- Any work which is performed on the sewer pipes would require intercepting flow upstream of the area of concern and re-routing it to a point below the work area.

Cost. Typically, line replacement is selected in the absence of accessibility and soil contamination problems if the relative costs of rehabilitation options are within 20 percent of each other. However, trenchless technologies are lower in cost than replacement. Past experience has found that whenever more than one dig-and-replace point repair per 100 feet of sewer is needed, cost considerations usually rule in favor of line replacement.

Conclusion. Sewer system rehabilitation is retained for further consideration in the development of removal alternatives as a viable methodology for eliminating the infiltration of contaminated groundwater and its subsequent discharge at IW-80. Due to the potential for crack propagation causing further deterioration of existing pipes, using grouting, this option has been eliminated from further consideration. Rehabilitation technology selection will be determined based on pipe size, depth, location, and existing condition. Replacement will be applied where pipes are too deteriorated for repair, have shallow burial depths, or are in locations which will be excavated during implementation of the soil removal alternative. Lining will be utilized in all other situations.

3.3.8 Disposal

Extracted groundwater, once treated sufficiently to achieve ARARs (if required), could be discharged to Mattawoman Creek via two mechanisms: 1) discharge to MH-1 or 2) discharge to the stormwater runoff (open) channel that runs parallel to Thomas Road.

Effectiveness. Both discharge options are potentially effective for disposal of the extracted groundwater. At this time, the discharge location of the open channel is unknown. Treatment of the groundwater to meet discharge standards may be required.

Implementability. Neither discharge option has significant, directly-related implementability concerns. The location where the open channel discharges would need to be verified prior to removal action design. Considering that the stormwater flow rates are of an order of magnitude or greater than the discharge rate expected from the groundwater treatment system (i.e., 30 gpm or 43,200 gpd), the capacity of the storm sewer to handle this additional loading is of no concern.

Costs. Costs that are directly related to either discharge option are expected to be low.

Conclusion. Retain both discharge options, discharge to MH-1 or the stormwater runoff channel, for further consideration.

3.3.9 Screening of Technologies and Process Options for Offgas Treatment

Offgas emissions of VOCs are expected from the treatment of groundwater as a result of active treatment by volatilization. The main technologies that are applicable to the treatment of volatile organics in the vapor phase are based on physical, thermal/chemical, and biological processes. These technologies convert the toxic VOCs into less harmful forms or transfer them into a less mobile phase.

Activated carbon adsorption is a physical process consisting of the passage of the contaminated vapors through a bed of activated carbon. The VOCs are adsorbed onto active sites within the internal surface area of the carbon particles. The treated vapor exits the system into the ambient air. When the entire accessible internal surface area of the carbon is covered by the adsorbed VOCs, the system loses its capacity to adsorb more VOCs from the vapors, and must be regenerated. The process of regeneration consists of thermal destruction of the adsorbed VOCs in a controlled facility. The activated carbon system is replenished with the regenerated carbon.

Incineration and catalytic oxidation are thermal/chemical processes. Incineration uses a flame to oxidize the VOCs into relatively less toxic gases such as carbon dioxide, water vapor, and if the VOCs are halogenated, hydrogen halides. Temperatures as high as 2,000°F may be required, depending on the ease of oxidation of the particular VOCs of concern. Adequate supply of oxygen in the form of a forced draft of air must be available to support combustion. Depending on the ability of the VOCs to support combustion and the concentrations of the VOCs, significant quantities of fuel may be required for combustion. Catalytic oxidation is also used to oxidize the VOCs into less harmful products, however, the temperature required for oxidation is significantly less than that of incineration, typically less than 900°F. Catalytic oxidation consists of the use of a preheater to raise the temperature of the VOC-laden vapor to the required temperature and the passage of the heated gas through a permeable catalyst bed. The catalyst activates the VOC molecules and makes them more reactive to the oxygen, thus obviating the necessity for high temperatures. Therefore, catalytic oxidation can achieve results similar to incineration but at lower temperatures.

Effectiveness. Activated carbon adsorption is widely used in industry and remediation projects for the treatment of offgases from process equipment. A wide variety of VOCs can be absorbed onto activated carbon. However, certain chlorinated VOCs are less amenable to activated carbon absorption. Vinyl chloride is one of the VOCs that have a low affinity for activated carbon absorption. Thus, under conditions of high flow rates or high concentrations of vinyl chloride leading to high mass loadings, the activated carbon consumption would be high.

Incineration and catalytic oxidation are effective technologies for the destruction of VOCs. Incineration is a proven technology for the destruction of gases containing toxic VOCs. However, incineration is usually cost effective only if the gases requiring treatment are inherently capable of supporting combustion. Catalytic oxidation is a relatively innovative technology that is proving to be effective in recent applications. The effectiveness of catalytic oxidation is based on a few field-scale applications and several bench- and pilot-scale tests.

Implementability. Activated carbon adsorption systems are readily available and do not require any specialized personnel for installation or operation. The spent carbon must be replenished with virgin activated carbon on a regular basis, which does not pose a major implementability concern.

Incineration and catalytic oxidation require specialized personnel for installation. After initial startup, the operation of both systems would need to be monitored periodically, although several fail-safe measures and alarm systems would be included in the equipment. The main implementability concerns for both systems are associated with the use of high temperatures. Catalytic oxidation systems would require replacement of the catalyst on a regular basis because certain chlorinated VOCs reduce the efficiency of operation of the

catalytic material. The treated gases might require further treatment to remove the halogen compounds, if any, followed by disposal of the treatment products.

Cost. Activated carbon adsorption systems have low capital and low to moderate O&M costs. Incineration and catalytic oxidation systems have moderate to high capital costs. Incineration has moderate to high or very high O&M costs. Catalytic oxidation has moderate to high O&M costs.

Conclusion. Do not retain activated carbon adsorption. This technology is ineffective in capturing vinyl chloride which might be present at levels high enough to be of concern. Retain catalytic oxidation because of its proven effectiveness.

3.4 SELECTION OF REPRESENTATIVE GROUNDWATER PROCESS OPTIONS

Process options are selected from the technologies that have been retained after screening. The selected process options would be representative of others within the same technology and thus: (1) focus on the development of a fewer number of alternatives which would bring out significant differences in effectiveness and costs between competing technologies, and (2) allow the flexibility of selection of a process option during the design or during bid evaluation from competing vendors offering equipment for the same technology.

The following process options have been retained for further analysis:

- No action is retained as a general response action.
- Minimal Action: Monitoring in the form of periodic sampling/analysis (monitoring) is retained.
- Containment/Removal: Collection trenches are selected because of greater confidence in their effectiveness over extraction wells given the limited knowledge of the site's hydrogeology.
- In situ: Air sparging is retained.
- Ex situ: Air stripping, activated carbon adsorption, and enhanced oxidation are retained.
- Prevention of Groundwater Infiltration into Storm Sewer: Storm sewer system rehabilitation is retained.

- Surface Discharge: Discharge to MH-1 and discharge to the stormwater runoff channel are retained because they are both potentially effective options.

- Offgas Treatment: Catalytic oxidation is retained.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES FOR SOIL

The Removal Action Alternatives for soil at IR Site 57 are as follows:

- Alternative 1: No Action
- Alternative 2: In-situ Soil Vapor Extraction
- Alternative 3: Excavation, Onsite Thermal Desorption, Backfilling, Restoration
- Alternative 4: Excavation, Offsite Incineration, Backfilling, Restoration

Alternatives 3 and 4 will be evaluated under two different scenarios, (a) excavation of all contaminated soils above Region III RBC SSLs for protection of groundwater, and (b) excavation of the "hot spot" in the vicinity of SG-07.

The following sections will evaluate these Removal Action Alternatives. The technologies will be evaluated for effectiveness, implementability, and cost as outlined in U.S. EPA Guidance (U.S. EPA, 1993a).

4.1 ALTERNATIVE 1: NO ACTION

The no action alternative is evaluated to provide a comparative baseline against which other alternatives can be evaluated. Under this alternative, no removal action will be taken. In the no action alternative, the material is considered to be left "as is", without the implementation of any containment, removal, treatment, or other mitigating actions.

4.1.1 Effectiveness

The no action alternative does not provide an effective solution to the problem identified at IR Site 57, nor does it comply with the stated ARARs and TBCs. Therefore, this alternative does not achieve the removal action objectives.

4.1.2 Implementability

Under the no action alternative, no removal action would be taken; therefore, there would not be any difficulties or uncertainties associated with implementation.

4.1.3 Cost

There are no capital, operational, or maintenance costs associated with this alternative.

4.2 ALTERNATIVE 2: IN-SITU SOIL VAPOR EXTRACTION

Soil vapor extraction (SVE) is an in-situ soil remediation technology in which a vacuum is applied to the soil in the unsaturated (vadose) zone via vapor extraction wells, to induce a controlled flow of air through the subsurface in order to remove volatile and some semivolatile contaminants from the soil. A typical layout of a SVE system for Site 57 is illustrated in Figure 4-1. Figure 4-2 is a detail drawing illustrating the equipment layout within a blower housing unit. A typical vapor extraction well detail is provided in Figure 4-3.

4.2.1 Effectiveness

Although SVE is generally effective in removing TCE from soil, a pilot-scale study conducted in March 1997 found that SVE is not an effective technology for Site 57 due to the presence of soils with low permeability to air. Air will not pass through subsurface soil at a suitable rate; therefore, SVE will not be sufficiently effective in achieving the Region III RBC SSLs for the protection of groundwater.

4.2.2 Implementability

Although SVE can be shown to be implementable, the SVE pilot study demonstrated that site-specific soil conditions are not amenable to the application of the technology. It is therefore not a viable alternative for this site.

4.2.3 Cost

Since SVE is neither effective nor able to be implemented, a cost estimate has not been prepared.

4.3 ALTERNATIVE 3: EXCAVATION, ONSITE THERMAL DESORPTION, BACKFILL, RESTORATION

Thermal desorption is a physical separation process which uses direct or indirect heating to thermally desorb or volatilize organic contaminants. The process is not designed to destroy organics. There are two types of thermal desorption processes, low temperature and high temperature. Low temperature thermal desorption (LTTD) systems are physical separation processes in which wastes are heated to between 90 and 320°C (200 to 600°F) to separate out the organic constituents. High temperature thermal

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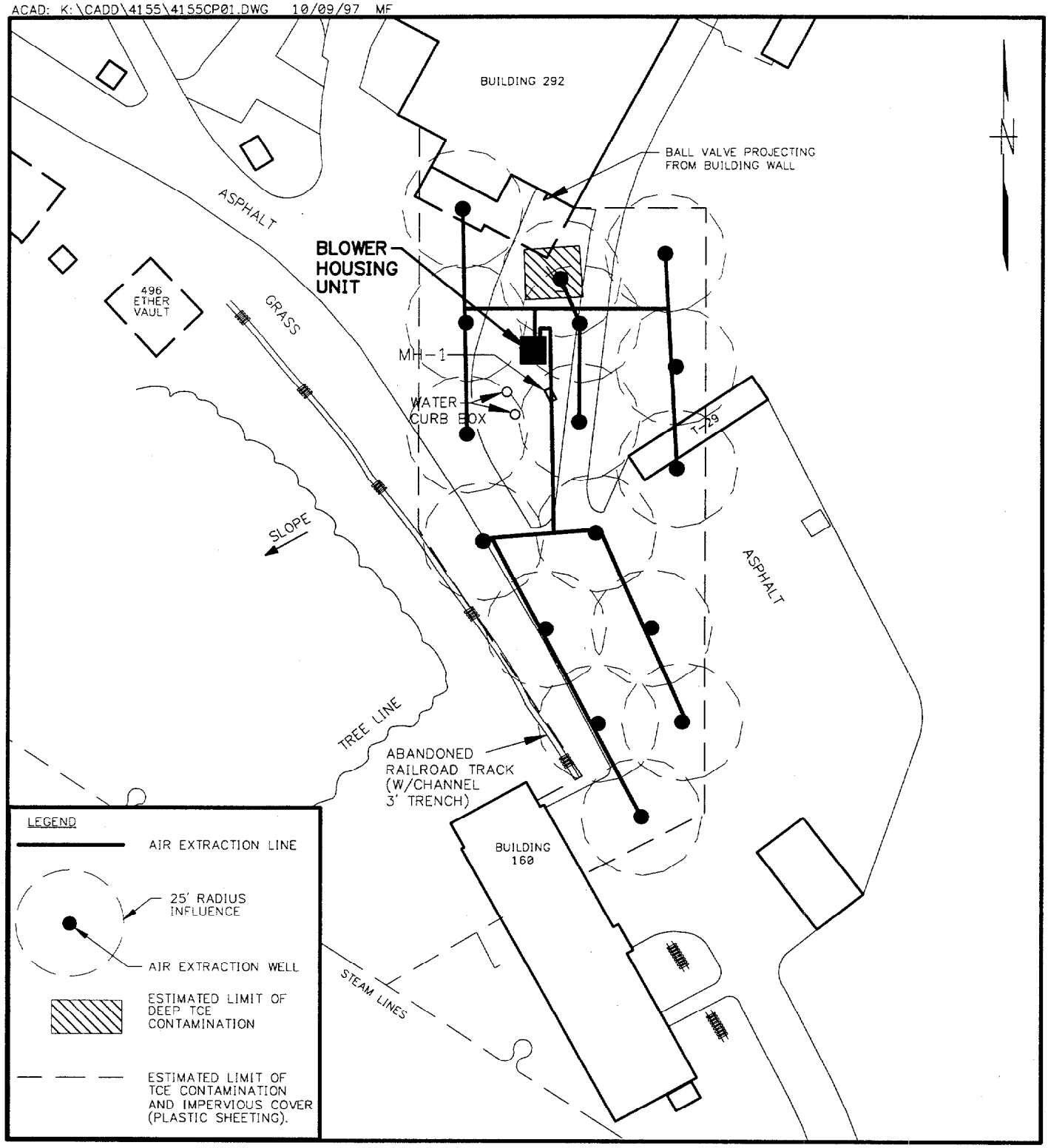

SVE SITE LAYOUT PLAN
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

0 50 100
SCALE IN FEET

FIGURE 4-1

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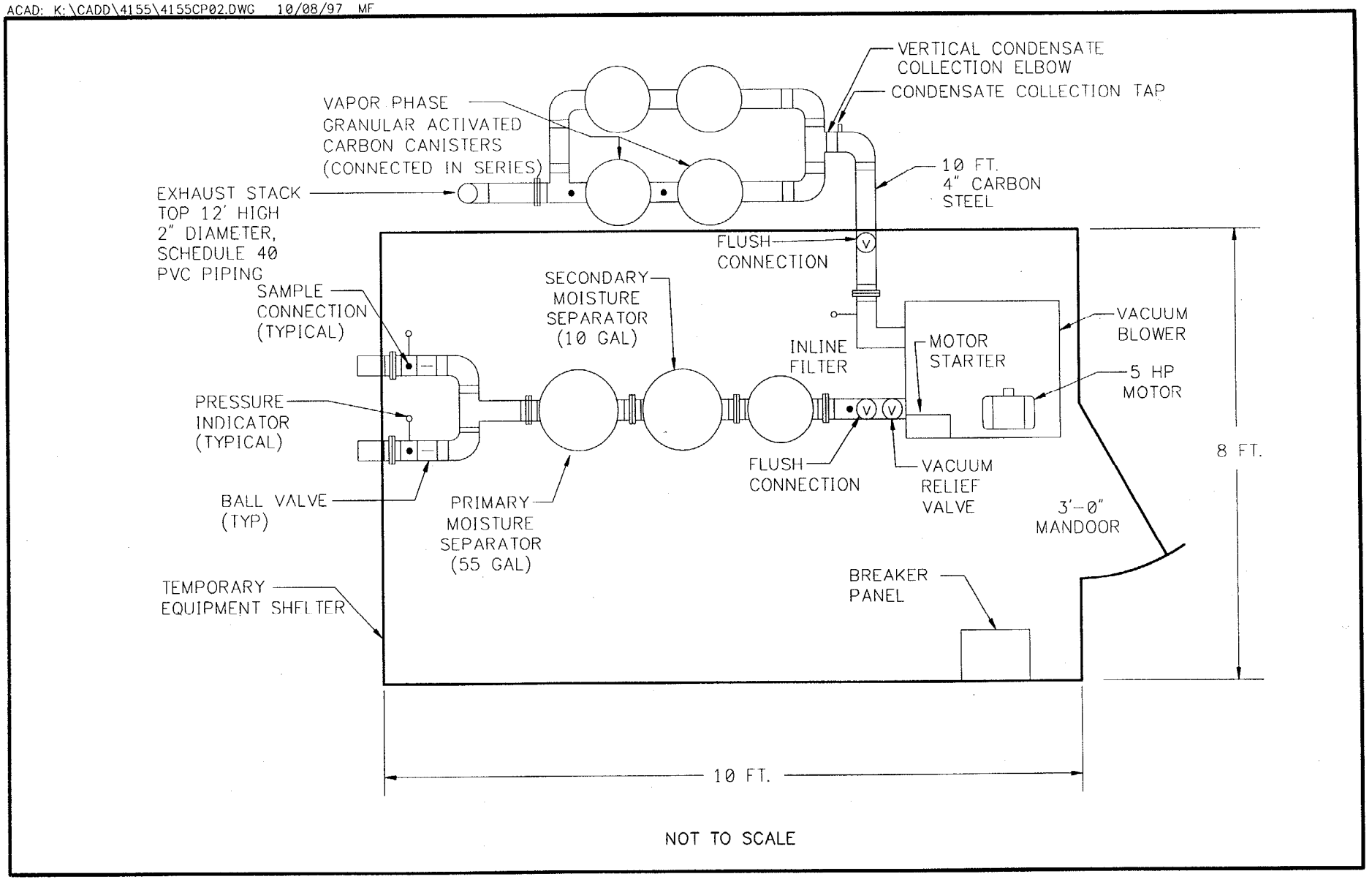

BLOWER HOUSING UNIT LAYOUT
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

FIGURE 4-2

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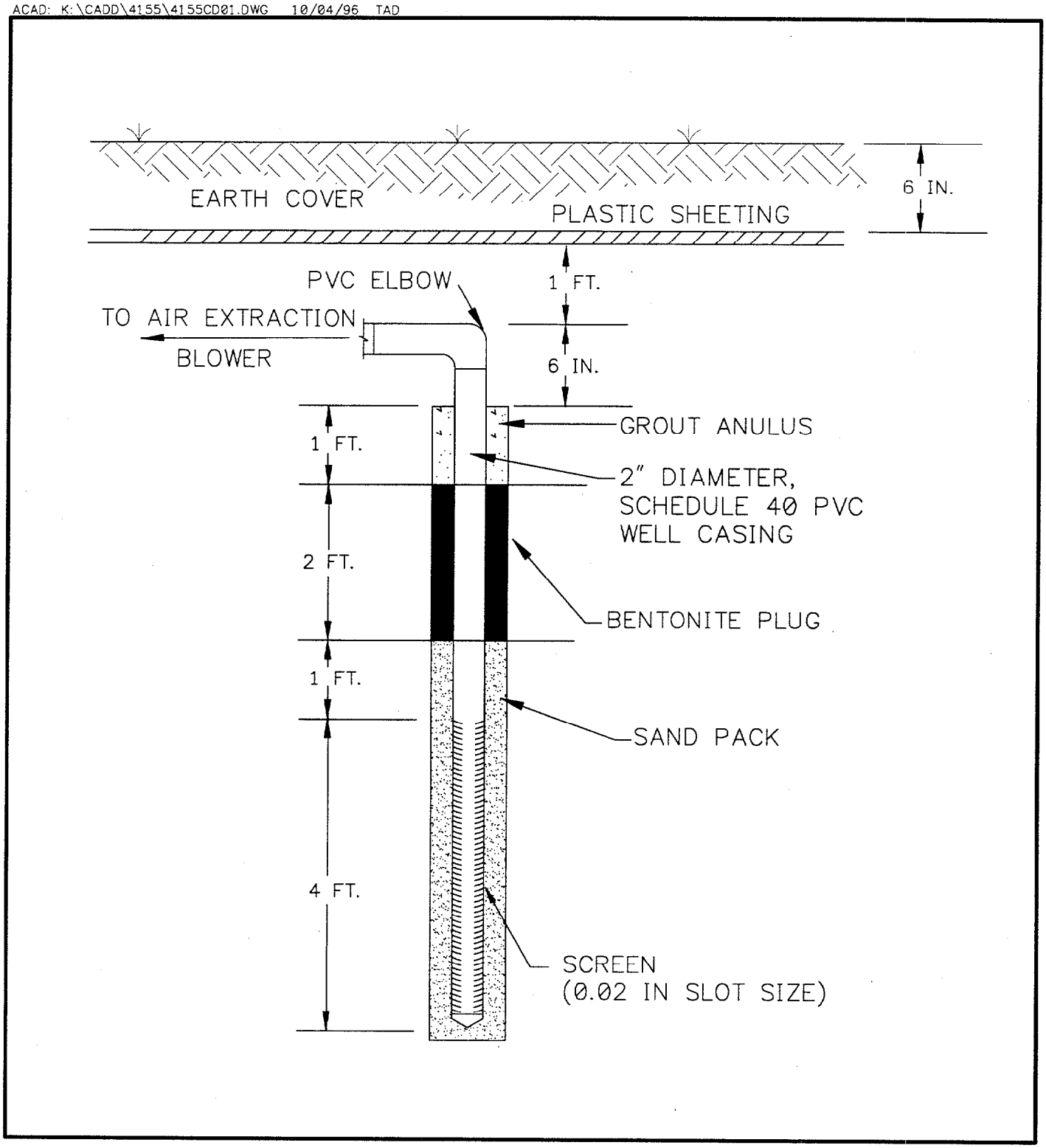

TYPICAL AIR EXTRACTION WELL DETAIL
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND
NOT TO SCALE

FIGURE 4-3

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desorption (HTTD) is a full-scale technology in which wastes are heated to 320 to 560°C (600 to 1,000°F). Thermal desorption systems are available as portable, skid-mounted systems for use on site.

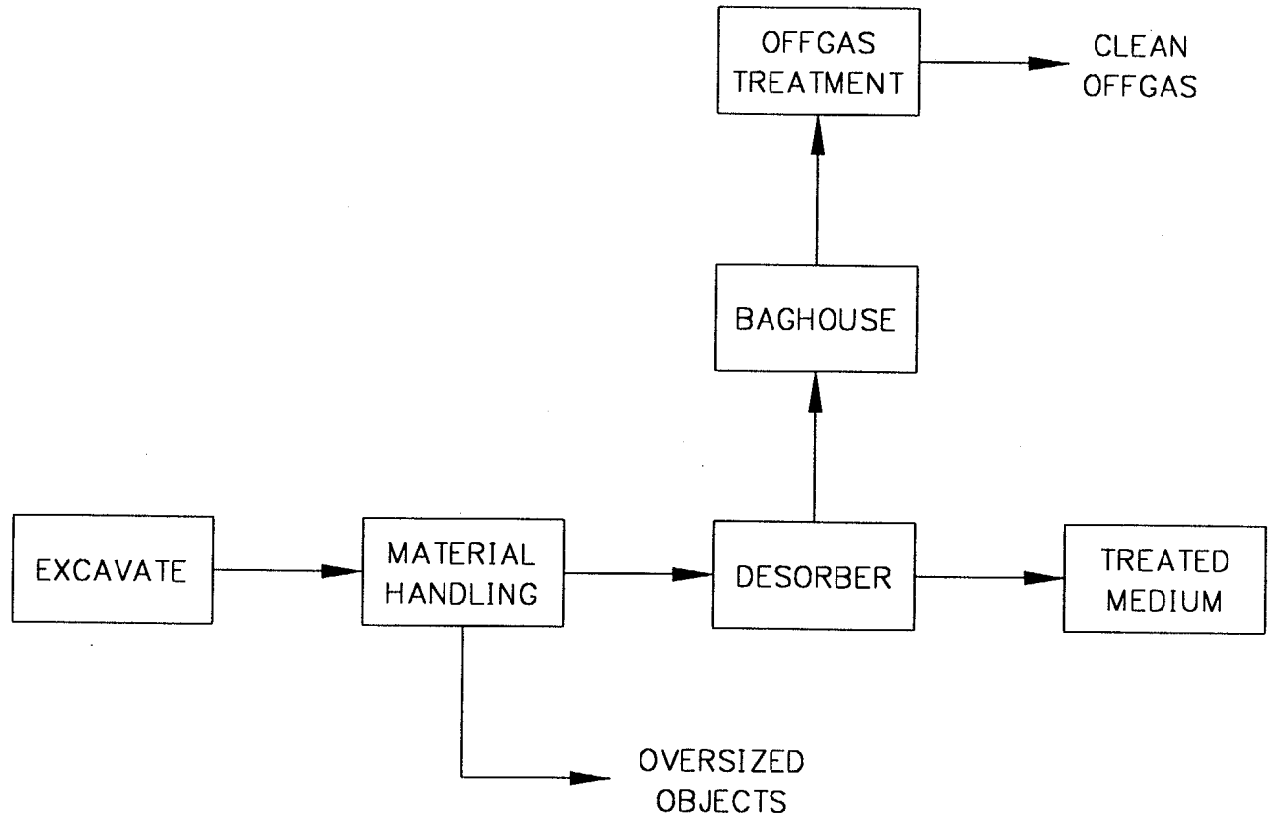
Typically, wastes are processed through an externally fired pug mill or rotary drum system equipped with heat transfer surfaces that are heated by circulating hot oil. An induced air flow conveys the desorbed organic chemicals through a secondary treatment system, such as a GAC adsorption unit, a catalytic oxidation unit, or a condenser unit. The offgas is then discharged through a stack. Treated soils can be used onsite for backfill or disposed of offsite. Soils contaminated with spent TCE (a listed hazardous waste solvent) is considered a RCRA-hazardous waste because of the "contained in" policy. In order for the soil to be considered nonhazardous and/or suitable as backfill, it would need to be treated so that it no longer contains a hazardous waste or would need to be delisted. It should be noted that Maryland Department of the Environment policy requires that treated media be administratively delisted by EPA prior to the media's reuse on the site.

Bed temperatures and typical residence times will cause selected contaminants to volatilize but not be oxidized. Soils and sediments with water contents greater than 20 to 25 percent may require the installation of a dryer in the feed system in order to reduce the energy required to heat the soil. Some volatilization of contaminants occurs in the dryer, and the gases are routed to a thermal treatment chamber. A process flow diagram is provided as Figure 4-4.

Since the temperatures used are contaminant- and matrix-specific, further evaluation would be needed to determine the exact parameters of the thermal desorption system. For the purposes of this EE/CA it will be assumed LTTD will be implemented. A bench scale study will need to be conducted to determine operating parameters and effectiveness prior to full scale operations. In addition to identifying soil contaminants and their concentrations, information necessary to evaluate the applicability of the technology include soil moisture content and classification, texture, mercury content, pH, and the appropriate temperature for treatment.

4.3.1 Alternative 3a. Excavation of Soils Contaminated above Region III SSL

This alternative requires the excavation of approximately 7,335 cy of soil, treatment via the portable thermal desorber, verification sampling of the excavation, and site restoration. See Figure 4-5 for a site map showing the estimated limits of contamination. The majority of the contaminated soil (7,260 cy) is located between the surface and seven feet below grade. A localized area of deeper contamination, approximately 20 feet square, will be excavated to a depth of 12 feet. Conventional excavation equipment can be employed to remove the asphalt pavement, excavate the soil, and backfill the site. Site restoration



PROCESS FLOW DIAGRAM – ON SITE THERMAL DESORPTION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

FIGURE 4-4

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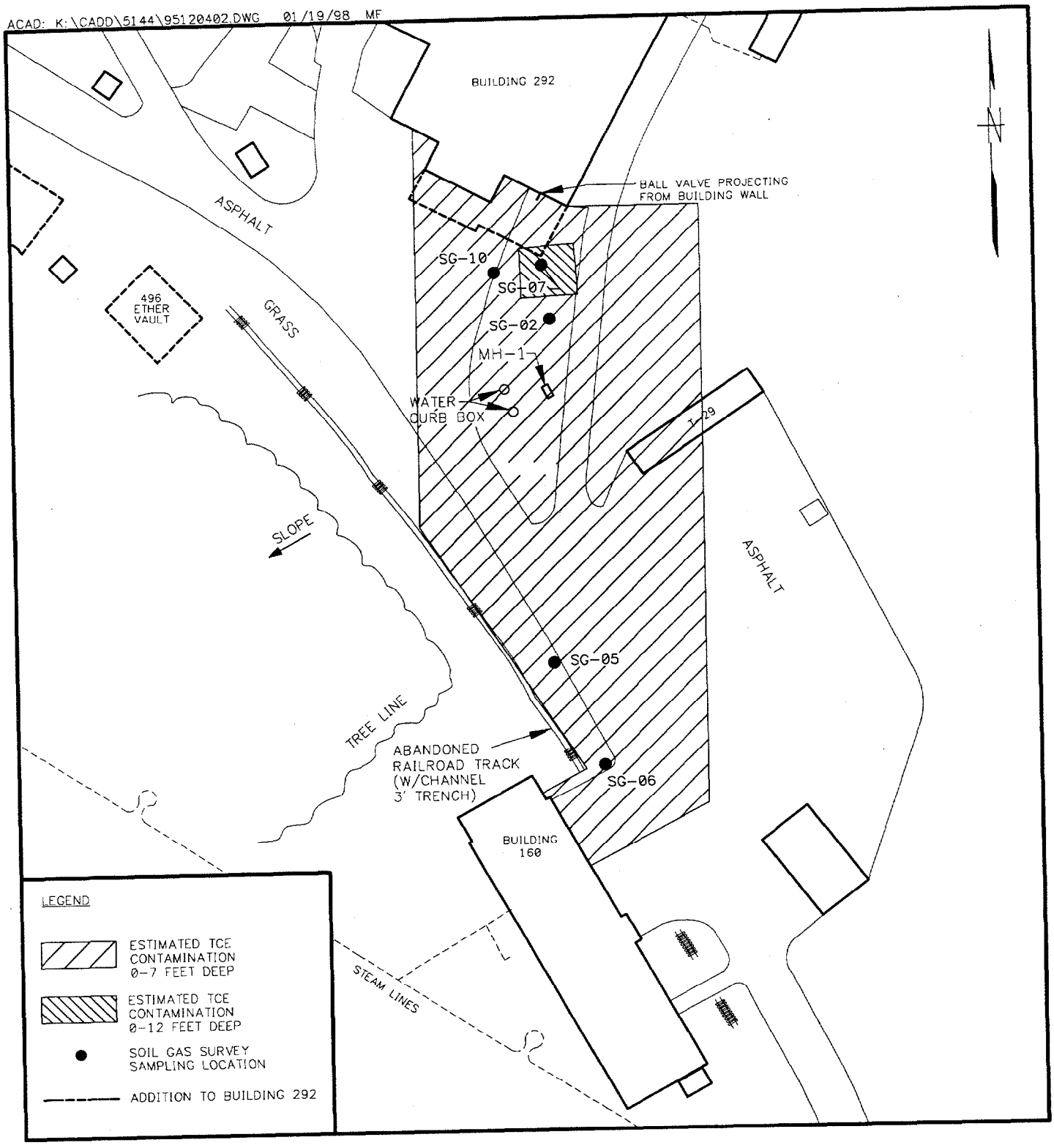

LATERAL EXTENT OF SOIL CONTAMINATION (ESTIMATED)
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

FIGURE 4-5

0 60 120
SCALE IN FEET

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will involve revegetation and replacement of asphalt pavement. Verification sampling will be conducted to confirm that removal goals have been achieved and contaminant levels in the remaining soil fall below permissible regulatory limits.

4.3.1.1 Effectiveness

While the removal of soil that is contaminated above Region III RBC SSLs would mitigate the leaching of TCE to the groundwater and minimize the risks to workers in the area, thereby meeting the secondary objective of the removal action, this alternative does not meet the primary objective. Soil removal would not have an immediate effect on mitigating the TCE contamination present at IW-80.

Additionally, there are some increased risks associated with removal of the soil for treatment as compared to not disturbing the soil. Excavation of the contaminated soil would increase the risk of exposure to workers in the area by exposing a greater surface area of soil to the air. This alternative complies with the ARARs identified in Section 2.

Groundwater at the site is approximately eight feet below ground surface. The majority of excavation will be above the groundwater soil interface. However, in the area of deep excavation, methods for preventing excessive accumulation of groundwater or for shoring the walls of the excavation may be necessary. Visual control and effectiveness of excavation would be significantly impacted by the presence of groundwater. The presence of water could also significantly limit the ability to collect verification samples.

Excavation and treatment of the impacted soils via thermal desorption would achieve the secondary removal objective and would be a long-term solution for the soil media which is consistent with the goals of the final remedial objectives. However, this alternative is ineffective in meeting the primary removal action objective.

4.3.1.2 Implementability

This alternative is technically feasible. Techniques to excavate materials similar to those of IR Site 57 are very common. Mobile units and contractors are readily available to perform onsite thermal desorption and the technology has been proven to be effective for soils contaminated with VOCs. A bench-scale study would be required to establish specific parameters and requirements. This alternative could be implemented in less than one year.

Offgas from the thermal desorption unit would have to be treated and the appropriate State agencies would have to be contacted to determine the degree of treatment required. The substantive requirements

of a RCRA hazardous waste treatment, storage, and disposal (TSD) facility would have to be met by an onsite thermal desorption system. Soil contaminated with spent TCE (a listed hazardous waste solvent) would need to be handled as a RCRA hazardous waste until it no longer contains TCE or is delisted as a hazardous waste. Such a system would also have to meet the substantive requirements of applicable air pollution regulations.

The equipment needed to implement this alternative is readily available. Standard equipment can be used to excavate, haul, and restore the site. Thermal desorption systems can treat between 50 and 150 cy of contaminated soil per day. For this alternative, treatment would require 46 days.

A large, open area is required for this alternative to house both the treatment unit and clean, stockpiled soil. If there is not adequate area immediately adjacent to Site 57, the implementability of this alternative becomes more difficult due to the need to transport soil either to the desorber or from the desorber to a stockpile location.

The removal action would require acceptance and implementation of an erosion and sediment control plan associated with the excavation of the soils. The removal area is contained within the Station and therefore no easements or impacts to adjoining properties are anticipated and institutional controls are easily implemented.

Complications which will arise during excavation of this soil are due to various structures which are adjacent to and within the area of concern. Building 292 is located on the northern edge of the area of proposed excavation. Information regarding the configuration of the Building 292 foundation is not currently available. Shoring may become necessary if the building has a spread foundation that is less than seven feet below grade. Should further investigation determine that the building foundation is comprised of pilings, or that the building has subterranean levels, shoring will not be necessary. A similar situation exists for Building 160 to the south.

There are several manholes and a variety of underground pipelines within the area to be excavated, as shown on Figure 1-2. Further investigation of the presence and location of subsurface utilities must be performed prior to any excavation activities. Pipes which are buried less than seven feet deep will have to be supported until the excavation can be backfilled. The exposed portions of the brick manholes will have to be shored pending backfill due to their age and the material of construction. All means of shoring will have to be substantial enough to support their respective structures for the period of time necessary for verification sampling and analytical activities to be performed. Excavation around and under these structures could weaken or damage them such that repair or replacement becomes necessary.

While pumping may be effective in preventing significant accumulation of groundwater in the excavation, the water would have to be containerized and sampled as it is potentially contaminated.

4.3.1.3 Cost

A detailed cost estimate is presented in Appendix B. The major cost items associated with this alternative include excavation of the soil, decontamination of equipment, mobilization of the desorber, treatment of the soil, backfilling the excavated area, and restoration of the site (e.g., pavement repair and seeding). The total cost to implement this alternative is approximately $2,974,000.

4.3.2 Alternative 3b. Excavation of the Contaminated Soil Hot Spot

This alternative limits excavation to the most heavily contaminated soil, approximately 180 cy, from an area measuring 20 feet square by 12 feet deep. The approximate location of this hot spot is illustrated on Figure 4-5. The soil will be treated on site. Verification sampling of the excavation will be performed to ensure that all soil exhibiting concentrations in excess of 1000 µg/kg are removed. This level has been selected as sufficient to ensure the removal of the most heavily contaminated soil, while limiting the volume to be excavated. The most elevated concentrations of TCE were identified in an area limited in lateral extent. Based on existing data, concentrations appear to drop off several orders of magnitude in a relatively short distance. The excavation will be backfilled.

Excavating only the hot spot leaves in place soil exceeding the SSL. Infiltration of precipitation through these soils may transport contaminants deeper into the subsurface and potentially to the groundwater. To mitigate the possible migration of contamination to the groundwater, as well as human contact, unpaved areas would be paved as part of this alternative. Installation of asphalt would require the excavation of one foot of soil from all unpaved areas. This soil, approximately 455 cy, would also be treated on site.

As with alternative 3a, conventional excavation equipment can be employed to remove the soil and restore the site.

4.3.2.1 Effectiveness

As with alternative 3a, while the removal of the soil hot spot and the capping of the area would mitigate the leaching of TCE to the groundwater and minimize the risk to workers in the area, thereby meeting the secondary objective of the removal action, this alternative does not meet the primary objective. Soil removal would not have an immediate effect on mitigating the TCE contamination present at IW-80.

The risks associated with removal of soil for treatment identified in alternative 3a are also applicable under this alternative. This alternative complies with the ARARs identified in Section 2 as direct human exposure to the contaminants would be eliminated and the leaching of contaminants to the groundwater would be mitigated.

As with alternative 3a, the presence of groundwater reduces the effectiveness of this removal alternative.

Excavation and treatment of the hot spot soils via thermal desorption and capping of the area would achieve the secondary removal objective and would be a long-term solution for the soil media which is consistent with the goals of the final remedial objectives. However, the alternative is ineffective in meeting the primary removal action objective.

4.3.2.2 Implementability

This alternative is technically feasible and the equipment is readily available with the same qualifications as outlined in alternative 3a. The smaller quantity of material associated with this alternative could be easily handled by an on site system.

As this area is not immediately adjacent to any buildings shoring is not an issue. However, the complications discussed above in regards to utilities still apply. The space constraints discussed in Alternative 3a are not as critical for this alternative due to the decrease in the volume of soil to be treated.

The side walls of the excavation may have to be sloped, depending on soil conditions, to prevent collapse of the side walls into the bottom of the excavation. This will also help maintain the integrity of the excavation pending verification sample results and site restoration. Sloping of the excavation walls will result in some over excavation of soil, but has little impact on the implementability of this alternative. The implementability issues discussed in alternative 3a with regards to groundwater in the excavation also apply here.

4.3.2.3 Cost

A detailed cost estimate is presented in Appendix B. The major cost items associated with this alternative include excavation of the soil, decontamination of equipment, mobilization of the desorber, backfilling the excavated area, and paving all unpaved areas. The total cost to implement this alternative is approximately $996,500. The high mobilization costs and small quantity of soil may make this a less cost effective alternative.

4.4 ALTERNATIVE 4: EXCAVATION, OFFSITE INCINERATION, BACKFILL, RESTORATION

Incineration is the process in which high temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. Commercial incinerator designs are rotary kilns, equipped with an afterburner, a quench, and an air pollution control system. The rotary kiln is a refractory-lined, slightly-inclined, rotary cylinder that serves as a combustion chamber and operates at temperatures up to 980°C (1,800°F).

Incinerator offgas requires treatment by an air pollution control system to remove particulates and neutralize and remove acid gases (HCl, NO_x, and SO_x). Baghouses, venturi scrubbers, and wet electrostatic precipitators remove particulates; packed-bed scrubbers and spray dryers remove acid gases.

Incineration has been selected or used as the remedial action at more than 150 Superfund sites and is subject to a series of technology-specific regulations.

The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99 percent requirement for hazardous waste. This technology would be effective given the conditions identified at Site 57. Information necessary for engineering thermal systems to specific applications includes soil moisture content and classification (no sieve analysis is necessary), the soil fusion temperature, and the soil heating value. If an offsite incinerator is used, the potential risk of transporting the hazardous waste through the community must be considered. Since the soil contains a listed RCRA hazardous waste (i.e., spent TCE solvent) it must be transported as a hazardous waste and treated at a RCRA permitted facility. There are approximately 20 commercial RCRA-permitted hazardous waste incinerators.

4.4.1 Alternative 4a. Excavation of Soils Contaminated above Region III SSL

This alternative is the same as alternative 3a, above, with contaminated soil being transported to an offsite incineration facility for treatment. Excavated areas would be backfilled with clean soil from an offsite source.

4.4.1.1 Effectiveness

While the removal of soil that is contaminated above Region III RBC SSLs would mitigate the leaching of TCE to the groundwater and minimize the risks to workers in the area, thereby meeting the secondary

objective of the removal action, this alternative does not meet the primary objective. Soil removal would not have an immediate effect of mitigating the TCE contamination present at IW-80.

As with alternative 3a, there are increased risks associated with the removal of soil for offsite treatment and disposal, but in addition to the increased risk to workers of exposure, transportation of the contaminated soil offsite introduces the potential for exposure of the community should an accident of spill occur. This alternative complies with the ARARs identified in Section 2.

Issues similar to those discussed in alternative 3a with regards to groundwater apply here as well.

Excavation and treatment of the impacted soils via incineration would achieve the secondary removal objective and would be a long-term solution for the soil media which is consistent with the goals of the final remedial objectives. However, this alternative is ineffective in meeting the primary removal action objective.

4.4.1.2 Implementability

Incineration facilities are capable of handling the volume of material to be generated. Incineration has been proven to be effective for soils contaminated with VOCs. This alternative could be implemented in less than one year. Implementability issues with respect to excavation are the same as those discussed in alternative 3a, above.

4.4.1.3 Cost

A detailed cost estimate is presented in Appendix B. The major cost items associated with this alternative include excavation of the soil, decontamination of equipment, hauling the material offsite, treatment via incineration, backfilling the excavated area, and site restoration. The total cost to implement this alternative is approximately $20,636,000.

4.4.2 Alternative 4b. Excavation of the Contaminated Soil Hot Spot

This alternative is the same as alternative 3b, above, with contaminated soil being transported to an offsite incineration facility for treatment. Excavated areas would be backfilled with clean soil from an offsite source.

4.4.2.1 Effectiveness

While the removal of hot spot soils and capping of the area would mitigate the leaching of TCE to the groundwater and minimize the risks to workers in the area, thereby meeting the secondary objective of the removal action, this alternative does not meet the primary objective. Soil removal would not have an immediate effect of mitigating the TCE contamination present at IW-80.

As with alternative 4a, there are increased risks associated with the removal of soil for offsite treatment and disposal. Issues similar to those discussed in alternative 3a with regards to groundwater apply here as well.

This alternative complies with the ARARs identified in Section 2 as direct human exposure to the contaminants would be eliminated and the leaching of contaminants to the groundwater would be mitigated.

Excavation and treatment of the impacted soils via incineration would achieve the secondary removal objective and would be a long-term solution for the soil media which is consistent with the goals of the final remedial objectives. However, this alternative is ineffective in meeting the primary removal action objective.

4.4.2.2 Implementability

Implementability issues with respect to excavation are the same as those discussed in 3b, above.

4.4.2.3 Cost

A detailed cost estimate is presented in Appendix B. The major cost items associated with this alternative include excavation of the soil, decontamination of equipment, hauling the material offsite, treatment via incineration, backfilling the excavated area, and restoration of the site, specifically paving of unpaved areas. The total cost to implement this alternative is approximately $1,910,000.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES FOR SOIL

This section compares the Removal Action Alternatives identified in Section 4.0 as:

- Alternative 1: No Action
- Alternative 3a: Excavation of Soils Contaminated above Region III SSL, Onsite Thermal Desorption, Backfilling, Restoration
- Alternative 3b: Excavation of Contaminated Soil Hot Spot, Onsite Thermal Desorption, Backfilling, Restoration
- Alternative 4a: Excavation of Soils Contaminated above Region III SSL, Offsite Incineration, Backfilling, Restoration
- Alternative 4b: Excavation of Contaminated Soil Hot Spot, Offsite Incineration, Backfilling, Restoration

These alternatives will be compared to each other using the criteria identified in Section 4.0. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect remedy selection can be identified.

5.1 EFFECTIVENESS

Except for the No Action Alternative these alternatives comply with the ARARs identified. The risk associated with impact to workers is the same for all alternatives due to the common need for excavation. The impact to the community is greater for alternatives 4a/b, as there is also offsite hauling of contaminated soil.

Both removal action alternatives 3a and 4a can achieve the removal objective of eliminating TCE concentrations in soil which exceed 20 µg/kg. However, alternatives 3b and 4b, while not prescribing the removal of all soils with contaminant levels in excess of the Region III SSL, do comply with the ARARs for protection of groundwater through capping of the surface overlying the contaminated soil. The cap reduces the potential for human exposure to contaminants and provides a barrier to infiltration, thereby mitigating the soil to groundwater contaminant pathway.

None of the alternatives meet the primary objective of the removal action which is to eliminate TCE at IW-80.

5.2 IMPLEMENTABILITY

Except for the No Action alternative, the other alternatives are technically feasible. Each alternative has been used on wastes similar to those at IR Site 57 and these technologies are commercially available. Alternatives 3a and 4a are less easily implemented due to complications resulting from excavation adjacent to building foundations and around active underground utilities.

Alternatives 4a/b require excavation and offsite hauling which has the potential to cause a greater short-term environmental impact and increased safety risks as compared to alternatives 3a/b.

Alternatives 3a and 4a have a greater potential for adverse health and ecological impacts related to disturbing the contaminated soil, due to the large quantity of material associated with these alternatives in comparison to alternatives 3b and 4b.

5.3 COST

Detailed cost estimates for the removal action alternatives are presented in Appendix B.

The costs associated with alternatives 3a and 4a exceed $2 million. Of the remaining two alternatives, alternative 3b is almost one half the cost of alternative 4a.

5.4 SUMMARY OF REMOVAL ACTION ALTERNATIVES COMPARATIVE ANALYSIS

The alternatives are technically feasible, appear to be institutionally acceptable, and are consistent with the goals of the final remedial objectives. None of the alternatives are effective in satisfying the primary removal action objective. A comparative analysis is presented in Table 5-1 in which the removal action alternatives are evaluated in the following terms; constructability, effectiveness in eliminating risk to human health or the environment, compliance with ARARs, and disposal requirements. The OSWER Directive indicates that thermal desorption should receive primary consideration, followed by incineration in selection of a removal action alternative.

TABLE 5-1

REMOVAL ALTERNATIVES
INDIAN HEAD, MARYLAND

#	Alternative	Constructability	Effectiveness	Compliance with ARARs	Offsite Treatment/ Disposal Required	Cost
1	No Action	high	low	no	no	$0
3a	Excavation of Contaminated Soils above Region III SSLs, Onsite Thermal Desorption, Backfilling, Restoration	high	low	yes	no	$2,973,695
3b	Excavation of Contaminant Hot Spot, Onsite Thermal Desorption, Backfilling, Restoration	high	low	yes	no	$996,504
4a	Excavation of Contaminated Soils above Region III SSLs, Offsite Incineration, Backfilling, Restoration	high	low	yes	yes	$20,636,739
4a	Excavation of Contaminant Hot Spot, Offsite Incineration, Backfilling, Restoration	high	low	yes	yes	$1,910,558

6.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES FOR GROUNDWATER

The Removal Action Alternatives for groundwater at IR Site 57 are as follows:

- Alternative 1: No Action
- Alternative 2: Storm Sewer System Rehabilitation
- Alternative 3: In Situ Air Sparging with Offgas Treatments
- Alternative 4: Extraction/Treatment/Discharge

The following sections will evaluate these Removal Action Alternatives. The technologies will be evaluated for effectiveness, implementability, and cost as outlined in U.S. EPA's *Guidance On Conducting Non-Time-Critical Removal Actions Under CERCLA* (U.S. EPA, 1993a).

6.1 ALTERNATIVE 1: NO ACTION

6.1.1 Description

The no action alternative is evaluated to provide a comparative baseline against which other alternatives can be evaluated. Under this alternative, no removal action will be taken. In the no action alternative, the groundwater is considered to be left "as is", without the implementation of any containment, removal, treatment, or other mitigating actions.

6.1.2 Effectiveness

Concerning discharge of contaminated groundwater to IW-80, the no action alternative will not provide an effective solution to the problem. No action would take place to prevent the infiltration of contaminants to the storm sewer system; therefore, storm sewer discharge would not comply with proposed NPDES discharge standards. There would be no measures to mitigate exposure and risks to human health and the environment. Therefore, this alternative is not effective.

6.1.3 Implementability

Under the no action alternative, no removal action would be taken; therefore, there would not be any difficulties or uncertainties associated with implementation.

6.1.4 Cost

There are no capital, operational, or maintenance costs associated with this alternative.

6.2 ALTERNATIVE 2: STORM SEWER SYSTEM REHABILITATION

6.2.1 Description

Storm sewer system rehabilitation would prevent the infiltration of contaminated groundwater into the storm sewer system. Given the limited knowledge of the storm sewer network, specifically the condition of individual pipes, and the uncertainty as to the lateral extent of the contaminated groundwater plume, the following is a recommendation for sewer system rehabilitation based on engineering judgment and previous experience. Inspection of the storm sewer system via television cameras would be necessary in order to assess their condition, thereby selecting the appropriate method. This further investigation may necessitate modifications to the following recommendations.

- As illustrated in Figure 6-1, the 24-inch vitrified clay pipe would be lined from manhole zero (MH-0) through MH-1 and continue for approximately 280 feet to a new manhole which would be installed to facilitate lining (MH-1A). MH-1A would also serve as a sampling point for monitoring the effectiveness of the sewer rehabilitation.

- The pipes extending from MH-1 to Building 292 would be replaced with similarly-sized, high density polyethylene (HDPE) pipe as TCE has been known to degrade PVC pipe.

- MH-1 would also be replaced because it is a brick structure and is another potential source of contaminated groundwater infiltration. MH-1 may also be weakened during the replacement of the pipes which would necessitate the replacement of MH-1.

- To verify that storm sewer rehabilitation was an effective step toward reducing the presence of TCE at the IW80 discharge, the IW80 discharge will be sampled monthly and the water analyzed for TCE. This sampling activity will be conducted as part of the monthly sampling required at IW80 by the NPDES permit approved February 1, 1998.

This scenario was selected as it is relatively conservative in nature with regard to the integrity of the existing system and accounts for the possibility of replacement of at lest a portion of the system.

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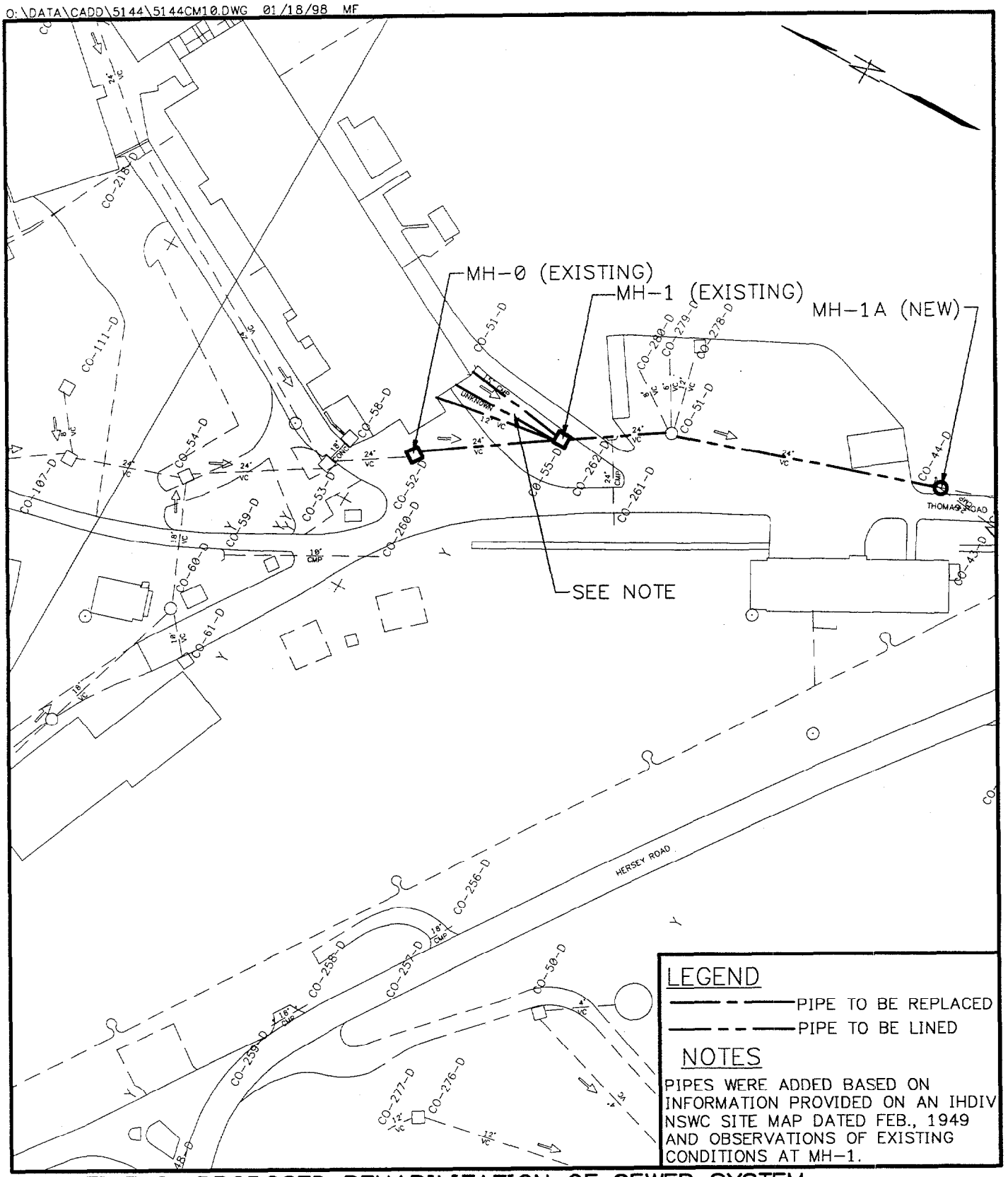

ALTERNATIVE 2: PROPOSED REHABILITATION OF SEWER SYSTEM
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

FIGURE 6-1

0 100 200
SCALE IN FEET

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MH-1A will be field located to ensure that it is outside of the zone of contaminated groundwater. This will minimize worker exposure to contamination during installation, and ensure that all of the pipe within the contaminated groundwater is rehabilitated.

6.2.2 Effectiveness

In the short term, this alternative would be protective of human health and the environment. Storm sewer system rehabilitation would inhibit the infiltration of contaminated groundwater into the system. Concentrations acceptable for discharge into Mattawoman Creek should be attained as soon as rehabilitation is complete. However, in the short term, ARARs for the contaminants present in the surficial aquifer would not be attained as contaminants would continue to remain in concentrations greater than MCLs. During implementation of this alternative, site workers would be required to wear proper personal protection equipment (PPE) for protection from the risks posed by site contaminants in groundwater and soil.

6.2.3 Implementability

This alternative is implementable. The methods recommended for storm sewer system rehabilitation are proven technologies that have been in use for many years and have been developed to the point where many vendors are available to provide these services. Prior to commencement of the rehabilitation, further investigation of the pipes and assessment of their condition would be required in order to select the appropriate method. Pipes can be inspected through the use of a closed circuit television camera. Use of a television camera for inspection requires a pipe diameter in excess of eight inches, accessibility to both ends of the pipe length, a pipe which is straight and free of significant obstructions, and a water level limitation in the pipe of less than one third of the pipe diameter. The pipe network is such that inspection via television cameras would be possible.

The inspection procedure would consist of cleaning a section of sewer using a water jet to scour the inside walls of the pipe and flush dirt and debris out of it. As analytical results from water samples obtained at the sewer discharge have indicated the presence of TCE contamination, debris and water scoured from the pipe interior during the cleaning process may also be contaminated. The rinse water from scouring would be collected and disposed of appropriately.

6.2.4 Cost

The following costs are associated with Alternative 2:

Capital:	$639,546
Operating and Maintenance:	$0 - $10,735/year
Present-worth (25-year):	$668,297

The present worth costs assume a 25-year duration in order to be comparable with the other alternatives. The details of the cost estimate are provided in Appendix B.

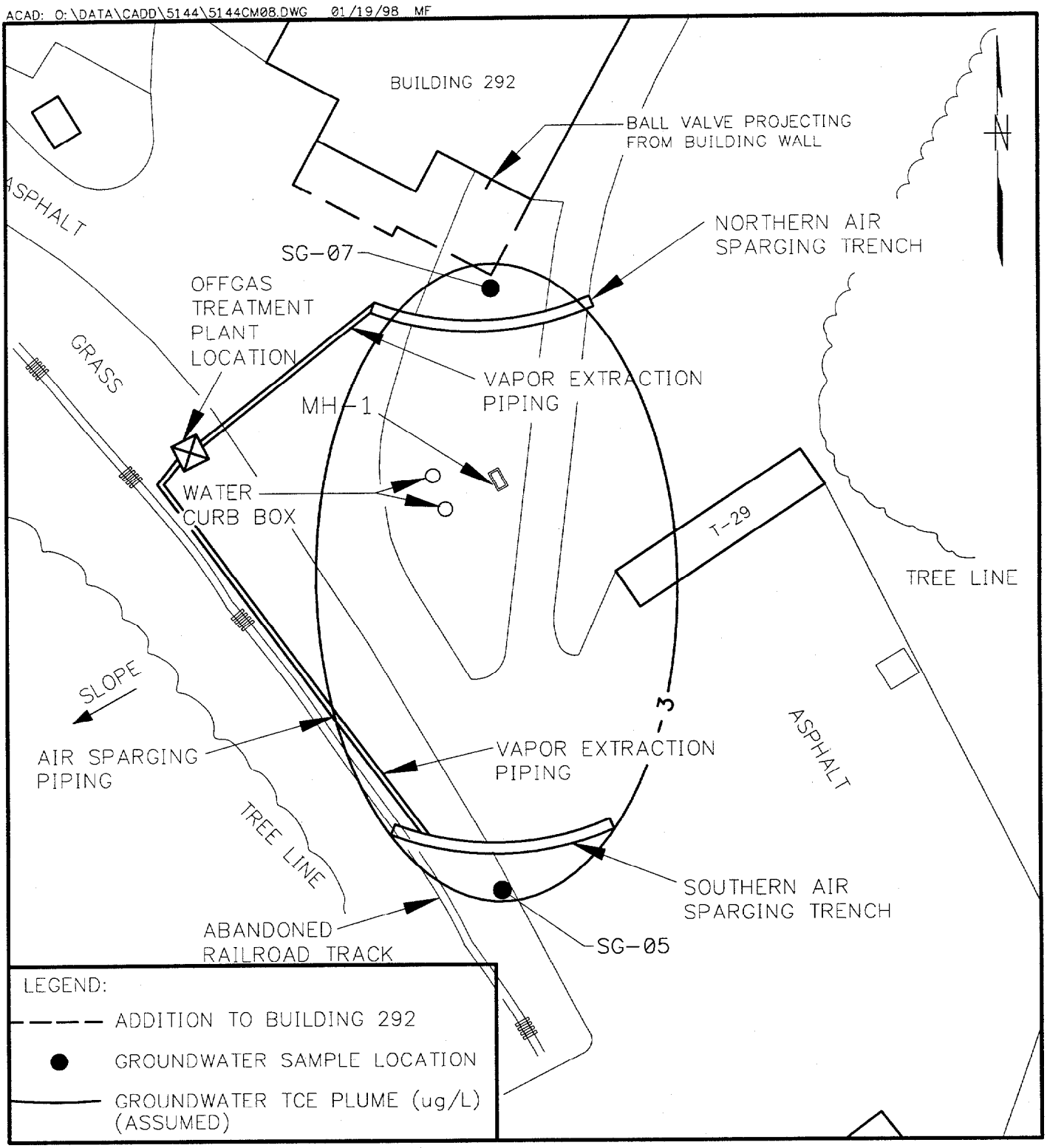
6.3 ALTERNATIVE 3: INSITU AIR SPARGING WITH OFFGAS TREATMENT

6.3.1 Description

Air sparging would remove the VOCs from the saturated zone followed by capture of the vapor-phase contaminants in the vadose zone. The vapor-phase contaminants would be treated aboveground in an offgas treatment unit. Figure 6-2 shows the conceptual layout of this alternative. This layout is based on an assumed plume boundary that must be defined at the time of removal action design. Figure 6-3 shows the conceptual plan for this alternative.

The conceptual design for this component consists of the use of two trenches installed perpendicular to the assumed axis of the groundwater VOC plume. The trenches would intercept the plume and the VOCs would be removed by air sparging within these trenches. One trench would be installed within the assumed source of the TCE plume. The other trench would be installed at the downgradient edge of the assumed TCE plume, where contaminant concentrations are at, or slightly in excess of, action levels. A set of horizontal perforated pipes (air sparging pipes) would be installed adjacent to the confining unit of the aquifer within each trench. The air sparging pipes would be connected through a header to a compressor that would supply clean ambient air to the system. Each trench would be backfilled to the level of typical groundwater table with native material. Native material excavated from the saturated zone is preferred as the backfill material because a more permeable material might cause short-circuiting of the air flow. On the other hand, a less permeable material would divert groundwater away from the trenches. A set of horizontal slotted pipes would be installed in the vadose zone in each trench and these pipes would be connected through a header to a vacuum extraction pump.

Vapor extraction flow rate would be at least 150 percent of the air sparging flow rate and the number of vapor extraction pipes would also be greater in order to ensure adequate capture of the VOCs. The vacuum extraction pump's outlet would be connected to an offgas treatment unit. A vapor barrier would be placed along the side walls and over the top of each trench within the vadose zone to prevent fugitive migration of VOCs. The trench would be backfilled with relatively more permeable material to grade to ensure adequate flow of vapors and capture of offgases.



ALTERNATIVE 3: LAYOUT OF AIR SPARGING/ VAPOR EXTRACTION/OFFGAS TREATMENT SYSTEM BUILDING 292, FORMER DRUM LOADING AREA NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

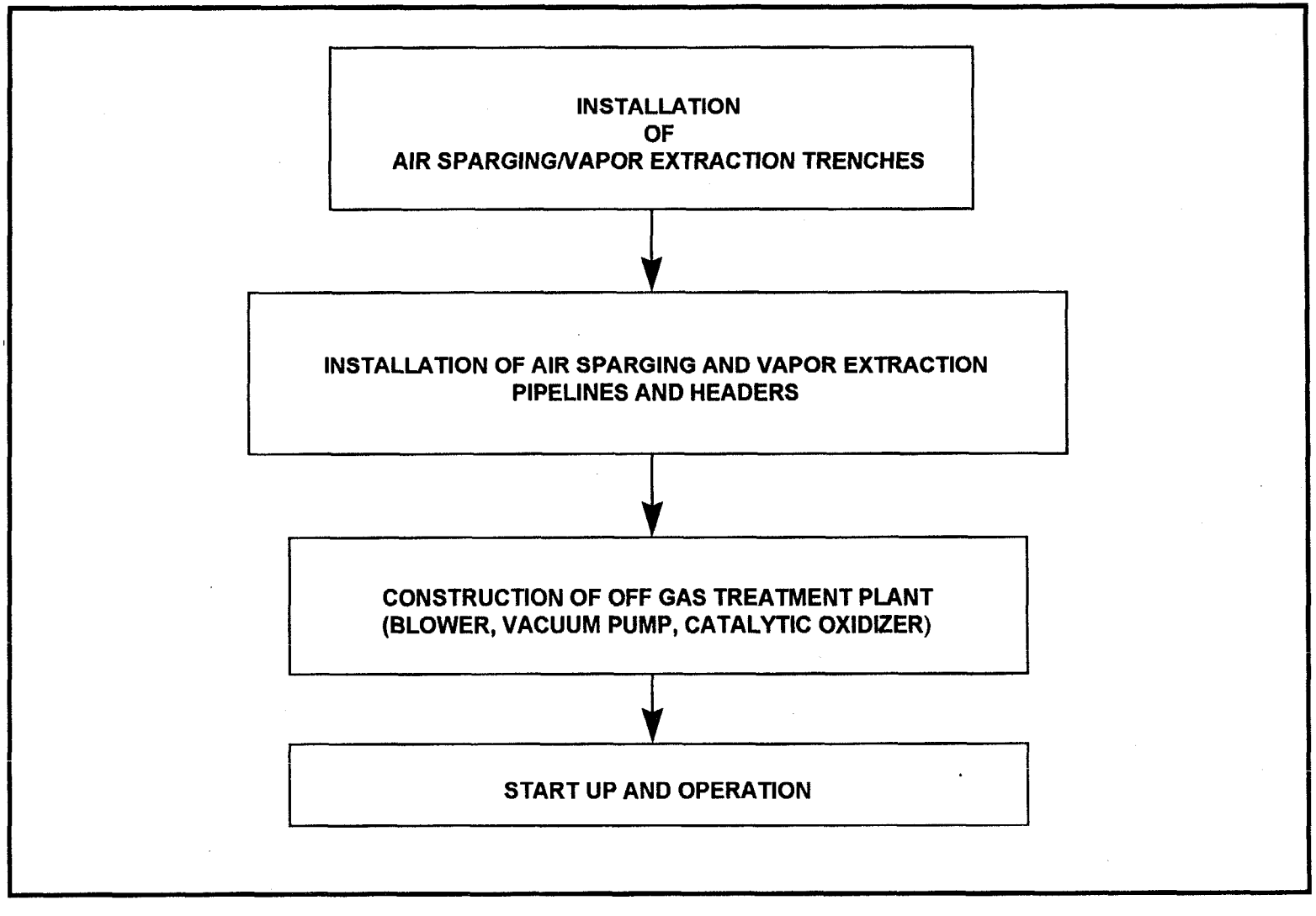
0 40 80
SCALE IN FEET

FIGURE 6-2

Brown & Root Environmental

CTO 0209

Figure 6-3
Alternative 3: Conceptual Removal Action Plan
IR Site 57, NSWC
Indian Head, Maryland



A total of approximately 560 cubic yards of soil would be excavated for the trenches. Of this volume, approximately 433 cubic yards of material would be replaced by relatively more permeable material such as coarse sand/gravel from an offsite borrow location. This excess material would be transported offsite for treatment/disposal via incineration.

The following are the salient features and assumptions of this preliminary conceptual design:

- Air sparging trenches would be approximately 120 feet in length based on the assumed width of the TCE plume and 14 feet in depth based on the depth to the confining unit.

- A minimum of two air sparging pipe lines would be placed in each trench adjacent to the confining unit, along the entire length of each trench.

- A minimum of five vapor extraction pipe lines would be placed in each trench within the vadose zone.

- Off-gas treatment would require catalytic or thermal oxidation because of the presence of vinyl chloride, which is not amenable to adsorption on activated carbon.

Pre-removal action design sampling is strongly recommended to define the extent of the TCE plume and determine design parameters for trench placement and to adjust the design of the air sparging and offgas treatment systems. At the time of removal action design, if it is determined that the levels of vinyl chloride in the plume are not significant, then offgas treatment may be conducted using activated carbon adsorption rather than by catalytic or thermal oxidation based on value engineering. One of the main aspects that would impact the value engineering analysis is the estimated operating and maintenance costs over the expected duration of the removal action, based on the expected VOC concentrations in the influent to the treatment plant during that time.

The following are recommended data requirements for the design of this removal action alternative:

- Definition of the plume
- Groundwater flow direction and rate

6.3.2 Effectiveness

This alternative would be effective in removing the VOCs in the groundwater and minimizing migration of the plume. VOC concentrations exceeding their respective MCLs would be removed and treated, in accordance with standards for protection of groundwater and for protection of Mattawoman Creek. However, this mitigation would require a substantial amount of time. Infiltration of the plume into the storm sewer would continue, unabated, and the discharge would be out of compliance with the NPDES permit for the IW-80 outfall. As such, this alternative does not meet the primary objective of this removal action.

Approximately 4 pounds per day of VOCs (consisting mainly of TCE) are estimated to be removed from the plume, assuming a groundwater flow rate of 30 gpm into the trenches and an average TCE concentration of 10 mg/L. The estimate assumes 100 percent removal from the aqueous phase for purposes of estimating conservative offgas concentrations. Actual removal rates can be more precisely determined by pilot-scale studies. These VOCs would be destroyed with an efficiency greater than 99 percent by offgas treatment using catalytic or thermal oxidation. The final products would be relatively innocuous gases, namely carbon dioxide, water vapor, and hydrogen chloride. If activated carbon adsorption is eventually used for offgas treatment, then the VOCs would be captured in the vapor phase and destroyed by thermal oxidation during regeneration of the spent activated carbon offsite. Although the estimated VOC emission rate is less than the de minimis 15 pounds per day limit for CERCLA remedial actions, offgas treatment is included as a conservative measure given that the source concentrations are very high and the plume is not defined.

Any exposure to the groundwater contaminants (for construction workers) during installation of the trench can be effectively controlled and minimized through the use of personal protective equipment (including respiratory protection as required) and by adhering to safe work practices as provided by OSHA guidance. Exposure to VOCs in the air would be adequately minimized by the use of offgas treatment, and thereby, both the onsite worker and the surrounding community would be adequately protected during the implementation of this alternative. Since this is an interim action, the source and downgradient plume would be adequately controlled until a comprehensive RI/FS is conducted. This alternative should not affect the implementation of any remedial action that may be selected at a later time. Erosion and sediment controls may be used as necessary, although most of the site is paved and the potential for migration of soil particles is expected to be minimal.

6.3.3 Implementability

The services and material required for the installation and operation of the air sparging system are readily available. The treatment system components such as trenches, air sparging and vapor extraction pipes,

compressors and vacuum pumps, etc. are available and commonly used in the remediation industry. Catalytic or thermal oxidation equipment is available from a fewer number of contractors, and are relatively new (less than 5 years) in the remediation industry but their availability is not so limited as to be of concern. Activated carbon adsorbers (if chosen) are readily available and are widely used in the remediation industry. Startup of the catalytic oxidation system requires personnel with specialized training. Operation and periodic maintenance does not required skilled labor, but does require a minimal level of training by the supplier. Periodic replacement (estimated to be every three years) of the catalyst would be required. Activated carbon adsorbers (if chosen) would require relatively little startup assistance and minimal operator attention. However, spent activated carbon replacement and disposal/regeneration would be required on a more frequent basis, depending on the VOC mass removal from the groundwater.

6.3.4 Cost

The following costs are associated with Alternative 3:

Capital:	$1,701,664
O&M:	$12,379 - $18,879/year
Present-worth:	$1,895,773

This cost estimate assumes the use of a catalytic oxidizer due to the potential for excessive levels of vinyl chloride. However, if a determination is made during pre-design activities that the levels of vinyl chloride are not of concern, then a value engineering analysis may be performed to determine the relative cost effectiveness of catalytic oxidation compared to activated carbon adsorption.

The present-worth cost is based on a 25-year operating duration. Although a shorter duration might be reasonably expected, a more precise estimate requires data connected with the extent of the plume and hydrogeologic characteristics. The details of the cost estimate are provided in Appendix B.

6.4 ALTERNATIVE 4: GROUNDWATER EXTRACTION/TREATMENT/DISCHARGE

6.4.1 Description

Groundwater extraction and treatment would remove contaminated groundwater by collecting it in trenches and treating it aboveground in a treatment plant using either air stripping with offgas treatment or enhanced oxidation. Figure 6-4 shows the conceptual layout of this alternative. This layout is based on an assumed plume boundary that must be defined at the time of removal action design. Figure 6-5 shows the conceptual plan for this alternative.

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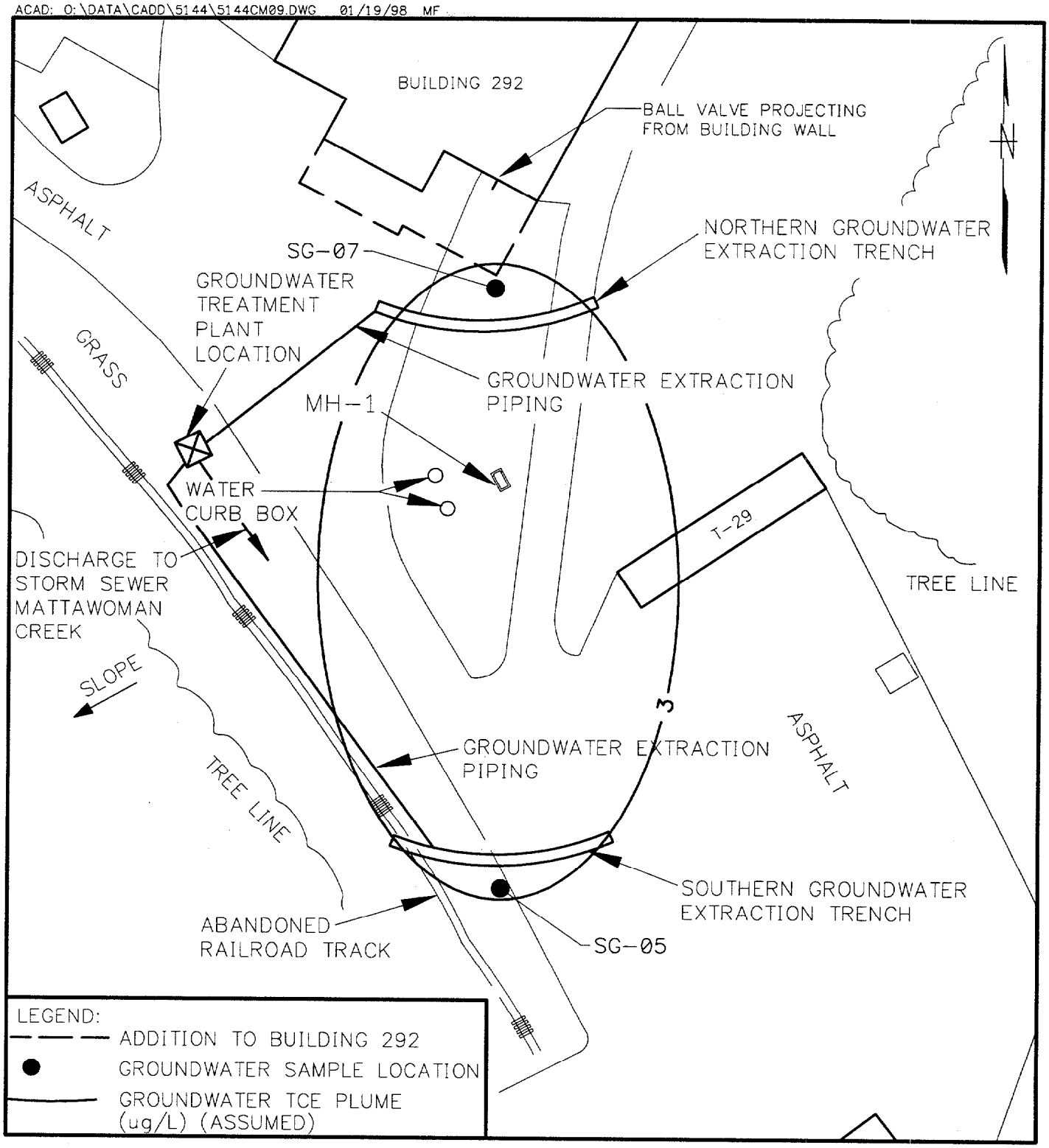


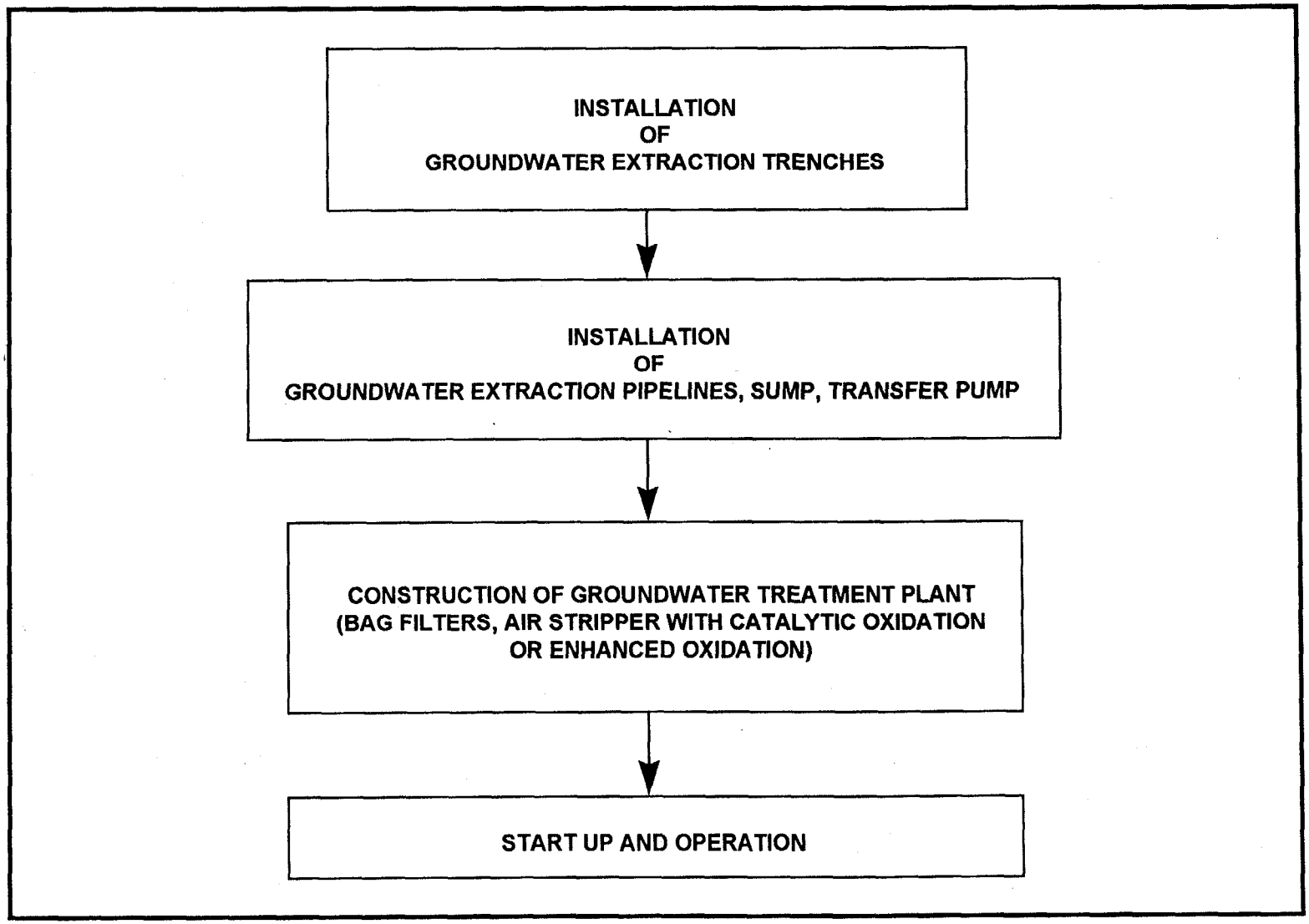
ALTERNATIVE 4: LAYOUT OF GROUNDWATER EXTRACTION/TREATMENT/DISCHARGE SYSTEM BUILDING 292, FORMER DRUM LOADING AREA NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

0 40 80
SCALE IN FEET

FIGURE 6-4

Brown & Root Environmental

Figure 6-5
Alternative 4: Conceptual Removal Action Plan
IR Site 57, NSWC
Indian Head, Maryland



The conceptual design for this alternative consists of the use of two trenches installed perpendicular to the assumed axis of the groundwater VOC plume. The trenches would intercept the plume and collect the contaminated groundwater that would be pumped to an aboveground treatment plant. One trench would be installed within the assumed source of the TCE plume. The other trench would be installed at the downgradient edge of the assumed TCE plume, where contaminant concentrations are at, or slightly in excess of, action levels. The location of these trenches would be similar to those described under Alternative 3. A horizontal collection pipe (drain) would be installed adjacent to the confining unit of the aquifer within each trench. The collection pipe would be sloped towards a sump at either end. A submersible pump would pump the water collected in the sumps to the treatment plant. The saturated zone in the trenches would be backfilled with relatively more permeable material in order to induce groundwater flow into trenches. The portion of the trenches above the water table would be backfilled with native excavated material.

A total of approximately 560 cubic yards of soil would be excavated for the trenches. Of this volume, approximately 127 cubic yards of material would be replaced by permeable material such as coarse sand/gravel from a suitable offsite borrow location. This excess material is assumed to be treated/disposed of offsite via incineration.

The groundwater would be treated by one of two possible ways: (1) air stripping with offgas treatment or (2) enhanced oxidation. For the purposes of preliminary conceptual design, the air stripping subalternative is expected to be conducted in a tray-type air stripper with catalytic oxidation of the offgases. The enhanced oxidation alternative is expected to be an ultraviolet light-enhanced system using hydrogen peroxide as the oxidizing chemical. The treated water is expected to be discharged to the storm sewer or the creek via gravity-aided drainage. The design of the air stripper and enhanced oxidation systems would be based on achieving the removal of TCE from an assumed average influent concentration of 10,000 μg/L to a residual level of 100 μg/L, in order to allow discharge to Mattawoman Creek via IW-80. Bag filtration is provided as a preliminary treatment to remove any suspended solids that might adversely affect the efficiency of either technology.

The following are the salient features and assumptions of this preliminary conceptual design:

- Groundwater collection trenches would be approximately 120 feet in length based on the assumed width of the TCE plume and 14 feet in depth based on the depth to the confining unit.

- A minimum of one extraction pipeline would be required for each trench to collect the groundwater and drain to each sump .

- A total groundwater extraction rate of 30 gpm was estimated based on a theoretical estimation of the hydraulic permeability using limited data on the lithology of the saturated zone, an estimate of the aquifer thickness, and an assumed site dimension.

- Under the air stripping option, offgas treatment would require catalytic or thermal oxidation because of the presence of vinyl chloride, which is not amenable to adsorption on activated carbon.

- Discharge limitation for the treated groundwater would be similar to the draft stormwater permit for IW-80.

The following are recommended data requirements for the design of this removal action alternative:

- Extent of the plume
- Groundwater flow direction and rates

6.4.2 Effectiveness

This alternative would be effective in mitigating the VOC contamination in the groundwater and minimizing migration of the plume. Groundwater containing VOCs at concentrations exceeding their respective MCLs would be removed and treated, in accordance with groundwater protection standards and surface water protection in Mattawoman Creek. However, this mitigation would require a substantial amount of time. Infiltration of the plume into the storm sewer would continue unabated and the discharge would be out of compliance with the NPDES permit for the IW-80 outfall. As such, this alternative does not meet the primary objective of this removal action.

Approximately 4 pounds per day of VOCs (consisting mainly of TCE) are estimated to be removed from the plume, assuming a groundwater extraction rate of 30 gpm from the trenches and an average TCE concentration of 10,000 µg/L. The groundwater would be treated by either air stripping or enhanced oxidation to achieve 99 percent or greater removal of TCE. Under the air stripping option, the VOCs would be transferred into the air stream, followed by offgas treatment using catalytic or thermal oxidation to achieve at least 99 percent or greater destruction. Under the enhanced oxidation option, the VOCs would be oxidized within the water using hydrogen peroxide catalyzed by ultraviolet radiation. The final products would be relatively innocuous gases, namely carbon dioxide, water vapor, and hydrogen

chloride. These products would be discharged in the air stream in the first option or in the water stream under the second option.

Under the air stripping alternative, if activated carbon adsorption is used, then the VOCs would be captured in the vapor phase and destroyed by thermal oxidation during regeneration of the spent activated carbon offsite. Although the estimated VOC emission rate is less than the de minimis 15 pounds per day limit for CERCLA remedial actions, offgas treatment is included as a conservative measure given that the source concentrations are very high and the plume is not defined.

Any exposure to the groundwater contaminants (for construction workers) during installation of the trench can be effectively controlled and minimized through the use of personal protective equipment (including respiratory protection as required) and following safe work practices as provided by OSHA guidance. Exposure to VOCs in the air would be adequately minimized by the use of offgas treatment. Onsite workers and the surrounding community would be adequately protected during the implementation of this alternative. Since this is an interim action, the source and downgradient plume would be adequately controlled until a comprehensive RI/FS is conducted. This alternative should not affect the implementation of any remedial action that may be selected at a later time.

6.4.3 Implementability

The services and material required for the installation and operation of the air stripping system are readily available. The treatment system components such as trenches, groundwater extraction pipes, transfer pumps, are available and commonly used in the remediation industry. Tray-type air stripping equipment is widely used in the remediation industry and is available from several suppliers. Under the air stripping option, catalytic or thermal oxidation equipment are available from a few contractors, and are relatively new (less than 5 years) in the remediation industry but their availability is not too limited to be of concern. Activated carbon adsorbers (if chosen) are readily available and are widely used in the remediation industry. Startup of the catalytic oxidation system requires specialized trained personnel. Operation and periodic maintenance does not require skilled labor, but does require a minimal level of training by the supplier. Periodic replacement of the catalyst (estimated to be every three years) would be required. Activated carbon adsorbers (if chosen) would require relatively little startup assistance and minimal operator attention. However, spent activated carbon replacement and disposal/regeneration would be required on a more frequent basis, depending on the VOC mass removal from the groundwater. Enhanced oxidation equipment are available from relatively fewer suppliers at this time, and this is expected to be of concern only from a cost competitiveness standpoint.

6.4.4 Cost

The following costs are associated with this alternative.

Option A		**Option B**	
Capital:	$877,853	Capital:	$929,762
O&M:	$15,469 - $24,969/year	O&M:	$38,884 - $43,884/year
Present-worth:	$1,128,031	Present-worth:	$1,491,235

This cost estimate for the air stripping option assumes the use of a catalytic oxidizer, because the potential levels of vinyl chloride are of concern. However, if at the time of pre-removal action design, a determination is made that the levels of vinyl chloride are not of concern, then a value engineering analysis may be performed to determine the cost effectiveness of activated carbon adsorption.

The present-worth costs assume a 25-year operating duration because of the need to provide a conservative estimate for the same reasons as those explained under Alternative 3. The details of the cost estimate are provided in Appendix B.

7.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES FOR GROUNDWATER

This section presents a comparison of the groundwater removal action alternatives based on the same detailed analysis criteria that were used in Section 6.0. The alternatives being comparatively analyzed are as follows:

- Alternative 1: No Action
- Alternative 2: Storm Sewer System Rehabilitation
- Alternative 3: In Situ Air Sparging with Offgas Treatment
- Alternative 4: Groundwater Extraction/Treatment/Discharge

7.1 EFFECTIVENESS

Alternative 1 would not be effective in attaining the removal action objectives for groundwater. Alternative 2 would be effective in minimizing the plume infiltration into the storm sewer, thereby preventing subsequent release of VOCs via IW-80 and meeting the primary objective of this removal action.

Alternatives 3 and 4 would more actively remove the VOCs from the source area and minimize plume migration but do not attain the primary objective of mitigating the release of TCE at IW-80. Alternative 4 offers better control over the removal and treatment of the VOCs from the plume than Alternative 3 where the VOCs are released insitu from the saturated zone into the vapor-phase and captured in the vadose zone, prior to being conveyed to the offgas treatment plant. Among the options in Alternative 4, treatment by enhanced oxidation offers a greater measure of control of the VOCs because destruction of VOCs would occur in the aqueous phase itself as opposed to treatment by air stripping followed by offgas catalytic oxidation.

7.2 IMPLEMENTABILITY

Alternative 1 would be immediately implementable. Alternative 2 would be readily implementable and would be the least dependent on the availability of equipment and services. Alternatives 3 and 4 are also implementable because the equipment and services are commonly available with a few exceptions. Catalytic oxidation equipment and enhanced oxidation equipment are offered by relatively fewer suppliers, although this is not expected to be a cause for concern. Alternatives 3 and 4 require additional investigations to determine the plume delineation, aquifer properties, and contaminant fate and transport modeling prior to interim action design.

7.3 COST

The following table summarizes the costs associated with each alternative:

Alternative	Capital ($)	O&M ($/yr)	Present Worth
1	0	0	0
2	$639,546	$0 - $10,735	$668,297
3	$1,701,664	$12,379 - $18,879	$1,895,773
4 (Option A)	$877,853	$15,469 - $24,969	$1,128,031
4 (Option B)	$929,762	$38,884 - $43,884	$1,491,235

8.0 RECOMMENDATIONS FOR REMOVAL ACTION AND FURTHER STUDY

This section presents recommendations in connection with removal action alternatives for soil and groundwater media at Site 57. For the purpose of meeting the requirements of a removal action, an alternative that offers the best balance of effectiveness and implementability while addressing the immediate threat of contamination at the site in a cost effective manner is preferred. The selected alternative for this removal action, which is interim in nature, must be compatible with a final remedial action for the site.

In addition to the evaluations presented in preceding sections of this EE/CA, the recommendations outlined below are guided by two important considerations. First, because the database currently available for Site 57 is less than comprehensive in its ability to characterize the affected media, as well as the extent of contamination, the developed alternatives are each necessarily accompanied by several uncertainties affecting the extent of remediation required and, in some instances, the technologies selected. Second, the Navy plans to initiate a Remedial Investigation effort at Site 57 within the next six months and that activity will provide an excellent opportunity to fill the data gaps causing the uncertainties.

Except for the No Action Alternative for soil, the soil alternatives are based on broad assumptions regarding the extent of soil remediation required. Implementing any of the alternatives without further field investigation risks incurring significant costs beyond those necessary to address remedial action goals developed on a more site-specific basis. Additionally, none of the alternatives are effective in meeting the primary objective of this removal action. It is recommended that a soil removal alternative not be implemented under this EE/CA. A more effective alternative will be possible given more complete data, and as such, work to mitigate soil contamination should be delayed pending the RI.

Similar to the soil related alternatives, alternatives addressing groundwater are based on broad assumptions. The assumptions affect determinations of the degree of treatment required, the selection of technologies to be implemented, and the placement of collection/treatment facilities. Also similar to the soil alternatives, the planned remedial investigation offers the opportunity to assemble site specific data that will permit the alternatives to be refined so as to be more cost effective.

However, one groundwater alternative presents a reasonable level of cost effectiveness along with implementability. Alternative 2, Storm Sewer System Rehabilitation provides positive steps toward addressing the discharge of TCE at IW-80 in addition to verifying the suitability of a very low cost alternative while contributing to the base of data regarding the site.

It is recommended that, of the removal actions developed and evaluated in this EE/CA, only groundwater Alternative 2, Storm Sewer System Rehabilitation, be implemented prior to the initiation of the planned remedial investigation at Site 57.

REFERENCES

B&R Environmental, 1996a. "Data Report for Subsurface Investigation, Former Drum Loading Area, Building 292." Indian Head Naval Surface Warfare Center, Indian Head, Maryland, March 1996.

B&R Environmental, 1996b. "Engineering Evaluation Cost Analysis (EE/CA) for IR Site 57, Former Drum Loading Area, Building 292." Indian Head Naval Surface Warfare Center, Indian Head, Maryland, October 1996.

B&R Environmental, 1997. "Findings Report: Pilot-Scale Soil Vapor Extraction Study, Site 57, NSWC Indian Head." May.

Chapelle, F.H., 1996. "Protocol for Assessing the Natural Attenuation of Chlorinated Ethenes in Groundwater Systems," F.H. Chapelle, U.S.G.S., Columbia, SC, in cooperation with Southern Division of Naval Facilities Engineering Command, Charleston, South Carolina, July, 1996.

Cox, E., et. al., 1995. "Intrinsic Biodegradation of Trichloroethene and Trichloroethane in a Sequential Anaerobic-Aerobic Aquifer," Cox, E., Edwards, E., Lehmicke, L., and Major, D., in Intrinsic Bioremediation, Hinchee., R.E. Wilson, J.T., Downey, DC, (editors), Batelle Press, Columbus.

DOD Environmental Technology Transfer Committee; Remedial Technology Screening Matrix and Reference Guide, second edition, October 1994, EPA/542/B-94/013, NTIS PB95-1047P2.

Driscoll, Fletcher, G., principal author and editor, "Groundwater and Wells", P.769. Published by Johnson Division, St. Paul, Minnesota, 1986.

Ellis, D.E., 1996. "Intrinsic Remediation in the Industrial Marketplace" Ellis, D.E., DuPont Specialty Chemicals-CRG, Wilmington, Delaware, in Symposium of Natural Attenuation of Chlorinated Organics in Groundwater, Dallas, Texas, September 11-13, 1996, EPA/540/R-06/509.

Engineering Evaluation/Cost Analysis (EE/CA) Report; IR Site 56, Indian Head Division NSWC; August 1995.

HNUS (Halliburton NUS Environmental Corporation), 1995. "Abbreviated Field Sampling Plan for Subsurface Investigation, Former Drum Loading Area, Building 292, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland."

McCarty, P.L., 1996. "Biotic and Abiotic Transformation of Chlorinated Solvents in Groundwater," Perry L. McCarty, Stanford University, California, in Symposium on Natural Attenuation of Chlorinated Organics in Groundwater, Dallas, Texas, September 11-13. 1996.

Title 40, Code of Federal Regulations, Part 268.

Title 40, Code of Federal Regulations, Part 300.

U.S. EPA 1989. Evaluation of Groundwater Extraction Remedies, Office of Solid Waste and Emergency Response. EPA/540/289/054.

U.S. EPA, 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)." Office of Emergency and Remedial Response, December.

U.S. EPA, 1993a. "Guidance on Conducting Nontime-Critical Removal Actions under CERCLA." EPA/540/R93/057. Publication 9760-0-32, PB93-963402, August.

U.S. EPA, 1993b. "EPA Guidance on Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with VOCs in Soil." OSWER Directive No. 9355.0-48FS; September.

U.S. EPA, 1993c. Guidance for Evaluating the Technical Implementability of Groundwater Restoration (Interim Final). EPA/540/R-93/080.

U.S. EPA, 1996. "Distribution Memorandum, Risk-Based Concentration Table - June 1996, USEPA, Region III," Roy L. Smith, Ph.D., Senior Toxicologist.

Weidmeier, et. al., 1996. "Overview of the Technical Protocol for Natural Attenuation of Chlorinated Aliphatic Hydrocarbons in Groundwater Under Development for the U.S. Air Force Center for Environmental Excellence" by T.D. Wiedemeier, et. al., Parsons Engineering Science, Inc., Denver, Colorado; J.T. Wilson and D.H. Kampbell, U.S. EPA, National Risk Management Research Laboratory, Ada, Oklahoma; and J.E. Hansen and P. Haas, U.S. Air Force Center for Environmental Excellence,

Technology Transfer Division, Brooks Air Force Base, Texas in Symposium on Natural Attenuation of Chlorinated Organics in Groundwater, Dallas, Texas, September 11-13, 1996. EPA/540/R-96/509.

Vidic, Radisav, D., 1996. "Technology Evaluation Report." Prepared for Groundwater Remediation Technologies Analysis Center, TE-96-01, October.

Wilson, J.T., et al., 1996. "Environmental Chemistry and the Kinetics of Biotransformation of Chlorinated Organic Compounds in Groundwater," Wilson, J.T., Kampbell, D.H., Weaver, J.W., U.S. EPA, National Risk Management Research Laboratory, Ada, Oklahoma, in Symposium on Natural Attenuation of Chlorinated Organics in Groundwater, Dallas, Texas, September 11-13, 1996. EPA/540/R-96/509.

APPENDIX A

PRELIMINARY CONCEPTUAL DESIGN CALCULATIONS

ATTACHMENT A.1

Development of a RAO for Surface Water Protection

DEVELOPMENT OF A GROUNDWATER RAO FOR PROTECTION OF MATTAWOMAN CREEK

In order to estimate the maximum allowable TCE concentration in Site 57 groundwater that would be protective of Mattawoman Creek water, the following discussion uses the draft NPDES permit limit for TCE in the IW-80 stormwater discharge to Mattawoman Creek at the NSWC, Indian Head. It is assumed that the draft NPDES permit limit has been determined to be protective of surface water in Mattawoman Creek at the flow rates expected at the IW-80 outfall. This discussion assumes that a similar flow-rate based TCE limit may be applied to the influx of groundwater into Mattawoman Creek from Site 57.

Groundwater inflow through the contaminated site area is estimated to be approximately 12 gpm (or 17,280 gpd). This assumption is based on a theoretical estimation of the hydraulic permeability of the aquifer using a limited grain-size distribution data base, an estimate of the aquifer thickness and an assumed plume dimension. Details of this estimation are presented in Attachment A.2 of this appendix.

The draft NPDES permit for stormwater discharge to Mattawoman Creek limits TCE concentrations to 100 μg/L. It is assumed that this permit is based on a flow rate at the IW-80 outfall that is in the range of 77,556 gpd and 2,625,998 gpd, the minimum and maximum respectively, measured during a seven year period starting from May 18, 1990 and ending on September 4, 1996 (Facsimile from S. Jorgensen, NSWC, Indian Head, to G. Latulippe, B&RE, September 24, 1997). For the purpose of theoretical estimation, it is assumed that the flow-rate based TCE concentration from the IW-80 outfall can be used as the basis for estimating allowable influx from the groundwater plume. If the mixing zones for the two contaminated streams are similar in size but distinct in location in the stream, then the allowable concentration limit in the groundwater is a factor of this mass loading and its flow rate. Therefore, assuming conservatively that the TCE limit for the outfall is based on the lowest recorded flow rate of 77,556 gpd, the allowable TCE concentration in the groundwater stream prior to its entrance to the creek can be estimated as follows:

Allowable TCE concentration in groundwater= TCE limit x Outfall flow rate/ G.W. flow rate

<u>Where:</u>

TCE limit= Draft NPDES permit limit on TCE for IW-80 Outfall= 100 μg/L

Outfall Flow rate= assumed NPDES flow rate basis= 77,556 gpd

G.W. flow rate= estimated groundwater flow rate through the site= 17,280 gpd

Based on this calculation, the allowable TCE concentration in Site 57 groundwater for protection of Mattawoman Creek is estimated to be 448 μg/L. This concentration is the maximum allowable in the groundwater plume before it enters the creek. Therefore, the concentrations in the plume at IR Site 57 could in fact be higher than 448 μg/L because several other mechanisms such as dilution, natural attenuation (abiotic and biodegradation), sorption, etc., could further reduce the concentrations of TCE during the migration of the plume from the site to the edge of the creek. However, this EE/CA makes the conservative assumption that a TCE concentration of 448 μg/L at the site (prior to migration to the creek vicinity) can be used as a remedial action objective for the purpose of protecting the surface water of Mattawoman Creek. When more data on the hydrogeological characteristics and lithology is obtained, a groundwater modeling study can be performed to estimate a more precise remedial action goal for TCE in Site 57 groundwater to protect surface water.

ATTACHMENT A.2

Approximate TCE Plume Isoconcentration Contours and Representative Average Concentration of Contaminants within Plume

CALCULATION WORKSHEET

Order No. 19116 (01-01)

CLIENT: NWSC Indian Head	JOB NUMBER:
SUBJECT: Approximate TCE Plume Isoconcentration contours	
BASED ON: Exponential Curve Fit	DRAWING NUMBER:
BY: JJB 10/2/97	CHECKED BY: [illegible] 10/9/97
APPROVED BY:	DATE:

Purpose: To estimate the isoconcentration contours of the TCE plume based on GW data from the Subsurface Investigation.

Assumptions: - Assume that TCE conc. in groundwater follows the non linear equation downgradient of the source

$$y = ae^{-bx}$$

where y = groundwater concentration (mg/L)
x = distance from source (Ft)
a & b = constants

- The TCE plume is assumed to be moving in a SW direction as indicated from soil gas survey results
- The following groundwater data points were obtained from the subsurface investigation

(x) distance from plume	GW concentration (mg/L) (y)
0 ft (at the source)	370,000
170 ft	3

- The concentration of TCE perpendicular to the flow of the plume does not follow the non-linear relationship

CALCULATION WORKSHEET

Order No. 19116 (01-01)

CLIENT: NSWC Indian Head	JOB NUMBER:
SUBJECT: Approximate TCE Plume characteristics	
BASED ON: Linear Regression	DRAWING NUMBER:
BY: JJB 10/2/97	CHECKED BY: JJ Mdep 10/9/97
APPROVED BY:	DATE:

calculate a

$$y = a e^{-bx}$$

$$370{,}000 = a e^{-b(0)}$$

$$a = 370{,}000$$

calculate b

$$3 = 370{,}000\, e^{-(b)(170)}$$

$$\ln\left(3/370{,}000\right) = \ln\left(e^{-b \cdot 170}\right)$$

$$-11.72 = -b \cdot 170$$

$$b = -0.069$$

$$y = (370{,}000) \cdot e^{-(0.069)(x)}$$

$$-\ln\left(y/370{,}000\right) \cdot \left(\frac{1}{0.069}\right) = x$$

Estimate X for a given concentration

TCE conc. (µg/L)	distance from source (ft)
370,000	0
300,000	3
200,000	9
100,000	19
10,000	52
1,000	86
100	120
5	162

CALCULATION WORKSHEET

Order No. 19116 (01-01)

CLIENT	JOB NUMBER
NSWC Indian Head	

SUBJECT: Calculate Representative Average Concentration of Contimants in plume

BASED ON	DRAWING NUMBER
Groundwater data	

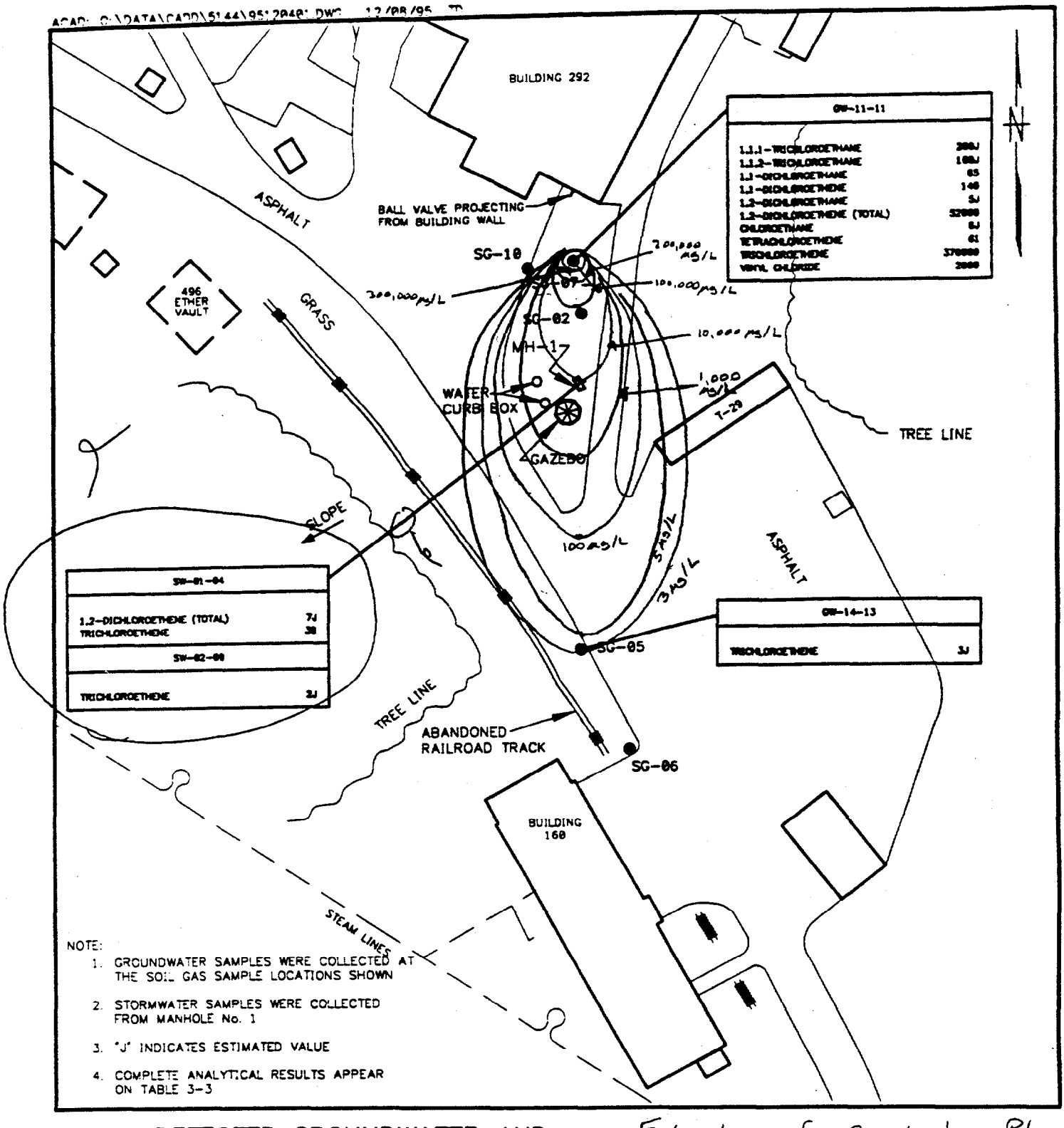
BY	CHECKED BY	APPROVED BY	DATE
JJB 10/2/97	JJ Gradel 10/9/97		

Purpose: From the assumed TCE isoconcentric countours, estimate the representative average concentration of contaminants with the plume.

Approach: Calculate the area between isocentric countour lines (see page 2 of 3). Using this area & the avg. concentration of the two contours, calculate a TCE weighted average concentration.

Using the ratio between the weighted avg. TCE / max TCE conc., estimate the weighted average of other contaminants within the plume.

Calculations: See attached spreadsheet (page 3 of 3).



~~DETECTED GROUNDWATER AND STORMWATER CONTAMINANTS (µg/L)~~

Estimation of Groundwater Plume characteristics

BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

FIGURE 4-2

Brown & Root Environmental

Upper Conc. (µg/L)	Lower Conc. (µg/L)	Avg. Conc. (µg/L)	Area [1] sq. inch.	Area [2] sq. ft.	Area [3] sq. ft.	Weighted Average (µg/L)
370,000	300,000	335,000	rad. = 5.0 ft.	79	79	2022.458
300,000	200,000	250,000	rad. = 7.5 ft.	177	98	1875.632
200,000	100,000	150,000	0.093	279	102	1172.499
100,000	10,000	55,000	0.3565	1,172	893	3752.533
10,000	1,000	5,500	0.868	3,348	2,176	914.68
1,000	100	550	1.674	6,138	2,790	117.2667
100	5	53	2.7745	10,100	3,962	15.89496
5	3	4	3.63475	13,085	2,985	0.912548
					13,086	9,872 = weighted average conc.

Assume 10,000 µg/l

1. Area of plume greater than the lower concentration limit as measured from the figure on Page 3 of 3 with a planimeter (in square inches).
2. Area of plume greater than the lower concentration limit (in square feet).
3. Area of plume between the upper and lower concentration limit = difference in Areas between the two isoconcentration limits (i.e., Area of plume between 5 µg/l and 3 µg/l = 13,085 ft^2 - 10,100 ft^2 = 2,985 ft^2)

Contaminant.	Max Conc. (µg/L)	Average Conc. (µg/L)
1,1,1-TCA	260	7
1,1,2-TCA	106	3
1,1-DCA	65	2
1,1-DCE	140	4
1,2-DCA	5	ND
1,2-DCE	52,000	1,400
Chloroethane	6	ND
PCE	61	2
TCE	370,000	10,000
Vinyl Chloride	2,000	54

ATTACHMENT A.3

Hydraulic Conductivity/Groundwater Flow Estimate

CALCULATION WORKSHEET Order No. 19116 (91-01)

CLIENT	JOB NUMBER
NSWC Indian Head	
SUBJECT: Estimation of Groundwater Flow through contaminant plume	
BASED ON: Freeze & Cherry, 1979	DRAWING NUMBER
BY: JJB 10/1/97	CHECKED BY: JJ Prudeh 10/9/97
APPROVED BY	DATE

Purpose: To estimate the groundwater flow at Site 57

Because hydraulic conductivity has not been measured in previous investigations, K will be estimated based on the following equation from Freeze, Allan & Cherry, J. Groundwater, Prentice Hall, Inc., 1979.

$$K = A\, d_{10}^2$$

where A = conversion factor = 1, for K = [cm/s] & d_{10} = [mm]

d_{10} = grain size diameter at which 10 % by weight of the soil particles are finer & 90 % are coarser.

From the Pilot-Scale SVE Study - at the 9-10 ft interval)

d_{10} = 0.2867 mm (see p. 2 of 5)

$$K = (1.0)(0.2867)^2 = 0.082 \text{ cm/s} = 7{,}085 \text{ cm/day}$$
$$= 2.69 \times 10^{-3} \text{ ft/s}$$

Using Darcy's Equation, a groundwater flow rate can be estimated

$$Q = K\, i\, A$$

where Q = Flow in, ft^3/s

K = hydraulic conductivity, ft/s

i = hydraulic gradient

A = cross sectional Area of plume

1" = 2000'
NAL PARK
I V E R
Chapman Point
Light
Potomac Heights
Riverview Village
Light
Sewage Disposal
Lackey High Sch
St Charles Ch
Glymont
Glymont Flint Ch
County Sch
Indian Head Sch
BM
111
Water
GOVERNMENT
RR
CREEK
STRAUSS
AVE
St Mary's Ch
Indian Head
Sewage Disposal
Perry Wright
Golf Course
NAVAL
Warington Hills
Horsehoe Cut
Site 57
Elevation ~35'
Elevation ~20'
MATTAWOMAN
Nelson Point
U.S. NAVAL
PROPELLANT PLANT
Distance
Between Elevations
= 600 ft
WASHINGTON, D.C. 25 MI.
LA PLATA 11 MI.
IKEY 3.5 MI.
280 000
(MD.)
35'

2 of 5

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT	JOB NUMBER
NSWC Indian Head	
SUBJECT: Est. of GW flow	
BASED ON: Freeze & Cherry	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
JTB 10/1/97	JJP 10/9/97		

The hydraulic gradient is not known. The surface topography will be used to estimate the hydraulic gradient. From the USGS Quad on page 4 of 5.

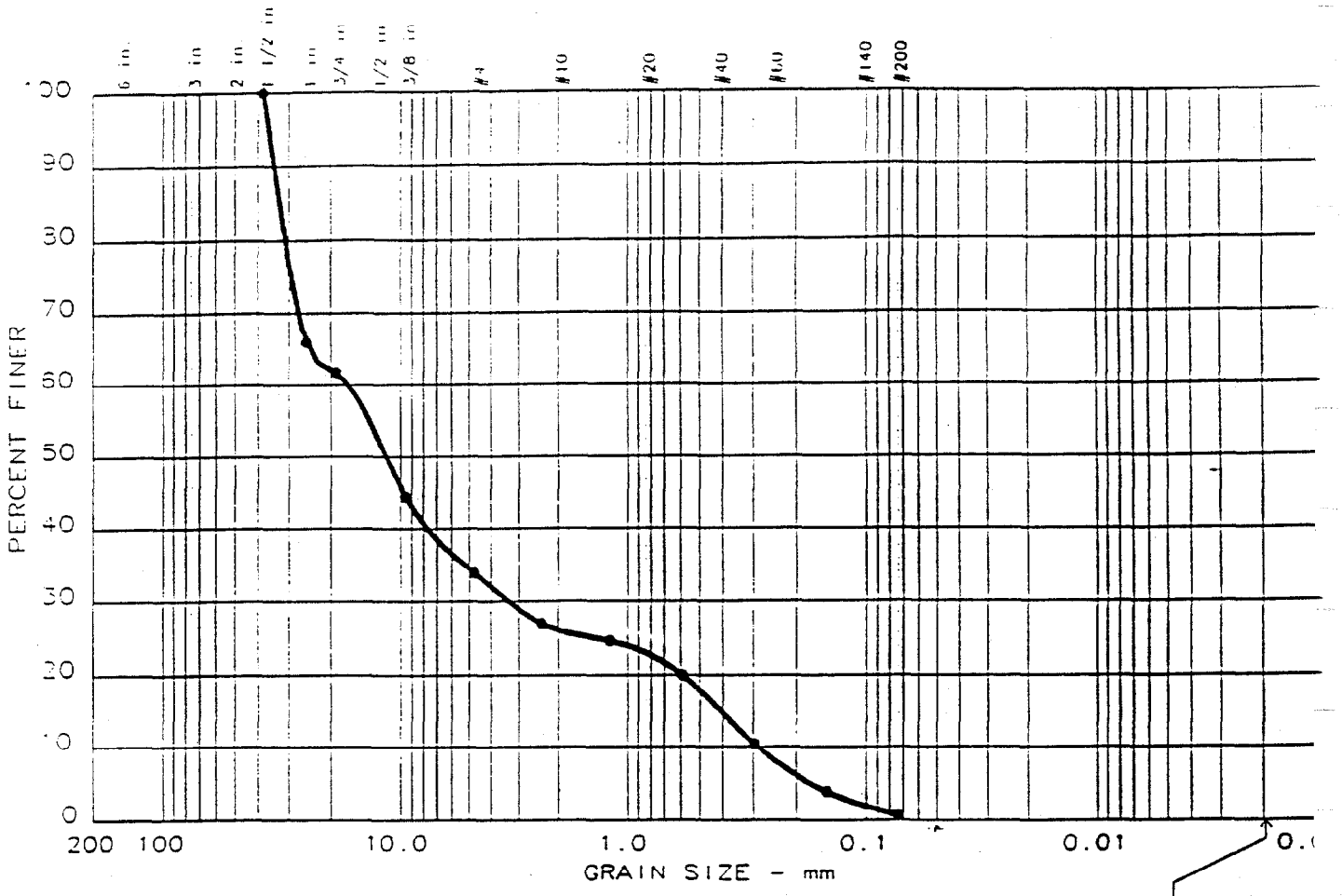
$$i = \frac{15 \text{ ft}}{600 \text{ ft}} = 0.025 \text{ ft/ft}$$

At the upgradient trench shown on page 5 of 5,
- Assume plume width of 65 ft wide & 6 ft deep CGW was located at depth between 8 to the confining layer at an ft assumed depth of 14 ft.

$$Q = (2.69 \times 10^{-3} \text{ ft/s})(0.025)(65 \text{ ft})(6 \text{ ft})$$
$$= 0.026 \text{ ft}^3/\text{s}$$
$$= 11.7 \text{ gpm}$$

It should be noted that this is a conservative estimate used for cost estimating purposes. Hydraulic conductivity would be measured in a pre-design study before implementation of related alternatives dependent on groundwater flow. Because of the uncertainties surrounding this estimation, a safety factor of 2 will be applied to the flow rate. Therefore, assume a flow rate of **24 gpm.**

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	[illegible]	0.0	66.1	33.2	0.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NA	NA	32.92	16.69	11.55	3.330	0.4097	0.2867	2.32	58.

MATERIAL DESCRIPTION	USCS	AASHTO
● WELL-GRADED GRAVEL WITH SAND	GW	A-1-a

Project No.: 97720

Project: NSWC, INDIAN HEAD, MD (CTO 209)

● Location: BUILDING 292, STATION NO. SO-02-0910

Date: 4-3-97

Remarks:

PILOT-SCALE AIR EXTRACTION WELL.

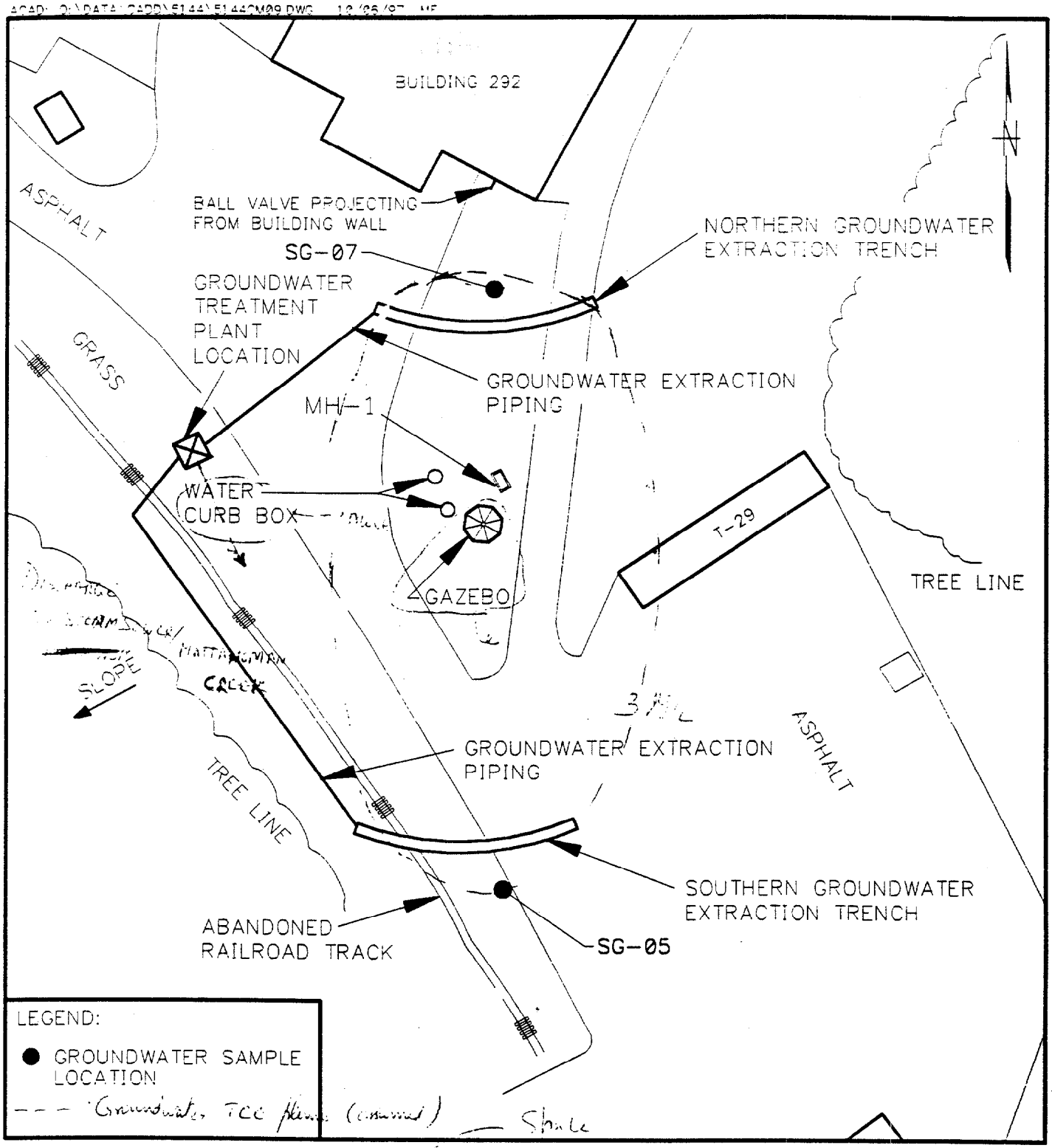
DEPTH: 9.0 TO 10.0 FT.

MOISTURE CONTENT: 7.5%

GRAIN SIZE DISTRIBUTION TEST REPORT

ACKENHEIL ENGINEERS, INC.

Figure No. _____



ALTERNATIVE 4: LAYOUT OFGROUNDWATER EXTRACTION/TREATMENT/DISCHARGE SYSTEM BUILDING 292, FORMER DRUM LOADING AREA NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

0 40 80
SCALE IN FEET

FIGURE 6-5

Brown & Root Environmental

ATTACHMENT A.4

Permeable Treatment Wall Preliminary Conceptual Design Calculations

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT	JOB NUMBER
NSWC Indian Head	5144-0105

SUBJECT: ~~Treatment Wall Design~~ Permeable treatment wall evaluation

BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
IJB 10/3/97	JJ Modaff 10/9/97		

Purpose: To Estimate the thickness of a Permeable Treatment wall at site 57.

Assumptions:
- The Groundwater Flow in the surficial aquifer is 12 gpm (from previous calculations)
- Assume that the wall is composed of 50% sand & 50% native aquifer material
- From previous calculations, assume avg TCE concentration is 10,000 µg/L, cDCE = 1,400 µg/L & VC = 54 µg/L
- Assume the there is no DNAPL source contributing to the plume
- from a case study from an industrial facility in Sunnyvale, CA, assume the following half lifes
  - TCE - 1.7 hrs
  - cDCE - 0.9 hrs
  - VC - 4.0 hrs
- The MCLs for the above listed compounds are TCE = 5 µg/L, cis-1,2 DCE = 7 µg/L, & VC = 2 µg/L
- Assume width of wall = 65 ft & aquifer depth of 6 ft
- Assume 1st order degradation reactions

Approach:
1) Calculate Kinetic rates for TCE & TCE by product degradation
2) Calculate expected concentrations for a given time (t) based on the following equations governing reactions occurring in series found in
   Hill, Charles G. An Introduction to chemical Engineering Kinetics & Reactor Design, 1977. p. 150 - 152.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
NSWC Indian Head	5144-0106

SUBJECT: Treatment Wall Design → Permeable treatment wall evaluation

BASED ON: | DRAWING NUMBER:

BY	CHECKED BY	APPROVED BY	DATE
JJB 10/8/97	Approved 10/9/97		

The following mathematical models for degradation are as follows.

$$[TCE] = [TCE]_0 \, e^{-k_1 t}$$ (Where $[TCE]_0$ = initial TCE Concentration)

$$[cDCE] = [cDCE]_0 \, e^{-k_2 t} + \frac{k_1 [TCE]_0}{k_2 - k_1}\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

$$[VC] = [VC]_0 \, e^{-k_3 t} + [cDCE]_0 \left(\frac{k_2 e^{-k_2 t}}{k_3 - k_2} - \frac{k_2 e^{-k_3 t}}{k_3 - k_2} \right)$$

$$+ [TCE] \left(\frac{k_1 k_2 e^{-k_1 t}}{(k_3 - k_1)(k_2 - k_1)} - \frac{k_1 k_2 e^{-k_2 t}}{(k_3 - k_2)(k_2 - k_1)} + \frac{k_1 k_2 e^{-k_3 t}}{(k_3 - k_2)(k_3 - k_1)} \right)$$

where k_1 = reaction rate for TCE degradation
k_2 = reaction rate for cDCE degradation
k_3 = reaction rate for VC degradation

- Calculate thickness of treatment wall based on required residence time

Calculations: 1) Calculate K

$k_1 = \ln(2)/\text{half life} = 0.693/1.7 = 0.408 \text{ hr}^{-1}$
$k_2 = 0.693/0.9 = 0.77 \text{ hr}^{-1}$
$k_3 = 0.693/4 = 0.173$

2) Calculate species concentrations

See attached spreadsheet (p. 3 of 4)

Permeable Treatment Wall Evaluation

Estimation of TCE and TCE degradation compound concentrations for a given time (t)

rate	(hr^{-1})
$k_{1=}$	0.408
$k_{2=}$	0.77
k_3	0.173

	µg/L
$[TCE]_o$	10000
$[cDCE]_o$	1400
$[VC]_o$	54

Time (hrs)	[TCE] µg/L	[cDCE] µg/L	[VC] µg/L
1	6649.788788	2924.518038	1736.958108
2	4421.969093	2867.781321	3558.106794
3	2940.51605	2334.39294	4837.539733
4	1955.381066	1750.20403	5504.143371
5	1300.287109	1255.47068	5680.564432
6	864.6634637	877.2836528	5521.595002
7	574.9829407	603.0171179	5159.494726
8	382.3515112	410.088158	4691.937449
9	254.2556793	276.910841	4185.134437
10	169.0746565	186.0895519	3680.971223
11	112.4310755	124.6483541	3204.014476
12	74.76429055	83.30649973	2767.149474
13	49.71667411	55.59059158	2375.723864
14	33.06053821	37.05617563	2030.437358
15	21.98455963	24.68306304	1729.284483
16	14.61926781	16.4329255	1468.821826
17	9.72150432	10.93644281	1244.970329
18	6.464595043	7.276621721	1053.505724
19	4.298819164	4.840706553	890.3442098
20	2.858623948	3.21985049	751.6964568
21	1.900924548	2.141541351	634.1388467
22	1.264074675	1.424269038	534.6342206
23	0.84058296	0.947196463	450.5230814
24	0.558969914	0.629906218	379.4986508
25	0.371703187	0.418893118	319.5741808
26	0.247174768	0.278563775	269.0476536
27	0.164366	0.185243054	226.4668907
28	0.109299919	0.123184583	190.5967436
29	0.072682137	0.08191601	160.3891929
30	0.048332086	0.054472816	134.9566654
31	0.032139817	0.036223457	113.5485694
32	0.021372299	0.02408792	95.53088112
33	0.014212128	0.016017998	80.36852108
34	0.009450765	0.010651648	67.61023174
35	0.006284559	0.00708313	56.87565721
36	0.004179099	0.004710136	47.84434304
37	0.002779013	0.003132143	40.24639529
38	0.001847985	0.002082809	33.85456481
39	0.001228871	0.001385025	28.4775501
40	0.000817173	0.000921012	23.954338
41	0.000543403	0.000612454	20.14942634
42	0.000361351	0.000407269	16.94879392
43	0.000240291	0.000270825	14.25650317
44	0.000159788	0.000180093	11.99183739
45	0.000106256	0.000119758	10.08688945
46	7.0658E-05	7.96366E-05	8.48453126
47	4.69861E-05	5.29567E-05	7.136704354
48	3.12447E-05	3.52151E-05	6.002981045
49	2.07771E-05	2.34173E-05	5.049353484
50	1.38163E-05	1.5572E-05	4.247214662
51	9.18756E-06	1.0355E-05	3.572500999
52	6.10954E-06	6.88589E-06	3.004970946
53	4.06271E-06	4.57897E-06	2.527598069
54	2.70162E-06	3.04492E-06	2.126060454
55	1.79652E-06 ✓	2.02481E-06 ✓	1.788311177 ☆
56	1.19465E-06	1.34645E-06	1.504216967

MCLs are attained

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NWSC Indian Head	JOB NUMBER: CTO 209 / 5144
SUBJECT: ~~Treatment wall Design~~ Permeable Treatment Wall Evaluation	
BASED ON	DRAWING NUMBER
BY: JJB 10/8/97	CHECKED BY: 10/9/97
APPROVED BY	DATE

3) Calculate wall thickness.

Wall thickness = residence time x GW velocity

Residence time = 55 hrs (from page 3 of 4

$$\text{Velocity} = Q/A = \frac{12\ \text{gal}}{\text{min}} \times \left(\frac{1}{6.5\ \text{ft} \cdot 6\ \text{ft}}\right) \times \frac{8.028\ \text{ft}^3/\text{hr}}{1\ \text{gal/min}}$$

$$= 0.247\ \text{ft/hr}$$

Wall thickness = (55 hrs)(0.247 ft/hr) = 13.59 ft. ≈ 14 ft

A wall thickness of ≈ 14 ft is not economically feasible. Do not retain.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NSWC, Indian Head	JOB NUMBER: CTO 209
SUBJECT: Permeable Treatment Wall Evaluation: Manual check	
BASED ON: Spreadsheet Calculations pg 3/4	DRAWING NUMBER:
BY: JPradeep	CHECKED BY: / APPROVED BY: / DATE: 10/9/97

$$[TCE]\Big|_{55y} = 10{,}000\ \mu g/L \times e^{-0.408\times 55}$$

$$= \underline{1.796\times 10^{-6}\ \mu g/L}$$

$$[DCE]\Big|_{55y} = 1{,}400\ \mu g/L \times e^{-0.77\times 55} + \frac{0.408\times 10{,}000\ \mu g/L}{(0.77-0.408)}\left(e^{-0.408\times 55} - e^{-0.77\times 55}\right)$$

$$= \underline{2.0248\times 10^{-6}\ \mu g/L}$$

$$[VC]\Big|_{55y} = \cancel{54\times e^{-0.173\times 55}}\ \text{ignore (negligible)} + 1{,}400\ \mu g/L \times \left(\frac{0.77 e^{-0.77\times 55}}{0.173-0.77} - \frac{0.77\times e^{-0.173\times 55}}{0.173-0.77}\right)$$

$$\cancel{-9.37\times 10^{-5}}\ \text{ignore}$$

$$+ 10{,}000\ \mu g/L \times \left[\frac{0.408\times 0.77\times e^{-0.408\times 55}}{(0.173-0.408)(0.77-0.408)}\left(\cancel{\frac{5.64\times 10^{-11}}{-0.235\times 0.362}}\ \text{ignore}\right)\right.$$

$$- \frac{0.408\times 0.77\times e^{-0.77\times 55}}{(0.173-0.77)(0.77-0.408)} - \cancel{\frac{1.27\times 10^{-19}}{-0.597\times 0.362}}\ \text{ignore}$$

$$\left. + \frac{0.408\times 0.77\ e^{-0.173\times 55}}{(0.173-0.77)(0.173-0.408)}\right] \quad \frac{2.31\times 10^{-5}}{-0.597\times -0.235}$$

$$= \underline{1.6\ \mu g/L}$$

ATTACHMENT A.5

This Attachment not Used

ATTACHMENT A.6

Air Sparging System Preliminary Conceptual Design Calculations

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NSWC, Indian Head	JOB NUMBER: CTO 209 / 5144
SUBJECT: IR Site 57 / EECA / Air Sparging: Cost input (Alt 3)	
BASED ON: Conceptual design calcs.	DRAWING NUMBER:
BY: J.P. Pradeep Kumar (JPP) / CHECKED BY: Joanne M Appleyard Jones	APPROVED BY: / DATE: 10/03/97

CAPITAL COST ITEMS

1. Trench Installation:

Northern trench – 60' long × 14' deep
Southern trench – 60' long × 14' deep

Assume 1H:2V slope

2' wide @ bottom
16' wide @ top

Volume: 560 cuyd (stockpile for partial reuse
– excess to be treated with soil alternatives)

Off site disposal of gw extracted during trench installation: 30,000 gal @ $230/drum

2. Air sparging:

pipes: 260' × 2" ϕ perforated PVC in 10' sections

Header: 320' × 4" ϕ PVC

Compressor: 2.0 H.P.

3. Vapor Extraction:

Pipes: 600' × 2" ϕ slotted PVC in 10' sections

Header: 440' × 4" ϕ PVC

Vaccum pump: 1.0 H.P.

4. Backfill:

① 127 cuyd native material: for saturated zone (excess = 433 cuyd)
② 433 cuyd coarse sand/gravel for vadose zone
③ Pipe bedding
Vapor barrier: 3,840 ft² Visqueen or appropriate

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC, Indian Head	JOB NUMBER CTO 209/514
SUBJECT IR Site 57 / EECA / Air Sparging : Cost input (Alt 3)	
BASED ON Conceptual design calcs	DRAWING NUMBER
BY JLP / CHECKED BY MMS	APPROVED BY / DATE 10/03/97

5. Offgas Treatment : Catalytic oxidizer : 72 scfm (use ERS)

6. Treatment Plant Building

O&M COST ITEMS

1. Electrical for oxidizer : 1.6 KW @ 24 h/day x 365 day/yr

Catalyst replacement : \$1,500/3yr

Troubleshooting + inspection : \$2,800 → yr 1

+ \$2,800/3yr yr 4 onwards

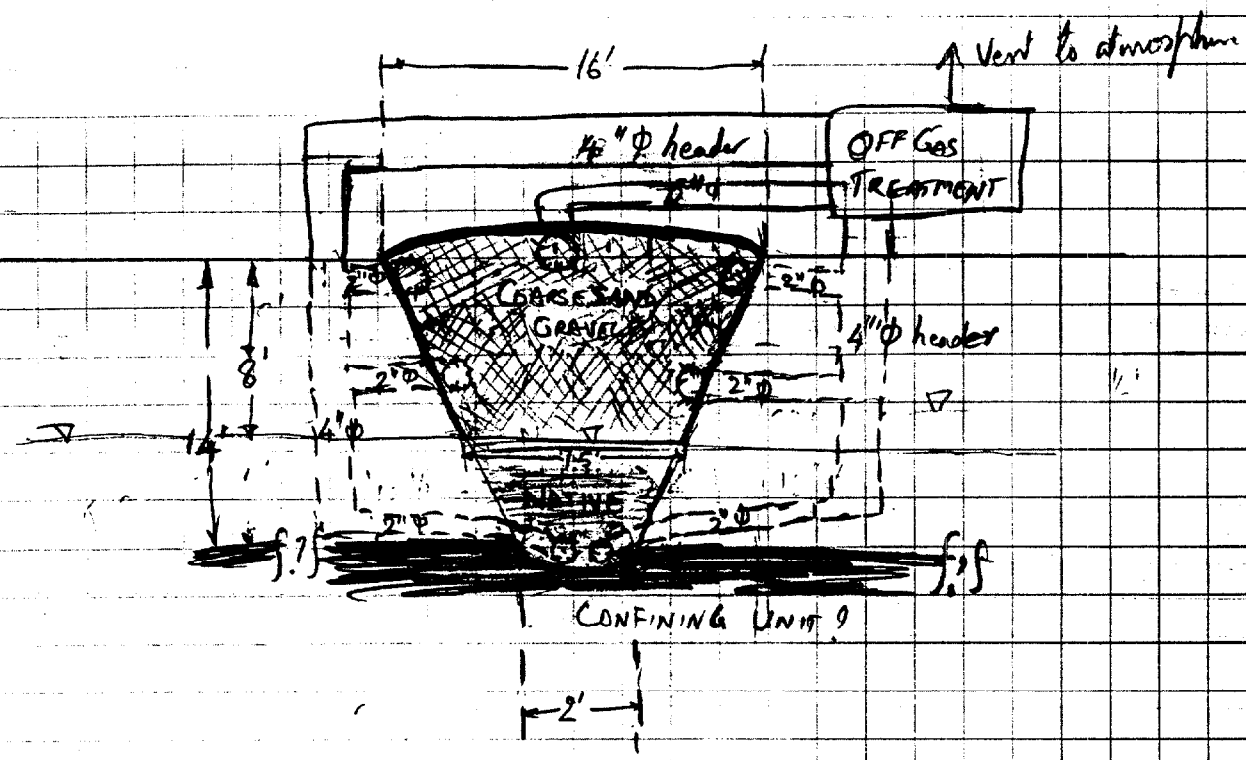
2. Compressor & Vacuum blower maintenance

3. Treatment Building utilities.

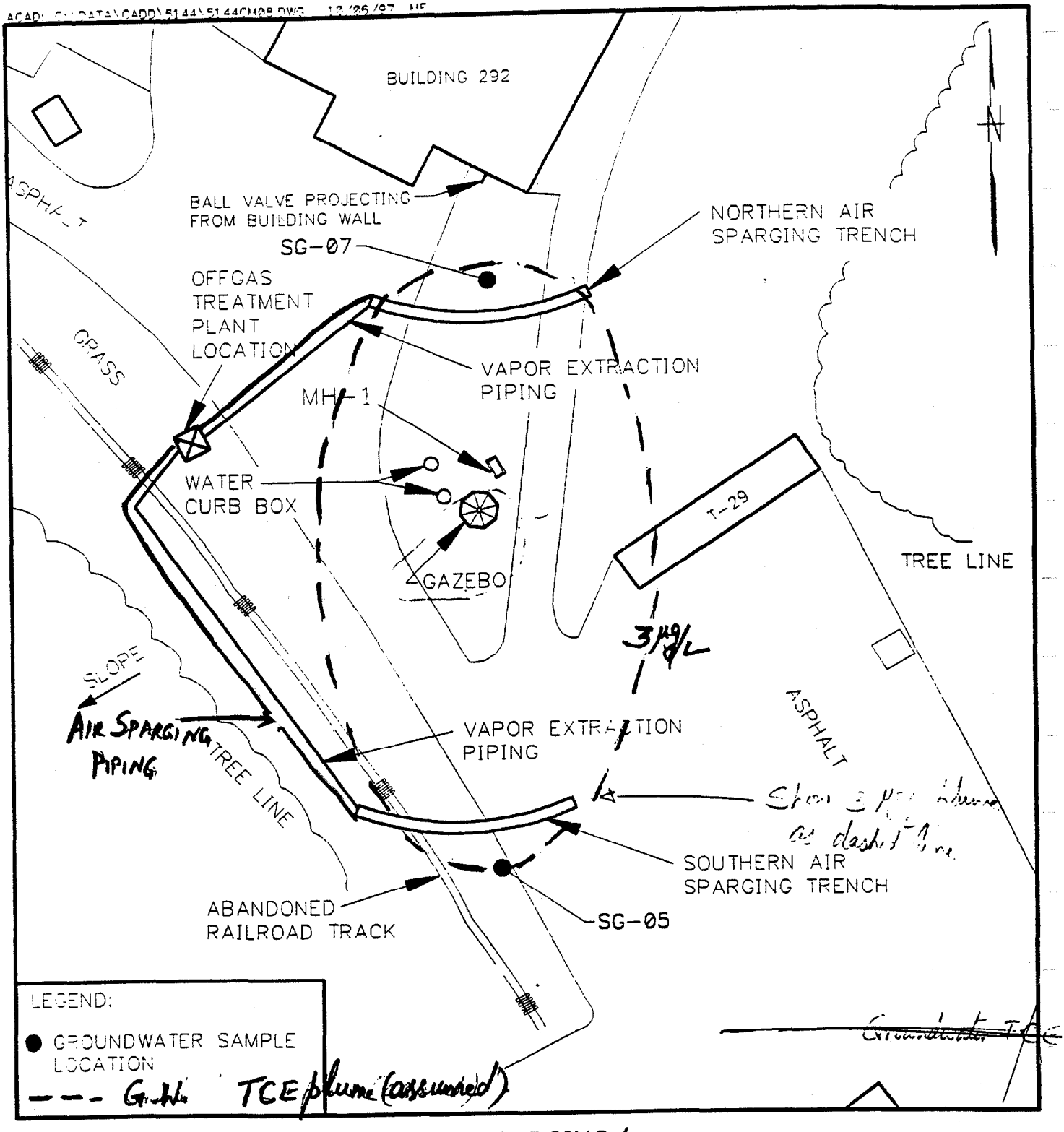
CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC, Indian Head	JOB NUMBER CTO 209/5144
SUBJECT IR Site 57 / EECA / Air Sparging: Conceptual Design Calcs (Alt 3)	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
			10/03/97



1. Excavate trench and stockpile for partial reuse as backfill
2. Place air sparging pipe lines & headers
3. place vapor extraction pipe lines & headers
4. Backfill with native material up to water table; then coarse sand/gravel to surface
5. Off gas treatment :



ALTERNATIVE 3: LAYOUT OF AIR SPARGING/ VAPOR EXTRACTION/OFF GAS TREATMENT SYSTEM BUILDING 292, FORMER DRUM LOADING AREA NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

0 40 80
SCALE IN FEET

FIGURE 6-3

Brown & Root Environmental

CLIENT NSWC, Indian Head	JOB NUMBER CT0209
SUBJECT IR Site 57/EECA/ Air Sparging: Conceptual design calcs.	
BASED ON	DRAWING NUMBER
BY JHP / CHECKED BY CJK	APPROVED BY / DATE 10/3/97

Total length of trenches: 2" x 60'/in = 120' (from Fig 6-3 attached)

Depth of each trench from surface to confining unit = 14' (based on Subsurface Investigation, B&R Environmental March 1996)

Width:

Assume slope = 1V : 2H

Assume minimum width @ bottom = 2' (minimum = 3x2"ϕ) + pipe bedding

Vertical depth = V = 14'

∴ H = 7'

∴ Width @ top = 2' + 7'x2

= 16'

(1) Volume for excavation = $120' \times \frac{[16' + 2']}{2} \times 14'$

= 15,120 ft³ = 560 cu yd

⇒ Volume of backfill ≈ 560 cu yd

Shoring: assume 14' V x [120' length] x 2

= 3360 ft²

Trench dewatering: Assume 30gpm inflow based on estimated flow through plume

Assume dewatering is required 4 hr/day x 4 days

⇒ 30gpm x 4hr/day x 60min/hr x 4days = 28,800 gal (≈30,000 gal)

CLIENT NSWC, Indian Head	JOB NUMBER C70 209
SUBJECT Ile site 57 / EECA / Air Sparging: Conceptual design calcs (ABS)	
BASED ON	DRAWING NUMBER
BY JP / CHECKED BY CF	APPROVED BY / DATE 10/3/97

2. Air sparging pipe lines:

$2 \times 120' = 240'$

Assume 2" ϕ perforated PVC @ 10' sections

Air sparging header:

Assume length required = Trench length × 2 + distance between trenches and treatment plant

$= 120' + 200'$

$= 320'$ (assume 4" ϕ)

Air Sparging Blower sizing:

Assume 2.0 scfm per section (total 24 sections) of sparging pipe line:

⇒ total airflowrate = 24×2 scfm

$= 48$ scfm

Minimum static head loss = 6" H_2O = 2.6 psi

∴ Friction loss = (48 scfm in 4" ϕ + @ 2.0 scfm in 2" ϕ)

(≈ minimal)

$= \frac{0.01''\ Hg}{100'\ pipe} \times \frac{13.6}{2.3} \times \frac{1}{12} = 5.0 \times 10^{-5}$ ft/ft

CLIENT NSWC, Indian Head	JOB NUMBER CTO 209
SUBJECT IR Site 57 / EECA / Air Sparging: Conceptual design calcs (AB3)	
BASED ON	DRAWING NUMBER
BY JP / CHECKED BY CJS	APPROVED BY / DATE 10/3/97

∴ Friction loss = 5.0×10^{-5} ft/ft × (240' + 320')

(= 0.03')

Additional friction loss in perforations say ≈ 1–2 psi

Blower size say: 50 scfm @ 5 psi say 20 H.P. (compressor)

(3) Vapor extraction pipe line:

5 × 120' = 600'

Assume 2" φ slotted PVC w/ 10' sections

Vapor extraction header

Trench length × 4 + distance between trenches and plant

= 240' + 200'

= 440'

Assume 4" φ header (PVC)

Vacuum pump sizing

Assume 1.5× air sparging flow rate to ensure capture

= 1.5 × 48 scfm

= 72 scfm

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NSWC, Indian Head	JOB NUMBER: CTO 209
SUBJECT: IR Site 57 / EECA / Air Sparging: Conceptual design calcs (Alt 3)	
BASED ON:	DRAWING NUMBER:
BY: JJP	CHECKED BY: CJF
APPROVED BY:	DATE: 10/3/97

Vacuum & pump sizing:

Headloss: minimal: 5×10^{-5} ft/ft (600' + 240')

(≈ 0.05 ft)

Additional loss in slots say ≈ 1 psi

Provide: 72 scfm @ 1 psi say 1.0 H.P.

4. Backfill: 870 cu yd. coarse sand / gravel + Vapor barrier

5. Off gas treatment. assume Catalytic oxidation (72 scfm)

Capital: ~~$25,000~~ vrel ERS (FALCO 100, Falmouth Products, May 20, 1997)

O&M: 1.6 KW @ 24 hr/day @ 365 day/yr

+ $1,500/3 yr for catalyst replacement

+ $2,800/3 yr for troubleshooting/inspection

Vapor barrier: Length of trenches × [width + 2 × side walls]

= 120' × [16' + 2 × 8']

= 3,840 ft² (Visqueen or appropriate)

ATTACHMENT A.7

Extraction Well/Aboveground Treatment System
Preliminary Conceptual Design Calculations

CLIENT NSWC, Indian Head	JOB NUMBER CTO 207 / 5144
SUBJECT IR Site 57 / EECA / Extraction & Above ground treatment : Cost input (Alt 4)	
BASED ON Conceptual design calcs	DRAWING NUMBER
BY J.P. Pradeep Kumar (JPK) CHECKED BY Yvonne M. Shipley (YMS)	APPROVED BY DATE 10/03/97

CAPITAL COST ITEMS

1. Extraction trenches – Northern & Southern trenches (60' x 14' deep each)
   – Excavate 560 cu yd as in Alt 3 (stockpile & partial reuse)
   – Offsite disposal of g.w. extracted during trench installation: 30,000 gal @ $230/drum
2. Extraction pipe 120' x 2" ϕ slotted PVC (2 sections)

   Sloped Towards sumps (2)

   2 Sumps: 100 gal each

   Transfer Pumps (2): Northern: 25 gpm @ 50' TDH : 0.5 H.P.
   Southern: 5 gpm @ 50' TDH : 0.5 H.P.

   Conveyance pipe : 200' x 2" ϕ P.E.

3. Backfill : ① Coarse sand / gravel : 127 cu yd
   ② Native material from excavation : 433 cu yd
   ③ Treat excess (127 cu yd) with soil alternatives

4. (a) Filtration / Air Stripping / Offgas Treatment
   – 2 bag filters
   – Tray-type air stripper : 4 trays (≈ $25,000 installed)
   – Catalytic oxidizer : 300 scfm (use ERS)
   – Discharge to local storm sewer by gravity

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC, Indian Head	JOB NUMBER CTO 209
SUBJECT IR Site 57/EECA/ Cost input (ALT 4)	
BASED ON	DRAWING NUMBER
BY JH / CHECKED BY LMS	APPROVED BY / DATE 10/03/97

4(b) Filtration / U.V. oxidation

- 2 bag filters
- 30 K.W. reactor w/ peroxide storage/feed module
- discharge by gravity

$100,000 (check EES)

O&M Cost Items

(a) Airstripping

- 300 scfm : 2.0 H.P. blower electrical
- 5.0 K.W. electrical for catalytic oxidizer (selected for this EECA)

  or

  7.0 lb/hr natural gas (may be revisited @ design)

- $ 4,500/3yr for catalyst replacement
- $ 2,800 → year 1

  + $ 2,800/3yr for troubleshooting / inspection

- Blower/pump maintenance

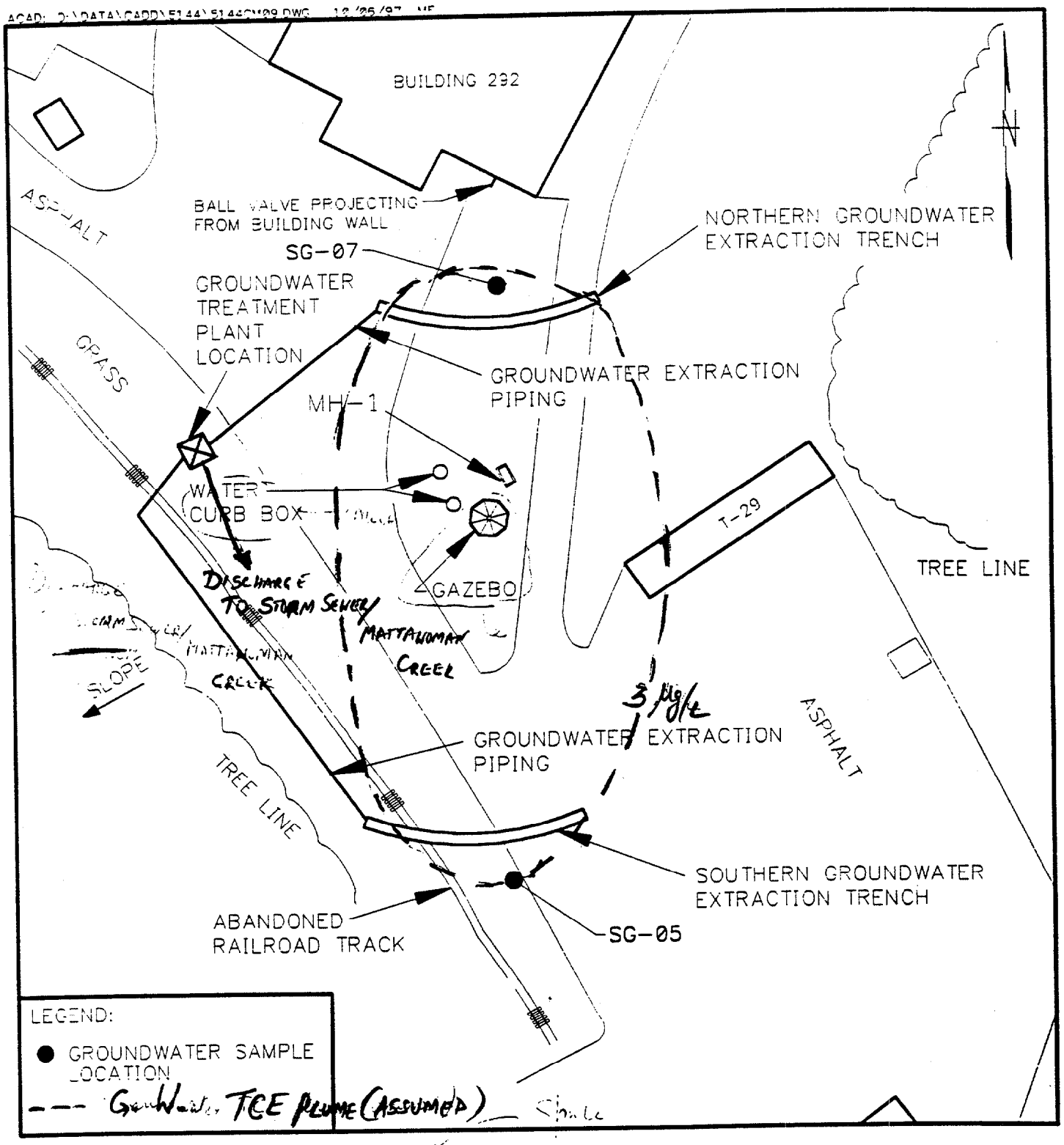
CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NSWC, Indian Head	JOB NUMBER: CTO 209
SUBJECT: IR Site 57/EECA / cost input (ALT 4)	
BASED ON	DRAWING NUMBER
BY: JP / CHECKED BY: GMS	APPROVED BY / DATE: 10/03/97

(b) U.V. Oxidation

- 30 K.W. electrical
- 11 lb/day @ $0.5/lb delivered as 100 gal tank ✓
  or @ ~~$0.7/lb delivered as 300 gal P.E.~~
- $2,500/lamp × 3 lamps/yr replacement

For both (a) and (b), building utilities.



ALTERNATIVE 4: LAYOUT OFGROUNDWATER EXTRACTION/TREATMENT/DISCHARGE SYSTEM BUILDING 292, FORMER DRUM LOADING AREA NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

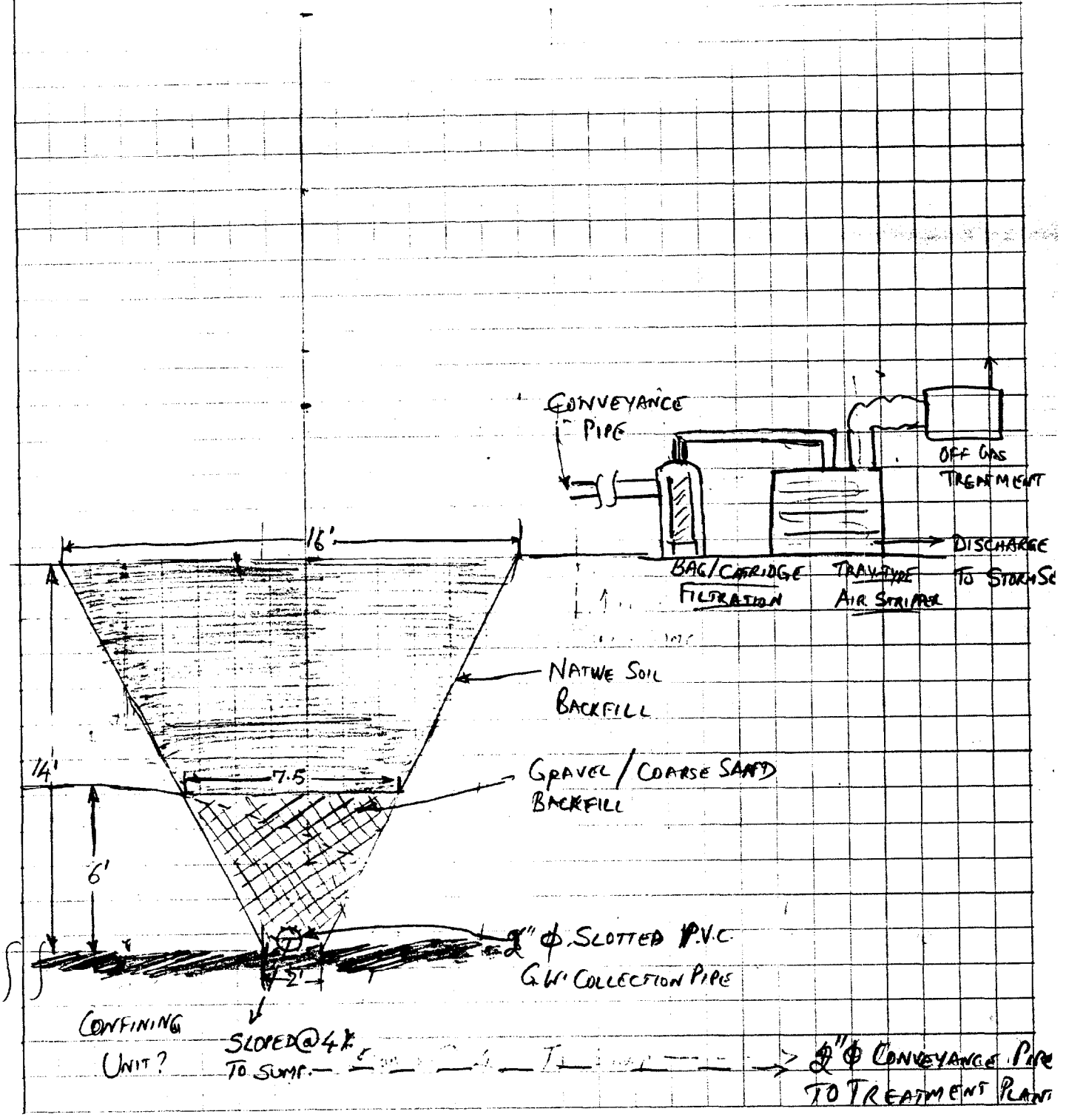
0 40 80
SCALE IN FEET

FIGURE 6-5

Brown & Root Environmental

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC Indian Head	JOB NUMBER CTO 209 / 5144
SUBJECT IR Site 57 / EECA / Extraction & Treatment Conceptual design Calcs (Alt 4)	
BASED ON	DRAWING NUMBER
BY JHP	CHECKED BY CK
APPROVED BY	DATE 10/03/97



CLIENT NSWC, Indian Head	JOB NUMBER CTO 209/5144
SUBJECT IR Site 57/EECA / Conceptual design calcs: Alt 4	
BASED ON	DRAWING NUMBER
BY JR / CHECKED BY CK	APPROVED BY / DATE 10/03/97

1. Excavate trench, stockpile partial volume for reuse as backfill, treat/discharge g.w.
2. Place extraction pipe lines, sump and conveyance pipes to treatment plant
3. Backfill with coarse sand/gravel up to water table elevation & native material to surface
4. (a) Filtration/Air stripping/Offgas Treatment

   (b) Filtration/U.V. Oxidation

FLOW RATE ESTIMATION:

Estimated flow rate through the plume width defined by 3 µg/L Contour ≈ 24 gpm

Assume two gw extraction trenches: (1) northern (for source area)
(2) southern (for plume control)

Assume a total flow rate of 30 gpm from the two trenches because the southern trench may have 25% excess from sidegradient flows.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC, Indian Head	JOB NUMBER CTO 209/5144
SUBJECT IR Site 57/EECA/ conceptual design calcs (Alt4)	
BASED ON	DRAWING NUMBER
BY AJP / CHECKED BY CJF	APPROVED BY / DATE 10/03/97

1. Trench installation

Total length of trenches : 2" × 60' = 120' (from Fig 6-5) attached

Depth of each trench from surface to assumed confining unit = 14'

Width :

Assume slope = 1V : 2H

Assume width @ bottom : 2' (min. = 2"ϕ + bedding)

Vertical depth : V = 14'

∴ H = 7'

∴ Width @ top = 2' + 7' × 2

= 16'

Volume for excavation = 560 cuyd (as calculated under Alt3)

Trench dewatering W.W disposal ~~as~~ = 30,000 gal (drummed haz) as in Alt3

2. Extraction pipe :

Length : 120' × 2" ϕ slotted PVC

Sloped towards sumps (2) : Say 100 gal each

Provide transfer pumps (2) : 25 gpm @ 50' TDH (northern)

5 gpm @ 50' TDH (southern)

Conveyance pipe : 180' × 2" ϕ P.E.

CLIENT NSWC Indian Head	JOB NUMBER CTO 209 / 5144
SUBJECT IR Site 57 / EECA / Extraction & Treatment conceptual design calcs (Alt 4)	
BASED ON	DRAWING NUMBER
BY JFP / CHECKED BY CJS	APPROVED BY / DATE 10/03/97

3. Backfill:

(1) Backfill with coarse sand/ gravel from confining unit to water table.

(2) Backfill from water table depth to surface with native material

Coarse sand/ gravel Volume

Average width × length of trenches × height

$= \left(\frac{7.5' + 2'}{2}\right) \times 120' \times 6'$

$= 3{,}420\ ft^3$ (= 127 cu yd)

Native material volume

Remainder from excavation (see Alt 3 calculation pg —)

= 560 cu yd − 124 cu yd

= 433 cu yd

Excess : 127 cu yd of contaminated soil for treatment with soil alternatives

CLIENT NSWC, Indian Head	JOB NUMBER CTO 209/5144
SUBJECT IR Site 57/ EECA / Conceptual design calcs (Alt 4)	
BASED ON	DRAWING NUMBER
BY JFF / CHECKED BY	APPROVED BY / DATE 10/03/97

4 (a) Filtration / Air Stripping / Offgas Treatment

Provide: 2x bag filters

Provide: Tray-Type air stripper w/ design flowrate: 30 gpm

(b) [4-trays are adequate – see attached Shallow Tray™ simulation print out – pg 6, 7/9

Provide: Catalytic oxidizer w/ design flowrate: 300 scfm ~~(≈ $45,000)~~

(b) Filtration / U.V. oxidation

Provide: 2x bag filters

Provide: 30 KW reactor w/ peroxide storage/feed module. (Minimum requirement = 20 KW – see attached calculations pg 8, 9/9)

ShallowTray
low profile air strippers

SAMPLE TRAY TYPE AIR STRIPPER PERFORMANCE

System Performance Estimate

Client and Proposal Information:
IR Site 57
NSWC, Indian Head, MD

Model Chosen:	2300
Water Flow Rate:	30.0 gpm
Air Flow Rate:	300 cfm
Water Temp:	50.0 F
Air Temp:	50.0 F
A/W Ratio:	74.8
Safety Factor:	None

Contaminant	Untreated Influent Effluent Target	Model 2311 Effluent Water Air(lbs/hr) % removal	Model 2321 Effluent Water Air(lbs/hr) % removal	Model 2331 Effluent Water Air(lbs/hr) % removal	Model 2341 Effluent Water Air(lbs/hr) % removal
Trichloroethylene	**10000 ppb** 100 ppb	**1278 ppb** 0.130888 87.2232%	**164 ppb** 0.147605 98.3675%	**21 ppb** 0.149751 99.7914%	**3 ppb** 0.150021 99.9734%

MODEL ACHIEVES 100 µg/L LIMIT

This report has been generated by ShallowTray Modeler software version 2.1W. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. North East Environmental Products, Inc. is not responsible for incidental or consequential damages resulting from the improper operation of either the software or the air stripping equipment.
Report generated: 10/7/1997

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SAMPLE TRAY-TYPE AIR STRIPPER

ShallowTray®
low profile air strippers

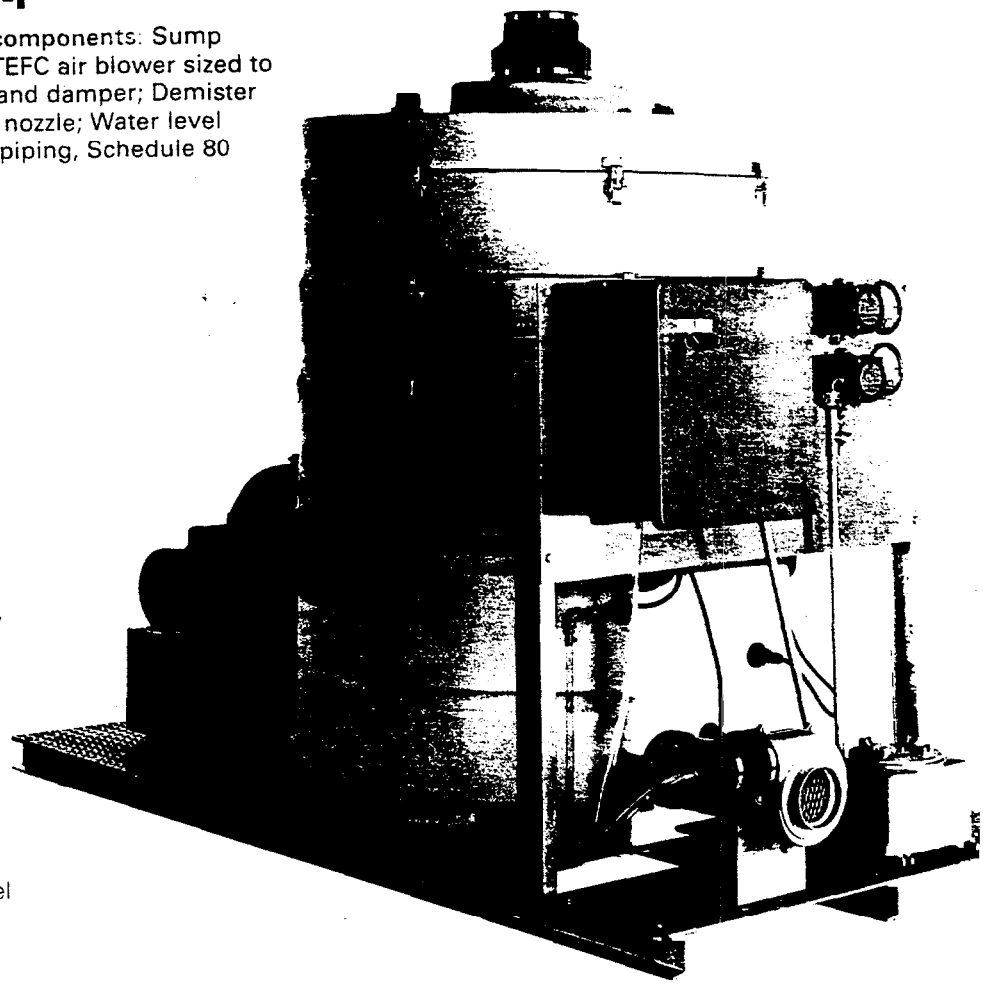
2300-P Series

Model Pictured: 2331-P

Basic system includes the following components: Sump tank, cover, and trays, Polyethylene; TEFC air blower sized to number of trays; Blower inlet screen and damper; Demister pad, stainless steel; Water inlet spray nozzle; Water level sight tube; Gaskets; Latches; Internal piping, Schedule 80 PVC.

Options chosen for model pictured:

- ☑ Air pressure gauge
- ☐ Gravity discharge
- ☑ Steel frame
- ☑ EXP blower motors
- ☐ Discharge and/or feed pump, TEFC or EXP
- ☐ Blower start/stop panel only
- ☐ Main disconnect switch
- ☐ Standard NEMA 3R system control panel with alarm interlocks, motor starter, relays, alarm light, UL listed
- ☐ NEMA 3R control panel with level controls for pumps, alarm interlocks, motor starters, relays, alarm light, UL listed
- ☑ PurgePanel™: NEMA 4X enclosure, small blower, pressure switch, and a small explosion-proof enclosure (NEMA 7)
- ☐ Control panel IS components for remote mounted NEMA 3R panel, UL listed
- ☐ NEMA 7 and/or custom control panel
- ☐ Strobe alarm light
- ☐ Alarm horn
- ☑ Low air pressure alarm switch
- ☑ High water level alarm switch
- ☑ Discharge pump level switch
- ☐ Water pressure gauges
- ☐ Digital water flow indicator and totalizer
- ☐ Air flow meter
- ☐ Temperature gauges
- ☐ Line sampling ports
- ☐ Air blower silencer
- ☐ Auto dialer
- ☐ Automatic operation components for multiple wells
- ☐ Other custom requirements (Please call)



The full range of options are available to meet your project's specifications.

Models	flow rate	# trays	width	length	height	min cf
2311-P	1-50gpm	1	5'2"	3'7"	4'2"	300
	0.2-11.4m³/hr		1.6m	1.1m	1.2m	509.6m³
2321-P	1-50gpm	2	5'2"	3'7"	4'11"	300
	0.2-11.4m³/hr		1.6m	1.1m	1.5m	509.6m³
2331-P	1-50gpm	3	5'2"	3'7"	5'8"	300
	0.2-11.4m³/hr		1.6m	1.1m	1.7m	509.6m³
2341-P	1-50gpm	4	5'2"	3'7"	6'5"	300
	0.2-11.4m³/hr		1.6m	1.1m	2m	509.6m³

Client:
NSWC, Indian Head, MD
Subject:
U.V.OX Calcs.
By:
J.P.Pradeep Kumar

CTO 209

Checked by:

10/03/97

ENHANCED OXIDATION (Reactor Sizing and O&M Requirements)

Assume ultraviolet radiation enhanced oxidation using hydrogen peroxide
Reaction is expected to be pseudo-first order between VOC conc.&. UV dosage
=>log (VOC conc) is linearly proportional to UV energy dosage
(1) For each contaminant obtain electrical energy/order of conc reduction from literature
(Pollution Engineering, Oct 1993, Solarchem brochure, 1994)
(2) Determine U.V. Dosage for each contaminant of concern as follows:
U.V. Dosage (kwh/1000 gal)= EE/O x log (influent conc/design effluent conc)

Where:
(1) EE/O = Electrical energy/Order of conc reduction (kwh/1000 gal/order)
(2) log (influent conc/design effluent conc)= order of concentration reduction

(3) Determine UV reactor power requirement as follows:
UV power required= U.V. Dosage(max) x 60 min/hr x flow rate/1000

Where:
(1)U.V. Dosage(max)= highest dosage of all determined previously (kwh/1000 gal)

(2) flow rate= design flow rate of groundwater= 30.00 gpm

(4) Determine appropriate reactor power based on UV power required
for the most recalcitrant contaminant (i.e. contaminant requiring highest dosage)
UV Dosage for each contaminant= EE/o x log(inf/eff)

Paramete	Design Inf (ug/L)	Design Eff Conc (ug/L)	EE/o (kwh/ 1000gal/or)	log(inf/eff	UV Dosage (kwh/1000gal)
TCE	10000.00	100.00	5.00	2.0	10.0
1,2-DCE	1400.00	70.00	5.00	1.3	6.5
Vinyl Cl	54.00	2.00	5.00	1.4	7.2
1,1,1TCA	(7)	NA	NA	NA	NA
1,1-DCE	(4)	NA	NA	NA	NA
1,2-DCA	(ND)	NA	NA	NA	NA
1,1-DCA	(2)	NA	NA	NA	NA

Note: Design influent concentration in parentheses indicates parameter is not a COC
NA= Not applicable because parameter is not a COC

CTO 209

Client:
NSWC, Indian Head, MD

Subject:
U.V.OX Calcs.

By:
J.P.Pradeep Kumar

Checked by: 10/03/97

	Highest U.V. dosage is required for TCE=				10.00	kwh/1000 gal			
	Therefore, UV power required= highest UV dosage x 60 min/hr x flow rate gpm/1000								
			=	18.00	kw				
				(Say 20 k.w reactor is minimum required)					
	Hydrogen peroxide requirement:								
	Estimate at higher of approximately 25 mg/L or 2xCOD (Solarchem brochure, 1994)								
	COD information is not available								
	Therefore, peroxide requirement=			25.00	mg/L @	30.00	gpm		
			=	9.00	lb/day of 100% H2O2				
			=	1.8	gpd of 50% hydrogen peroxide; sp gr=1.2)				
	Obtain as 50% solution and store/feed from hydrogen peroxide module provided with system								

APPENDIX B

COST ESTIMATES

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Soil Excavation, Thermal Desorption and Soil Replacement
Alternative No. 3A

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	4	mo	$500.00				$2,000	$0	$0	$0	$2,000	
1.2 Storage Trailer (1)	4	mo	$500.00				$2,000	$0	$0	$0	$2,000	
1.3 Construction Survey	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	4	ea			$75.00	$225.00	$0	$0	$300	$900	$1,200	
1.6 Site Utilities	4	mo	$4,000.00				$16,000	$0	$0	$0	$16,000	
1.7 Erosion & Sediment Control (silt fence)	1000	lf		$0.43	$0.20		$0	$430	$200	$0	$630	
1.8 Security Fence	800	lf		$2.15	$3.24		$0	$1,720	$2,592	$0	$4,312	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	4	mo	$1,500.00				$6,000	$0	$0	$0	$6,000	
2.2 Laundry Service	16	wks	$250.00				$4,000	$0	$0	$0	$4,000	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	4	mo	$1,200.00				$4,800	$0	$0	$0	$4,800	
2.5 Decon Water	26400	gal	$0.20				$5,280	$0	$0	$0	$5,280	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (6 trips @ 300 miles)	1800	mi	$4.00				$7,200	$0	$0	$0	$7,200	
2.9 Off-site Disposal of Decon Water	26400	gal	$2.13				$56,232	$0	$0	$0	$56,232	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 SITE PREPARATION												
3.1 Trailer Removal	1	ls			$400.00	$100.00	$0	$0	$400	$100	$500	
3.2 Pavement Removal, 4" to 6" thick	1704	sy			$2.20	$2.98	$0	$0	$3,749	$5,078	$8,827	
3.3 Pavement Disposal, up to 5 miles	284	cy			$2.24	$6.95	$0	$0	$636	$1,974	$2,610	
4 EXCAVATION/BACKFILL												
4.1 0' to 7' using 1 1/2 cy excavator	7261	cy			$0.99	$1.48	$0	$0	$7,159	$10,710	$17,869	Level C
4.2 7' to12' using 1 1/2 cy excavator	74	cy			$1.09	$1.65	$0	$0	$80	$122	$203	Level C
4.3 Shoring of Deep Excavation	1200	sf		$2.11	$2.56	$2.92	$0	$2,532	$3,072	$3,504	$9,108	
4.4 Spread Treated Backfill	7335	cy			$0.30	$0.85	$0	$0	$2,201	$6,235	$8,435	
4.5 Compaction with Sheepsfoot	7335	cy			$0.11	$0.21	$0	$0	$807	$1,540	$2,347	
5 TREATMENT & DISPOSAL												
5.1 Treatment/Stockpile Pad, 200' by 200' (install & remove)	1	ls		$25,000.00	$5,000.00	$5,000.00	$0	$25,000	$5,000	$5,000	$35,000	
5.1 Mobilization & Demobilization of Treatment Unit	1	ea	$304,725.00				$304,725	$0	$0	$0	$304,725	
5.2 Permitting/Engineering for Unit	1	ea	$36,566.00				$36,566	$0	$0	$0	$36,566	
5.3 16 cy Dump Truck with Driver	3	mo			$3,408.00	$4,147.00	$0	$0	$10,224	$12,441	$22,665	Haul from & to excavation
5.4 Front End Loader with Operator	3	mo			$3,734.00	$4,288.00	$0	$0	$11,202	$12,864	$24,066	Move soils around unit
5.5 On-site Thermal Desorption	10900	ton	$93.28				$1,016,752	$0	$0	$0	$1,016,752	55 working days to treat
6 RESTORATION												
6.1 Topsoil, 6" thick	235	cy	$16.01				$3,762	$0	$0	$0	$3,762	
6.2 Spread Topsoil	235	cy			$0.30	$0.85	$0	$0	$71	$200	$270	
6.3 Hydro-seed, fertilize, mulch	13	msf	$33.20				$432	$0	$0	$0	$432	
6.4 Pavement Base Course, 1 1/2" stone, 6" thick	1704	sy		$5.45	$0.24	$0.29	$0	$9,287	$409	$494	$10,190	
6.5 Pavement Binder Course, 4" thick	1704	sy	$6.13				$10,446	$0	$0	$0	$10,446	
6.6 Pavement Wear Course, 2" thick	1704	sy	$3.77				$6,424	$0	$0	$0	$6,424	
6.7 Trailer Replacement	1	ls			$400.00	$100.00	$0	$0	$400	$100	$500	
Subtotal							$1,490,033	$52,787	$55,820	$61,928	$1,660,568	
Overhead on Labor Cost @ 30%									$16,746		$16,746	
G & A on Labor Cost @ 10%									$5,582		$5,582	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Soil Excavation, Thermal Desorption and Soil Replacement
Alternative No. 3A

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
G & A on Material Cost @	10%							$5,279			$5,279	
G & A on Subcontract Cost @	10%						$149,003				$149,003	
Total Direct Cost							$1,639,036	$58,066	$78,148	$61,928	$1,837,178	
Indirects on Total Direct Labor Cost @	75%								$58,611		$58,611	
Profit on Total Direct Cost @	10%										$183,718	
Subtotal											$2,079,507	
Health & Safety Monitoring @	10%										$207,951	
Total Field Cost											$2,287,458	
Contingency on Total Field Cost @	20%										$457,492	
Engineering on Total Field Cost @	10%										$228,746	
TOTAL COST											**$2,973,695**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Hot Spot Soil Excavation, Thermal Desorption and Soil Replacement
Alternative No. 3B

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.2 Storage Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.3 Construction Survey	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	3	ea			$75.00	$225.00	$0	$0	$225	$675	$900	
1.6 Site Utilities	2	mo	$4,000.00				$8,000	$0	$0	$0	$8,000	
1.7 Erosion & Sediment Control (silt fence)	100	lf		$0.43	$0.20		$0	$43	$20	$0	$63	
1.8 Security Fence	100	lf		$2.15	$3.24		$0	$215	$324	$0	$539	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	2	mo	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.2 Laundry Service	6	wks	$250.00				$1,500	$0	$0	$0	$1,500	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	2	mo	$1,200.00				$2,400	$0	$0	$0	$2,400	
2.5 Decon Water	5000	gal	$0.20				$1,000	$0	$0	$0	$1,000	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (1 trips @ 300 miles)	300	mi	$4.00				$1,200	$0	$0	$0	$1,200	
2.9 Off-site Disposal of Decon Water	5000	gal	$2.13				$10,650	$0	$0	$0	$10,650	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 EXCAVATION/BACKFILL												
3.1 0' to 7' using 1 1/2 cy excavator	549	cy			$0.99	$1.48	$0	$0	$541	$810	$1,351	Level C
3.2 7' to12' using 1 1/2 cy excavator	74	cy			$1.09	$1.65	$0	$0	$80	$122	$203	Level C
3.3 Shoring of Excavation	1200	sf		$2.11	$2.56	$2.92	$0	$2,532	$3,072	$3,504	$9,108	
3.4 Spread Treated Backfill	163	cy			$0.30	$0.85	$0	$0	$49	$139	$187	
3.5 Compaction with Sheepsfoot	163	cy			$0.11	$0.21	$0	$0	$18	$34	$52	
3.6 Offsite Disposal of Excess Treated Soil	460	cy	$25.00				$11,500	$0	$0	$0	$11,500	isposal at a sanitary landfill
4 TREATMENT & DISPOSAL												
4.1 Treatment/Stockpile Pad, 100' by 100' (install & remove	1	ls		$6,250.00	$1,250.00	$1,250.00	$0	$6,250	$1,250	$1,250	$8,750	
4.2 Mobilization & Demobilization of Treatment Unit	1	ea	$304,725.00				$304,725	$0	$0	$0	$304,725	
4.3 Permitting/Engineering for Unit	1	ea	$36,566.00				$36,566	$0	$0	$0	$36,566	
4.4 16 cy Dump Truck with Driver	1	mo			$3,408.00	$4,147.00	$0	$0	$3,408	$4,147	$7,555	Haul from & to excavation
4.5 Front End Loader with Operator	1	mo			$3,734.00	$4,288.00	$0	$0	$3,734	$4,288	$8,022	Move soils around unit
4.6 On-site Thermal Desorption	925	ton	$93.28				$86,284	$0	$0	$0	$86,284	7 working days to treat
5 RESTORATION												
5.1 Pavement Base Course, 1 1/2" stone, 6" thick	1408	sy		$5.45	$0.24	$0.29	$0	$7,674	$338	$408	$8,420	
5.2 Pavement Binder Course, 4" thick	1408	sy	$6.13				$8,631	$0	$0	$0	$8,631	
5.3 Pavement Wear Course, 2" thick	1408	sy	$3.77				$5,308	$0	$0	$0	$5,308	
Subtotal							$487,178	$30,532	$20,378	$16,043	$554,131	
Overhead on Labor Cost @ 30%									$6,113		$6,113	
G & A on Labor Cost @ 10%									$2,038		$2,038	
G & A on Material Cost @ 10%								$3,053			$3,053	
G & A on Subcontract Cost @ 10%							$48,718				$48,718	
Total Direct Cost							$535,896	$33,585	$28,530	$16,043	$614,054	
Indirects on Total Direct Labor Cost @ 75%									$21,397		$21,397	
Profit on Total Direct Cost @ 10%											$61,405	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Hot Spot Soil Excavation, Thermal Desorption and Soil Replacement
Alternative No. 3B

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
Subtotal											$696,856	
Health & Safety Monitoring @ 10%											$69,686	
Total Field Cost											$766,542	
Contingency on Total Field Cost @ 20%											$153,308	
Engineering on Total Field Cost @ 10%											$76,654	
TOTAL COST											**$996,504**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Soil Excavation and Incineration
Alternative No. 4A

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	4	mo	$500.00				$2,000	$0	$0	$0	$2,000	
1.2 Storage Trailer (1)	4	mo	$500.00				$2,000	$0	$0	$0	$2,000	
1.3 Construction Survey	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	4	ea			$75.00	$225.00	$0	$0	$300	$900	$1,200	
1.6 Site Utilities	4	mo	$4,000.00				$16,000	$0	$0	$0	$16,000	
1.7 Erosion & Sediment Control (silt fence)	1000	lf		$0.43	$0.20		$0	$430	$200	$0	$630	
1.8 Security Fence	800	lf		$2.15	$3.24		$0	$1,720	$2,592	$0	$4,312	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	4	mo	$1,500.00				$6,000	$0	$0	$0	$6,000	
2.2 Laundry Service	16	wks	$250.00				$4,000	$0	$0	$0	$4,000	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	4	mo	$1,200.00				$4,800	$0	$0	$0	$4,800	
2.5 Decon Water	26400	gal	$0.20				$5,280	$0	$0	$0	$5,280	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (6 trips @ 300 miles)	1800	mi	$4.00				$7,200	$0	$0	$0	$7,200	
2.9 Off-site Disposal of Decon Water	26400	gal	$2.13				$56,232	$0	$0	$0	$56,232	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 SITE PREPARATION												
3.1 Trailer Removal	1	ls			$400.00	$100.00	$0	$0	$400	$100	$500	
3.2 Pavement Removal, 4" to 6" thick	1704	sy			$2.20	$2.98	$0	$0	$3,749	$5,078	$8,827	
3.3 Pavement Disposal, up to 5 miles	284	cy			$2.24	$6.95	$0	$0	$636	$1,974	$2,610	
4 EXCAVATION/BACKFILL												
4.1 0' to 7' using 1 1/2 cy excavator	7261	cy			$0.99	$1.48	$0	$0	$7,159	$10,710	$17,869	Level C
4.2 7' to12' using 1 1/2 cy excavator	74	cy			$1.09	$1.65	$0	$0	$80	$122	$203	Level C
4.3 Shoring of Deep Excavation	1200	sf		$2.11	$2.56	$2.92	$0	$2,532	$3,072	$3,504	$9,108	
4.4 Common Backfill	6815	cy	$5.20				$35,438	$0	$0	$0	$35,438	
4.5 Haul Fill to Center (10 mile R/T)	6815	cy	$5.13				$34,961	$0	$0	$0	$34,961	
4.6 Spread Backfill	6815	cy			$0.30	$0.85	$0	$0	$2,045	$5,793	$7,837	
4.7 Compaction with Sheepsfoot	6815	cy			$0.11	$0.21	$0	$0	$750	$1,431	$2,181	
5 INCINERATION & DISPOSAL												
5.1 Waste Profile	2	ea	$914.00				$1,828	$0	$0	$0	$1,828	
5.2 Haul Waste (370 trips @ 600 miles one way)	220,050	mi	$4.00				$880,200	$0	$0	$0	$880,200	20 cy per truck
5.3 Off-site Incineration	7335	cy	$1,462.00				$10,723,770	$0	$0	$0	$10,723,770	
6 RESTORATION												
6.1 Topsoil, 6" thick	235	cy	$16.01				$3,762	$0	$0	$0	$3,762	
6.2 Spread Topsoil	235	cy			$0.30	$0.85	$0	$0	$71	$200	$270	
6.3 Hydro-seed, fertilize, mulch	13	msf	$33.20				$432	$0	$0	$0	$432	
6.4 Pavement Base Course, 1 1/2" stone, 6" thick	1704	sy		$5.45	$0.24	$0.29	$0	$9,287	$409	$494	$10,190	
6.5 Pavement Binder Course, 4" thick	1704	sy	$6.13				$10,446	$0	$0	$0	$10,446	
6.6 Pavement Wear Course, 2" thick	1704	sy	$3.77				$6,424	$0	$0	$0	$6,424	
6.7 Trailer Replacement	1	ls			$400.00	$100.00	$0	$0	$400	$100	$500	
Subtotal							$11,808,187	$27,787	$29,181	$31,072	$11,896,226	
Overhead on Labor Cost @ 30%									$8,754		$8,754	
G & A on Labor Cost @ 10%									$2,918		$2,918	
G & A on Material Cost @ 10%								$2,779			$2,779	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Soil Excavation and Incineration
Alternative No. 4A

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
G & A on Subcontract Cost @	10%						$1,180,819				$1,180,819	
Total Direct Cost							$12,989,005	$30,566	$40,854	$31,072	$13,091,496	
Indirects on Total Direct Labor Cost @	75%								$30,640		$30,640	
Profit on Total Direct Cost @	10%										$1,309,150	
Subtotal											$14,431,286	
Health & Safety Monitoring @	10%										$1,443,129	
Total Field Cost											$15,874,415	
Contingency on Total Field Cost @	20%										$3,174,883	
Engineering on Total Field Cost @	10%										$1,587,441	
TOTAL COST											**$20,636,739**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Hot Spot Soil Excavation and Incineration
Alternative No. 4B

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.2 Storage Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.3 Construction Survey	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	3	ea			$75.00	$225.00	$0	$0	$225	$675	$900	
1.6 Site Utilities	2	mo	$4,000.00				$8,000	$0	$0	$0	$8,000	
1.7 *Erosion & Sediment Control (silt fence)*	1000	lf		$0.43	$0.20		$0	$430	$200	$0	$630	
1.8 Security Fence	800	lf		$2.15	$3.24		$0	$1,720	$2,592	$0	$4,312	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	2	mo	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.2 Laundry Service	6	wks	$250.00				$1,500	$0	$0	$0	$1,500	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	2	mo	$1,200.00				$2,400	$0	$0	$0	$2,400	
2.5 Decon Water	5000	gal	$0.20				$1,000	$0	$0	$0	$1,000	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (1 trips @ 300 miles)	300	mi	$4.00				$1,200	$0	$0	$0	$1,200	
2.9 Off-site Disposal of Decon Water	5000	gal	$2.13				$10,650	$0	$0	$0	$10,650	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 EXCAVATION/BACKFILL												
3.1 0' to 7' using 1 1/2 cy excavator	549	cy			$0.99	$1.48	$0	$0	$541	$810	$1,351	Level C
3.2 7' to 12' using 1 1/2 cy excavator	74	cy			$1.09	$1.65	$0	$0	$80	$122	$203	Level C
3.3 Shoring of Excavation	1200	sf		$2.11	$2.56	$2.92	$0	$2,532	$3,072	$3,504	$9,108	
3.4 Common Backfill	163	cy	$5.20				$848	$0	$0	$0	$848	
3.5 Haul Fill to Center (10 mile R/T)	163	cy	$5.13				$836	$0	$0	$0	$836	
3.6 Spread Backfill	163	cy			$0.30	$0.85	$0	$0	$49	$139	$187	
3.7 Compaction with Sheepsfoot	163	cy			$0.11	$0.21	$0	$0	$18	$34	$52	
4 INCINERATION & DISPOSAL												
4.1 Waste Profile	1	ea	$914.00				$914	$0	$0	$0	$914	
4.2 Haul Waste (32 trips @ 600 miles one way)	19200	mi	$4.00				$76,800	$0	$0	$0	$76,800	20 cy per truck
4.3 *Off-site Incineration*	623	cy	$1,462.00				$910,826	$0	$0	$0	$910,826	
5 RESTORATION												
5.1 Pavement Base Course, 1 1/2" stone, 6" thick	1408	sy		$5.45	$0.24	$0.29	$0	$7,674	$338	$408	$8,420	
5.2 Pavement Binder Course, 4" thick	1408	sy	$6.13				$8,631	$0	$0	$0	$8,631	
5.3 Pavement Wear Course, 2" thick	1408	sy	$3.77				$5,308	$0	$0	$0	$5,308	
Subtotal							$1,041,327	$26,174	$14,434	$6,358	$1,088,293	
Overhead on Labor Cost @ 30%									$4,330		$4,330	
G & A on Labor Cost @ 10%									$1,443		$1,443	
G & A on Material Cost @ 10%								$2,617			$2,617	
G & A on Subcontract Cost @ 10%							$104,133				$104,133	
Total Direct Cost							$1,145,460	$28,791	$20,208	$6,358	$1,200,817	
Indirects on Total Direct Labor Cost @ 75%									$15,156		$15,156	
Profit on Total Direct Cost @ 10%											$120,082	
Subtotal											$1,336,055	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Hot Spot Soil Excavation and Incineration
Alternative No. 4B

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
Health & Safety Monitoring @	10%										$133,605	
Total Field Cost											$1,469,660	
Contingency on Total Field Cost @	20%										$293,932	
Engineering on Total Field Cost @	10%										$146,966	
TOTAL COST											**$1,910,558**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Storm Sewer Rehabilitation
Alternative No. 2

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	1	mo	$500.00				$500	$0	$0	$0	$500	
1.2 Storage Trailer (1)	1	mo	$500.00				$500	$0	$0	$0	$500	
1.3 Temporary Decon Facilities	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000	
1.4 Construction Survey	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000	
1.5 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.6 Equipment Mobilization/Demobilization	1	ea			$75.00	$225.00	$0	$0	$75	$225	$300	
1.7 Site Utilities	1	mo	$4,000.00				$4,000	$0	$0	$0	$4,000	
1.8 Erosion & Sediment Control (silt fence)	100	lf		$0.43	$0.20		$0	$43	$20	$0	$63	
1.9 Security Fence	250	lf		$2.15	$3.24		$0	$538	$810	$0	$1,348	
2 SEWER SYSTEM REHABILITATION												
2.1 Inspect System w/ TV Camera	1	ea	$400.00				$400	$0	$0	$0	$400	
2.2 24" VC - Repair (Slipline)	430	lf	$150.00				$64,500	$0	$0	$0	$64,500	
2.3 Excavate 15" CMP and 2 - 12" VC	173	cy			$0.99	$1.48	$0	$0	$171	$255	$426	- 10' burial depth; Level C
2.4 Import Bedding	34.5	cy	$13.50				$466	$0	$0	$0	$466	
2.5 Install Bedding	34.5	cy			$3.53	$1.44	$0	$0	$122	$50	$171	
2.6 Install 15" HDPE	70	lf		$18.93	$3.54	$0.51	$0	$1,325	$248	$36	$1,609	
2.7 Install 12" HDPE	170	lf		$12.02	$2.24	$0.33	$0	$2,044	$382	$56	$2,481	
2.8 Common Backfill	130.3	cy	$5.20				$678	$0	$0	$0	$678	
2.9 Haul Fill to Center (10 mile R/T)	130.3	cy	$5.13				$668	$0	$0	$0	$668	
2.10 Backfill Trench	130.3	cy			$0.49	$0.71	$0	$0	$64	$93	$156	
2.11 Replace MH-1 (12' deep, 48", pre-cast concrete)	1	ea		$1,950.00	$2,025.00		$0	$1,950	$2,025	$0	$3,975	
2.12 Install MH-1A (8' deep, 48", pre-cast concrete)	1	ea		$1,350.00	$1,325.00		$0	$1,350	$1,325	$0	$2,675	
3 DISPOSAL OF CONTAMINATED MATERIAL EXCAVATED FOR PIPELINE REPLACEMENT												
3.1 Waste Profile	1	ea	$914.00				$914	$0	$0	$0	$914	
3.2 Haul Waste (9 trips @ 600 miles one way)	5,400	mi	$4.00				$21,600	$0	$0	$0	$21,600	20 cy per truck
3.3 Off-site Incineration	173	cy	$1,462.00				$252,926	$0	$0	$0	$252,926	
4 RESTORATION												
4.1 Topsoil, 6" thick	45	cy	$16.01				$720	$0	$0	$0	$720	
4.2 Spread Topsoil	45	cy			$0.30	$0.85	$0	$0	$14	$38	$52	
4.3 Re-seed disturbed areas by hand	2.4	msf		$7.35	$16.20	$6.05	$0	$18	$39	$15	$71	
Subtotal							$354,372	$7,267	$5,293	$767	$367,699	
Overhead on Labor Cost @ 30%									$1,588		$1,588	
G & A on Labor Cost @ 10%									$529		$529	
G & A on Material Cost @ 10%								$727			$727	
G & A on Subcontract Cost @ 10%							$35,437				$35,437	
Total Direct Cost							$389,809	$7,994	$7,410	$767	$405,980	
Indirects on Total Direct Labor Cost @ 75%									$5,557		$5,557	
Profit on Total Direct Cost @ 10%											$40,598	
Subtotal											$452,135	
Health & Safety Monitoring @ 15%											$67,820	
Total Field Cost											$519,956	
Contingency on Total Field Cost @ 20%											$103,991	
Engineering on Total Field Cost @ 3%											$15,599	
TOTAL COST											**$639,546**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Storm Sewer Rehabilitation
Alternative No. 2
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 thru 5	Notes
1 Sampling:			
Manhole	$5,000	$1,500	Sample Manhole monthly first 6 months & semi-annually years 2 thru 5.
2 Analysis:			
Manhole	$735	$210	1 sample for VOCs
3 Reporting:			
Manhole	$5,000		Additional $5,000 for a site review in years 5, 10, 15, 20 and 25.
TOTALS	$10,735	$1,710	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Storm Sewer Rehabilitation
Alternative No. 2
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 5%	Present Worth
0	$639,546		$639,546	1.000	$639,546
1		$10,735	$10,735	0.952	$10,220
2		$1,710	$1,710	0.907	$1,551
3		$1,710	$1,710	0.864	$1,477
4		$1,710	$1,710	0.823	$1,407
5		$6,710	$6,710	0.784	$5,261
6		$0	$0	0.746	$0
7		$0	$0	0.711	$0
8		$0	$0	0.677	$0
9		$0	$0	0.645	$0
10		$5,000	$5,000	0.614	$3,070
11		$0	$0	0.585	$0
12		$0	$0	0.557	$0
13		$0	$0	0.530	$0
14		$0	$0	0.505	$0
15		$5,000	$5,000	0.481	$2,405
16		$0	$0	0.458	$0
17		$0	$0	0.436	$0
18		$0	$0	0.416	$0
19		$0	$0	0.396	$0
20		$5,000	$5,000	0.377	$1,885
21		$0	$0	0.359	$0
22		$0	$0	0.342	$0
23		$0	$0	0.326	$0
24		$0	$0	0.310	$0
25		$5,000	$5,000	0.295	$1,475
				Total Present Worth	**$668,297**

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Air Sparging
Alternative No. 3

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.2 Storage Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.3 Construction Survey	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	3	ea			$75.00	$225.00	$0	$0	$225	$675	$900	
1.6 Site Utilities	1.5	mo	$4,000.00				$6,000	$0	$0	$0	$6,000	
1.7 Erosion & Sediment Control (silt fence)	200	lf		$0.43	$0.20		$0	$86	$40	$0	$126	
1.8 Security Fence	500	lf		$2.15	$3.24		$0	$1,075	$1,620	$0	$2,695	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	2	mo	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.2 Laundry Service	6	wks	$250.00				$1,500	$0	$0	$0	$1,500	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	1.5	mo	$1,200.00				$1,800	$0	$0	$0	$1,800	
2.5 Decon Water	2000	gal	$0.20				$400	$0	$0	$0	$400	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (1 trip @ 300 miles)	300	mi	$4.00				$1,200	$0	$0	$0	$1,200	
2.9 Off-site Disposal of Decon Water	2000	gal	$2.13				$4,260	$0	$0	$0	$4,260	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 SITE PREPARATION												
3.1 Pavement Removal, 4" to 6" thick	90	sy			$2.20	$2.98	$0	$0	$198	$268	$466	
3.2 Pavement Disposal, up to 5 miles	15	cy			$2.24	$6.95	$0	$0	$34	$104	$138	
4 AIR SPARGING/VAPOR EXTRACTION PIPELINES												
4.1 Excavate Trench (14' depth)	622	cy			$1.09	$1.65	$0	$0	$676	$1,026	$1,703	Level C
4.2 Excavate Trench for Header Pipes (2' depth)	30	cy			$1.50	$1.67	$0	$0	$45	$50	$95	
4.3 Excavate Sump for dewatering w/ 24" CMP Pipe	28	vf		$10.40	$19.21	$6.75	$0	$291	$538	$189	$1,018	Level C
4.4 Submersible Electric Pump - Rental	2	week			$100.00		$0	$0	$200	$0	$200	55 GPM
4.5 Trench Box	2	week			$475.00		$0	$0	$950	$0	$950	8' x 16'
4.6 Contaminated Groundwater Storage Tank	3	ea		$5,000.00	$400.00		$0	$15,000	$1,200	$0	$16,200	5000 Gallon
4.7 Haul Contaminated Groundwater (7 trips @ 300 miles)	2100	mi	$4.00				$8,400	$0	$0	$0	$8,400	
4.8 Off-site Disposal of Contaminated Groundwater	35000	gal	$2.13				$74,550	$0	$0	$0	$74,550	
4.9 Waste Profile Contaminated Groundwater	1	ea	$914.00				$914	$0	$0	$0	$914	
4.10 Install 2" Perf PVC (extraction/injection)	840	lf		$1.39	$2.21		$0	$1,168	$1,856	$0	$3,024	w/ silt sock
4.11 Install 2" PVC Tees	84	ea		$1.11	$21.06		$0	$93	$1,769	$0	$1,862	
4.12 Install 2" Solid PVC (transfer)	456	lf		$1.30	$2.21		$0	$593	$1,008	$0	$1,601	
4.13 Install 2x4 PVC Reducer	84	ea		$9.02			$0	$758	$0	$0	$758	
4.15 Install 4" PVC Tees	84	ea		$8.70	$38.38		$0	$731	$3,224	$0	$3,955	
4.14 Install 4" Solid PVC (header)	1008	lf		$1.68	$1.47		$0	$1,693	$1,482	$0	$3,175	
4.15 Install 4" PVC 90s	8	ea		$2.76	$29.00		$0	$22	$232	$0	$254	
4.16 Backfill Trench w/ Native Material	160	cy		$1.13	$1.03		$0	$181	$164	$0	$345	Level C
4.17 Install Vapor Barrier	3840	sf		$0.23	$0.01	$0.01	$0	$883	$38	$38	$960	20 mil PVC
4.18 Import Coarse Sand/Gravel	445	cy	$20.80				$9,256	$0	$0	$0	$9,256	
4.19 Backfill Trench w/ Coarse Sand/Gravel	445	cy		$0.47	$0.44		$0	$209	$196	$0	$405	
4.20 Import Pipe Bedding	7.6	cy	$20.80				$158	$0	$0	$0	$158	
4.21 Install Pipe Bedding (Header Pipes)	7.6	cy		$0.97	$0.46		$0	$7	$3	$0	$11	
4.22 Backfill Trench	22.4	cy		$17.45	$1.01		$0	$391	$23	$0	$414	by hand
5 GROUNDWATER TREATMENT SYSTEM												
5.1 Equipment Building	225	sf	$25.00				$5,625	$0	$0	$0	$5,625	
5.2 6" Concrete Foundation	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000	
5.3 Electrical Panel/Starters	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	6 - 10' burial depth
5.4 Electrical Power Supply	1	ls	$750.00				$750	$0	$0	$0	$750	
5.5 Air Sparging System	1	ls	$4,443.00				$4,443	$0	$0	$0	$4,443	2 hp Blower, 50 scfm @ 5 psi
5.6 Vapor Extraction System	1	ls	$5,395.00				$5,395	$0	$0	$0	$5,395	1 hp Blower, 72 scfm @ 1 psi

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Air Sparging
Alternative No. 3

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
5.7 Offgas Treatment System - Catalytic Oxidation	1	ls	$37,615.00				$37,615	$0	$0	$0	$37,615	100 scfm unit
5.8 Instrumentation	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	
5.9 Piping and Valves	1	ls		$8,000.00	$2,000.00		$0	$8,000	$2,000	$0	$10,000	
6 DISPOSAL OF CONTAMINATED MATERIAL EXCAVATED FOR TRENCHES												
6.1 Waste Profile	1	ea	$914.00				$914	$0	$0	$0	$914	
6.2 Haul Waste (22 trips @ 600 miles one way)	13,200	mi	$4.00				$52,800	$0	$0	$0	$52,800	20 cy per truck
6.3 Off-site Incineration	433	cy	$1,462.00				$633,046	$0	$0	$0	$633,046	
7 RESTORATION												
7.1 Topsoil, 6" thick	27	cy	$16.01				$432	$0	$0	$0	$432	
7.2 Spread Topsoil	27	cy			$0.30	$0.85	$0	$0	$8	$23	$31	
7.3 Re-seed disturbed areas by hand	1.4	msf		$7.35	$16.20	$6.05	$0	$10	$23	$8	$41	
7.4 Pavement Base Course, 1 1/2" stone, 6" thick	90	sy		$5.45	$0.24	$0.29	$0	$491	$22	$26	$538	
7.5 Pavement Binder Course, 4" thick	90	sy	$6.13				$552	$0	$0	$0	$552	
7.6 Pavement Wear Course, 2" thick	90	sy	$3.77				$339	$0	$0	$0	$339	
7.7 Install Monitoring Wells	84	lf	$100.00				$8,400	$0	$0	$0	$8,400	6 wells at 14' deep
Subtotal							$872,163	$50,501	$27,092	$3,075	$952,831	
Overhead on Labor Cost @ 30%									$8,128		$8,128	
G & A on Labor Cost @ 10%									$2,709		$2,709	
G & A on Material Cost @ 10%								$5,050			$5,050	
G & A on Subcontract Cost @ 10%							$87,216				$87,216	
Total Direct Cost							$959,380	$55,551	$37,929	$3,075	$1,055,934	
Indirects on Total Direct Labor Cost @ 75%									$28,447		$28,447	
Profit on Total Direct Cost @ 10%											$105,593	
Subtotal											$1,189,975	
Health & Safety Monitoring @ 10%											$118,997	
Total Field Cost											$1,308,972	
Contingency on Total Field Cost @ 20%											$261,794	
Engineering on Total Field Cost @ 10%											$130,897	
TOTAL COST											**$1,701,664**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Air Sparging
Alternative No. 3
Annual Sampling and Evaluation Costs

	Item	Item Cost Annually	Item Cost per 5 Years	Notes
1	Semi-Annual Sampling	$352		1 Laborer / 1 Day / Twice per year
		$1,400		Mobilization & Demobilization (airfare, per diem)
		$2,100		TCL VOCs (10 samples/sampling event - 1 per well + 4 QA/QC
		$250		Misc. Materials (sample jars)
		$300		Misc. Equipment (peristaltic pump, hand tools)
2	Site Review		$5,000	Additional $5,000 for a site review in years 5, 10, 15, 20 and 25.
	TOTALS	$4,402	$5,000	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Air Sparging
Alternative No. 3
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Year 1 Item	Annual Beg. Year 2	Every 3rd Yr Beg. Year 4	Notes
1	Energy - Electric	40416	Kw-hr	$0.061	$2,465	$2,465		Oxidizer, 1 HP Motor, 2 HP Motor
2	Maintenance	1	ls	$3,591	$3,591	$3,591		5% of Capital Cost
3	Catalyst Replacement	1	ls	$1,500.00			$1,500	
4	Operator - Year One	128	hr	$20.00	$2,560			First month 40 hours then 8 hours per month
5	Operator - Years Two - 25	96	hr	$20.00		$1,920		8 hours per month
	Total Annual Cost				**$8,617**	**$7,977**	**$1,500**	

Note: Annual Cost - 24 hr/ day - 365 days/ year

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Air Sparging
Alternative No. 3
Present Worth Analysis

Year	Capital Cost	O & M Cost	Sampling/Evaluation Cost	Total Annual Cost	Annual Discount Rate at 5%	Present Worth
0	$1,701,664			$1,701,664	1.000	$1,701,664
1		$8,617	$4,402	$13,019	0.952	$12,394
2		$7,977	$4,402	$12,379	0.907	$11,228
3		$7,977	$4,402	$12,379	0.864	$10,695
4		$9,477	$4,402	$13,879	0.823	$11,422
5		$7,977	$9,402	$17,379	0.784	$13,625
6		$7,977	$4,402	$12,379	0.746	$9,235
7		$9,477	$4,402	$13,879	0.711	$9,868
8		$7,977	$4,402	$12,379	0.677	$8,380
9		$7,977	$4,402	$12,379	0.645	$7,984
10		$9,477	$9,402	$18,879	0.614	$11,592
11		$7,977	$4,402	$12,379	0.585	$7,242
12		$7,977	$4,402	$12,379	0.557	$6,895
13		$9,477	$4,402	$13,879	0.530	$7,356
14		$7,977	$4,402	$12,379	0.505	$6,251
15		$7,977	$9,402	$17,379	0.481	$8,359
16		$9,477	$4,402	$13,879	0.458	$6,356
17		$7,977	$4,402	$12,379	0.436	$5,397
18		$7,977	$4,402	$12,379	0.416	$5,150
19		$9,477	$4,402	$13,879	0.396	$5,496
20		$7,977	$9,402	$17,379	0.377	$6,552
21		$7,977	$4,402	$12,379	0.359	$4,444
22		$9,477	$4,402	$13,879	0.342	$4,747
23		$7,977	$4,402	$12,379	0.326	$4,035
24		$7,977	$4,402	$12,379	0.310	$3,837
25		$9,477	$9,402	$18,879	0.295	$5,569
					Total Present Worth	**$1,895,773**

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Catalytic Oxidation
Alternative No. 4a

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.2 Storage Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.3 Construction Survey	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	3	ea			$75.00	$225.00	$0	$0	$225	$675	$900	
1.6 Site Utilities	1.5	mo	$4,000.00				$6,000	$0	$0	$0	$6,000	
1.7 Erosion & Sediment Control (silt fence)	200	lf		$0.43	$0.20		$0	$86	$40	$0	$126	
1.8 Security Fence	500	lf		$2.15	$3.24		$0	$1,075	$1,620	$0	$2,695	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	2	mo	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.2 Laundry Service	6	wks	$250.00				$1,500	$0	$0	$0	$1,500	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	1.5	mo	$1,200.00				$1,800	$0	$0	$0	$1,800	
2.5 Decon Water	2000	gal	$0.20				$400	$0	$0	$0	$400	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (1 trip @ 300 miles)	300	mi	$4.00				$1,200	$0	$0	$0	$1,200	
2.9 Off-site Disposal of Decon Water	2000	gal	$2.13				$4,260	$0	$0	$0	$4,260	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 SITE PREPARATION												
3.1 Pavement Removal, 4" to 6" thick	90	sy			$2.20	$2.98	$0	$0	$198	$268	$466	
3.2 Pavement Disposal, up to 5 miles	15	cy			$2.24	$6.95	$0	$0	$34	$104	$138	
4 GROUNDWATER EXTRACTION PIPELINES												
4.1 Excavate Trench (14' depth)	622	cy			$1.09	$1.65	$0	$0	$676	$1,026	$1,703	Level C
4.2 Excavate Trench for Conveyance Pipes (2' depth)	30	cy			$1.50	$1.67	$0	$0	$45	$50	$95	
4.3 Excavate Sump for dewatering w/ 24" CMP Pipe	28	vf		$10.40	$19.21	$6.75	$0	$291	$538	$189	$1,018	Level C
4.4 Submersible Electric Pump - Rental	2	week			$100.00		$0	$0	$200	$0	$200	55 GPM
4.5 Trench Box	2	week			$475.00		$0	$0	$950	$0	$950	8' x 16'
4.6 Contaminated Groundwater Storage Tank	3	ea		$5,000.00	$400.00		$0	$15,000	$1,200	$0	$16,200	5000 Gallon
4.7 Haul Contaminated Groundwater (7 trips @ 300 miles)	2100	mi	$4.00				$8,400	$0	$0	$0	$8,400	
4.8 Off-site Disposal of Contaminated Groundwater	35000	gal	$2.13				$74,550	$0	$0	$0	$74,550	
4.9 Waste Profile Contaminated Groundwater	1	ea	$914.00				$914	$0	$0	$0	$914	
4.10 Install 2" Perf PVC (extraction)	120	lf			$1.39	$2.21	$0	$0	$167	$265	$432	w/ silt sock
4.11 Concrete Sump (100 gallon capacity)	2	ea		$500.00			$0	$1,000	$0	$0	$1,000	
4.12 Submersible Electric Pump (purchase)	2	ea			$2,500.00		$0	$0	$5,000	$0	$5,000	
4.13 Import Pipe Bedding	7.6	cy	$20.80				$158	$0	$0	$0	$158	
4.14 Install Pipe Bedding (Header Pipes)	7.6	cy			$0.97	$0.46	$0	$0	$7	$3	$11	
4.15 Install 2" Solid PVC (conveyance)	200	lf			$1.30	$2.21	$0	$0	$260	$442	$702	
4.16 Import Coarse Sand/Gravel	127	cy	$20.80				$2,642	$0	$0	$0	$2,642	
4.17 Backfill Trench w/ Coarse Sand/Gravel	127	cy			$0.47	$0.44	$0	$0	$60	$56	$116	
4.18 Backfill Trench w/ Native Material	433	cy			$1.13	$1.03	$0	$0	$490	$444	$934	Level C
4.19 Backfill Conveyance Trench	22.4	cy			$17.45	$1.01	$0	$0	$391	$23	$414	by hand
5 GROUNDWATER TREATMENT SYSTEM												
5.1 Equipment Building	225	sf	$25.00				$5,625	$0	$0	$0	$5,625	
5.2 6" Concrete Foundation	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000	
5.3 Electrical Panel/Starters	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	6 - 10' burial depth
5.4 Electrical Power Supply	1	ls	$750.00				$750	$0	$0	$0	$750	
5.5 Bag Cartridge/Filtration	2	ea	$1,862.00				$3,724	$0	$0	$0	$3,724	0-50 gpm
5.6 Air Stripper	1	ls	$25,000.00				$25,000	$0	$0	$0	$25,000	tray type, 30 gpm, 4 trays
5.7 Offgas Treatment System - Catalytic Oxidation	1	ls	$45,000.00				$45,000	$0	$0	$0	$45,000	300 scfm unit
5.8 Instrumentation	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	
5.9 Piping and Valves	1	ls		$8,000.00	$2,000.00		$0	$8,000	$2,000	$0	$10,000	
6 DISPOSAL OF CONTAMINATED MATERIAL EXCAVATED FOR TRENCHES												

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Catalytic Oxidation
Alternative No. 4a

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
6.1 Waste Profile	1	ea	$914.00				$914	$0	$0	$0	$914	
6.2 Haul Waste (7 trips @ 600 miles one way)	4,200	mi	$4.00				$16,800	$0	$0	$0	$16,800	20 cy per truck
6.3 Off-site Incineration	127	cy	$1,462.00				$185,674	$0	$0	$0	$185,674	
7 RESTORATION												
7.1 Topsoil, 6" thick	27	cy	$16.01				$432	$0	$0	$0	$432	
7.2 Spread Topsoil	27	cy			$0.30	$0.85	$0	$0	$8	$23	$31	
7.3 Re-seed disturbed areas by hand	1.4	msf		$7.35	$16.20	$6.05	$0	$10	$23	$8	$41	
7.4 Pavement Base Course, 1 1/2" stone, 6" thick	90	sy		$5.45	$0.24	$0.29	$0	$491	$22	$26	$538	
7.5 Pavement Binder Course, 4" thick	90	sy	$6.13				$552	$0	$0	$0	$552	
7.6 Pavement Wear Course, 2" thick	90	sy	$3.77				$339	$0	$0	$0	$339	
7.7 Install Monitoring Wells	84	lf	$100.00				$8,400	$0	$0	$0	$8,400	6 wells at 14' deep
Subtotal							$408,448	$44,771	$23,472	$4,269	$480,960	
Overhead on Labor Cost @ 30%									$7,041		$7,041	
G & A on Labor Cost @ 10%									$2,347		$2,347	
G & A on Material Cost @ 10%								$4,477			$4,477	
G & A on Subcontract Cost @ 10%							$40,845				$40,845	
Total Direct Cost							$449,293	$49,249	$32,860	$4,269	$535,671	
Indirects on Total Direct Labor Cost @ 75%									$24,645		$24,645	
Profit on Total Direct Cost @ 10%											$53,567	
Subtotal											$613,883	
Health & Safety Monitoring @ 10%											$61,388	
Total Field Cost											$675,271	
Contingency on Total Field Cost @ 20%											$135,054	
Engineering on Total Field Cost @ 10%											$67,527	
TOTAL COST											**$877,853**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Catalytic Oxidation
Alternative No. 4a
Annual Sampling and Evaluation Costs

	Item	Item Cost Annually	Item Cost per 5 Years	Notes
1	Semi-Annual Sampling	$352		1 Laborer / 1 Day / Twice per year
		$1,400		Mobilization & Demobilization (airfare, per diem)
		$2,100		TCL VOCs (10 samples/sampling event - 1 per well + 4 QA/QC)
		$210		TCL VOCs (1 sample/sampling event - treatment plant effluent)
		$250		Misc. Materials (sample jars)
		$300		Misc. Equipment (peristaltic pump, hand tools)
2	Site Review		$5,000	Additional $5,000 for a site review in years 5, 10, 15, 20 and 25.
	TOTALS	$4,612	$5,000	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Catalytic Oxidation
Alternative No. 4a
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Year 1 Item	Annual Beg. Year 2	Every 3rd Yr Beg. Year 4	Notes
1	Energy - Electric	70200	Kw-hr	$0.061	$4,282	$4,282		Oxidizer, 2 HP Motor (stripper), 2 - 1/2 HP Motors (pumps)
2	Maintenance	1	ls	$4,655	$4,655	$4,655		5% of Capital Cost
3	Catalyst Replacement	1	ls	$4,500			$4,500	
4	Operator - Year One	128	hr	$20.00	$2,560			First month 40 hours then 8 hours per month
5	Operator - Years Two - 25	96	hr	$20.00		$1,920		8 hours per month
	Total Annual Cost				**$11,497**	**$10,857**	**$4,500**	

Note: Annual Cost - 24 hr/ day - 365 days/ year

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Catalytic Oxidation
Alternative No. 4a
Present Worth Analysis

Year	Capital Cost	O & M Cost	Sampling & Evaluation Cost	Total Annual Cost	Annual Discount Rate at 5%	Present Worth
0	$877,853			$877,853	1.000	$877,853
1		$11,497	$4,612	$16,109	0.952	$15,336
2		$10,857	$4,612	$15,469	0.907	$14,031
3		$10,857	$4,612	$15,469	0.864	$13,365
4		$15,357	$4,612	$19,969	0.823	$16,435
5		$10,857	$9,612	$20,469	0.784	$16,048
6		$10,857	$4,612	$15,469	0.746	$11,540
7		$15,357	$4,612	$19,969	0.711	$14,198
8		$10,857	$4,612	$15,469	0.677	$10,473
9		$10,857	$4,612	$15,469	0.645	$9,978
10		$15,357	$9,612	$24,969	0.614	$15,331
11		$10,857	$4,612	$15,469	0.585	$9,049
12		$10,857	$4,612	$15,469	0.557	$8,616
13		$15,357	$4,612	$19,969	0.530	$10,584
14		$10,857	$4,612	$15,469	0.505	$7,812
15		$10,857	$9,612	$20,469	0.481	$9,846
16		$15,357	$4,612	$19,969	0.458	$9,146
17		$10,857	$4,612	$15,469	0.436	$6,745
18		$10,857	$4,612	$15,469	0.416	$6,435
19		$15,357	$4,612	$19,969	0.396	$7,908
20		$10,857	$9,612	$20,469	0.377	$7,717
21		$10,857	$4,612	$15,469	0.359	$5,553
22		$15,357	$4,612	$19,969	0.342	$6,829
23		$10,857	$4,612	$15,469	0.326	$5,043
24		$10,857	$4,612	$15,469	0.310	$4,795
25		$15,357	$9,612	$24,969	0.295	$7,366
					Total Present Worth	**$1,128,031**

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Ultraviolet Oxidation
Alternative No. 4b

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Office Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.2 Storage Trailer (1)	2	mo	$500.00				$1,000	$0	$0	$0	$1,000	
1.3 Construction Survey	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
1.4 Portable Communication Equipment	1	set	$1,500.00				$1,500	$0	$0	$0	$1,500	
1.5 Equipment Mobilization/Demobilization	3	ea			$75.00	$225.00	$0	$0	$225	$675	$900	
1.6 Site Utilities	1.5	mo	$4,000.00				$6,000	$0	$0	$0	$6,000	
1.7 Erosion & Sediment Control (silt fence)	200	lf		$0.43	$0.20		$0	$86	$40	$0	$126	
1.8 Security Fence	500	lf		$2.15	$3.24		$0	$1,075	$1,620	$0	$2,695	
2 DECONTAMINATION FACILITIES & SERVICES												
2.1 Decontamination Trailer	2	mo	$1,500.00				$3,000	$0	$0	$0	$3,000	
2.2 Laundry Service	6	wks	$250.00				$1,500	$0	$0	$0	$1,500	
2.3 Truck Decon Pad												
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000	
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565	
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613	
d) Collection Sump	1	ls		$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170	
e) Splash Guard	780	sf		$1.25	$1.00		$0	$975	$780	$0	$1,755	
2.4 Decontamination Services	1.5	mo	$1,200.00				$1,800	$0	$0	$0	$1,800	
2.5 Decon Water	2000	gal	$0.20				$400	$0	$0	$0	$400	
2.6 Clean Water Storage Tank	1	ea		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300	3000 Gallon
2.7 Spent Water Storage Tank	1	ea		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400	5000 Gallon
2.8 Haul Decon Water (1 trip @ 300 miles)	300	mi	$4.00				$1,200	$0	$0	$0	$1,200	
2.9 Off-site Disposal of Decon Water	2000	gal	$2.13				$4,260	$0	$0	$0	$4,260	
2.10 Waste Profile Decon Water	1	ea	$914.00				$914	$0	$0	$0	$914	
3 SITE PREPARATION												
3.1 Pavement Removal, 4" to 6" thick	90	sy			$2.20	$2.98	$0	$0	$198	$268	$466	
3.2 Pavement Disposal, up to 5 miles	15	cy			$2.24	$6.95	$0	$0	$34	$104	$138	
4 GROUNDWATER EXTRACTION PIPELINES												
4.1 Excavate Trench (14' depth)	622	cy			$1.09	$1.65	$0	$0	$676	$1,026	$1,703	Level C
4.2 Excavate Trench for Conveyance Pipes (2' depth)	30	cy			$1.50	$1.67	$0	$0	$45	$50	$95	
4.3 Excavate Sump for dewatering w/ 24" CMP Pipe	28	vf		$10.40	$19.21	$6.75	$0	$291	$538	$189	$1,018	Level C
4.4 Submersible Electric Pump - Rental	2	week			$100.00		$0	$0	$200	$0	$200	55 GPM
4.5 Trench Box	2	week			$475.00		$0	$0	$950	$0	$950	8' x 16'
4.6 Contaminated Groundwater Storage Tank	3	ea		$5,000.00	$400.00		$0	$15,000	$1,200	$0	$16,200	5000 Gallon
4.7 Haul Contaminated Groundwater (7 trips @ 300 miles)	2100	mi	$4.00				$8,400	$0	$0	$0	$8,400	
4.8 Off-site Disposal of Contaminated Groundwater	35000	gal	$2.13				$74,550	$0	$0	$0	$74,550	
4.9 Waste Profile Contaminated Groundwater	1	ea	$914.00				$914	$0	$0	$0	$914	
4.10 Install 2" Perf PVC (extraction)	120	lf			$1.39	$2.21	$0	$0	$167	$265	$432	w/ silt sock
4.11 Concrete Sump (100 gallon capacity)	2	ea		$500.00			$0	$1,000	$0	$0	$1,000	
4.12 Submersible Electric Pump (purchase)	2	ea			$2,500.00		$0	$0	$5,000	$0	$5,000	
4.13 Import Pipe Bedding	7.6	cy	$20.80				$158	$0	$0	$0	$158	
4.14 Install Pipe Bedding (Header Pipes)	7.6	cy			$0.97	$0.46	$0	$0	$7	$3	$11	
4.15 Install 2" Solid PVC (conveyance)	200	lf			$1.30	$2.21	$0	$0	$260	$442	$702	
4.16 Import Coarse Sand/Gravel	127	cy	$20.80				$2,642	$0	$0	$0	$2,642	
4.17 Backfill Trench w/ Coarse Sand/Gravel	127	cy			$0.47	$0.44	$0	$0	$60	$56	$116	
4.18 Backfill Trench w/ Native Material	433	cy			$1.13	$1.03	$0	$0	$490	$444	$934	Level C
4.19 Backfill Conveyance Trench	22.4	cy			$17.45	$1.01	$0	$0	$391	$23	$414	by hand
5 GROUNDWATER TREATMENT SYSTEM												
5.1 Equipment Building	225	sf	$25.00				$5,625	$0	$0	$0	$5,625	
5.2 6" Concrete Foundation	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000	
5.3 Electrical Panel/Starters	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	
5.4 Electrical Power Supply	1	ls	$750.00				$750	$0	$0	$0	$750	
5.5 Bag Cartridge/Filtration	2	ea	$1,862.00				$3,724	$0	$0	$0	$3,724	0-50 gpm
5.6 30 Kw UV Oxidation System	1	ls	$100,000.00				$100,000	$0	$0	$0	$100,000	Reactor, H2O2 strg, controls
5.7 Instrumentation	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	
5.8 Piping and Valves	1	ls		$8,000.00	$2,000.00		$0	$8,000	$2,000	$0	$10,000	
6 DISPOSAL OF CONTAMINATED MATERIAL EXCAVATED FOR TRENCHES												
6.1 Waste Profile	1	ea	$914.00				$914	$0	$0	$0	$914	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Ultraviolet Oxidation
Alternative No. 4b

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Comments
6.2 Haul Waste (7 trips @ 600 miles one way)	4,200	mi	$4.00				$16,800	$0	$0	$0	$16,800	20 cy per truck
6.3 Off-site Incineration	127	cy	$1,462.00				$185,674	$0	$0	$0	$185,674	
7 RESTORATION												
7.1 Topsoil, 6" thick	27	cy	$16.01				$432	$0	$0	$0	$432	
7.2 Spread Topsoil	27	cy			$0.30	$0.85	$0	$0	$8	$23	$31	
7.3 Re-seed disturbed areas by hand	1.4	msf		$7.35	$16.20	$6.05	$0	$10	$23	$8	$41	
7.4 Pavement Base Course, 1 1/2" stone, 6" thick	90	sy		$5.45	$0.24	$0.29	$0	$491	$22	$26	$538	
7.5 Pavement Binder Course, 4" thick	90	sy	$6.13				$552	$0	$0	$0	$552	
7.6 Pavement Wear Course, 2" thick	90	sy	$3.77				$339	$0	$0	$0	$339	
7.7 Install Monitoring Wells	84	lf	$100.00				$8,400	$0	$0	$0	$8,400	6 wells at 14' deep
Subtotal							$438,448	$44,771	$23,472	$4,269	$510,960	
Overhead on Labor Cost @ 30%									$7,041		$7,041	
G & A on Labor Cost @ 10%									$2,347		$2,347	
G & A on Material Cost @ 10%								$4,477			$4,477	
G & A on Subcontract Cost @ 10%							$43,845				$43,845	
Total Direct Cost							$482,293	$49,249	$32,860	$4,269	$568,671	
Indirects on Total Direct Labor Cost @ 75%									$24,645		$24,645	
Profit on Total Direct Cost @ 10%											$56,867	
Subtotal											$650,183	
Health & Safety Monitoring @ 10%											$65,018	
Total Field Cost											$715,201	
Contingency on Total Field Cost @ 20%											$143,040	
Engineering on Total Field Cost @ 10%											$71,520	
TOTAL COST											**$929,762**	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Ultraviolet Oxidation
Alternative No. 4b
Annual Sampling and Evaluation Costs

	Item	Item Cost Annually	Item Cost per 5 Years	Notes
1	Semi-Annual Sampling	$352		1 Laborer / 1 Day / Twice per year
		$1,400		Mobilization & Demobilization (airfare, per diem)
		$2,100		TCL VOCs (10 samples/sampling event - 1 per well + 4 QA/QC
		$210		TCL VOCs (1 sample/sampling event - treatment plant effluent)
		$250		Misc. Materials (sample jars)
		$300		Misc. Equipment (peristaltic pump, hand tools)
2	Site Review		$5,000	Additional $5,000 for a site review in years 5, 10, 15, 20 and 25.
	TOTALS	$4,612	$5,000	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Ultraviolet Oxidation
Alternative No. 4b
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Year 1 Item	Annual Beg. Year 2	Notes
1	Energy - Electric	273600	Kw-hr	$0.061	$16,690	$16,690	Oxidizer, 2 - 1/2 HP Motors (pumps)
2	Maintenance	1	ls	$6,155	$6,155	$6,155	5% of Capital Cost
3	H2O2 Replacement	4015	lb	$0.50	$2,008	$2,008	11 lbs/day
4	Lamp Replacement	3	lamps	$2,500.00	$7,500	$7,500	3 lamps per year
5	Operator - Year One	128	hr	$20.00	$2,560		First month 40 hours then 8 hours per month
6	Operator - Years Two - 25	96	hr	$20.00		$1,920	8 hours per month
	Total Annual Cost				**$34,912**	**$34,272**	

Note: Annual Cost - 24 hr/ day - 365 days/ year

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Building 292, Former Drum Loading Area
Pump and Treat - Ultraviolet Oxidation
Alternative No. 4b
Present Worth Analysis

Year	Capital Cost	O & M Cost	Sampling & Evaluation Cost	Total Annual Cost	Annual Discount Rate at 5%	Present Worth
0	$929,762			$929,762	1.000	$929,762
1		$34,912	$4,612	$39,524	0.952	$37,627
2		$34,272	$4,612	$38,884	0.907	$35,268
3		$34,272	$4,612	$38,884	0.864	$33,596
4		$34,272	$4,612	$38,884	0.823	$32,002
5		$34,272	$9,612	$43,884	0.784	$34,405
6		$34,272	$4,612	$38,884	0.746	$29,008
7		$34,272	$4,612	$38,884	0.711	$27,647
8		$34,272	$4,612	$38,884	0.677	$26,325
9		$34,272	$4,612	$38,884	0.645	$25,080
10		$34,272	$9,612	$43,884	0.614	$26,945
11		$34,272	$4,612	$38,884	0.585	$22,747
12		$34,272	$4,612	$38,884	0.557	$21,658
13		$34,272	$4,612	$38,884	0.530	$20,609
14		$34,272	$4,612	$38,884	0.505	$19,636
15		$34,272	$9,612	$43,884	0.481	$21,108
16		$34,272	$4,612	$38,884	0.458	$17,809
17		$34,272	$4,612	$38,884	0.436	$16,953
18		$34,272	$4,612	$38,884	0.416	$16,176
19		$34,272	$4,612	$38,884	0.396	$15,398
20		$34,272	$9,612	$43,884	0.377	$16,544
21		$34,272	$4,612	$38,884	0.359	$13,959
22		$34,272	$4,612	$38,884	0.342	$13,298
23		$34,272	$4,612	$38,884	0.326	$12,676
24		$34,272	$4,612	$38,884	0.310	$12,054
25		$34,272	$9,612	$43,884	0.295	$12,946
					Total Present Worth	**$1,491,235**

APPENDIX C

OSWER DIRECTIVE 9355.0 - 48FS
PRESUMPTIVE REMEDIES

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Directive: 9355.0-48FS
EPA 540-F-93-048
PB 93-963346
September 1993

EPA

Presumptive Remedies: Site Characterization and Technology Selection For CERCLA Sites With Volatile Organic Compounds In Soils

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM).**

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive identifies the presumptive remedies for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites with soils contaminated by ***volatile organic compounds (VOCs).*** In addition, EPA is developing guidance on presumptive remedies for wood treatment, municipal landfill, PCB, grain storage, coal gasification, and contaminated ground-water sites. EPA has also developed a directive entitled *Presumptive Remedies: Policy and Procedures*, (Directive 9355.0-47FS) which outlines and addresses the issues common to all presumptive remedies (e.g., role of *innovative technologies*, consistency with the NCP, State, community involvement).

PURPOSE

The purpose of this directive is to provide guidance on selecting a presumptive remedy at sites with soils contaminated with VOCs. Specifically this guidance:

- Presents the presumptive remedies for this site type;
- Describes the presumptive remedy process in terms of site characterization and technology screening steps; and
- Outlines the data required to select these presumptive remedies.

Since a presumptive remedy is a technology that EPA believes, based upon its past experience, generally will be the most appropriate remedy for a specified type of site, the presumptive remedy approach will accelerate site-specific analysis of remedies by focusing the feasibility study efforts. Where several presumptive remedies are identified, EPA believes that all deserve substantial consideration before utilizing the presumptive remedy approach. EPA personnel should review the directive entitled *Presumptive Remedies: Policy and Procedures* (Directive 9355.0-47FS) for general information on the presumptive remedy process.

Soil vapor extraction (SVE), thermal desorption, and **incineration** are the presumptive remedies for Superfund sites with VOC-contaminated soil assuming the site characteristics meet certain criteria. Table 1 provides a brief description of each of these presumptive remedies.

The decision to establish these technologies as presumptive remedies for this site type is based on EPA's collective knowledge about site investigation and remedy selection for VOC-contaminated soils,

TABLE 1
Presumptive Remedies for VOCs in Soil

Soil Vapor Extraction - Soil vapor extraction (SVE) is an in-situ or ex-situ process which physically removes contaminants from ***vadose zone*** soils by inducing air flow through the soil matrix. The flowing air strips volatile compounds from the solids and carries them to extraction wells. The recovered vapors may require further treatment. In-situ SVE is the primary focus of this document.

Thermal Desorption - Thermal desorption is an ex- situ process that uses direct or indirect heat exchange to vaporize organic contaminants from soil, sediment, sludge or other solid and semisolid matrices. The vapors are then condensed or otherwise collected for further treatment.

Incineration - Incineration is an ex-situ engineered process that employs thermal decomposition via oxidation at temperatures usually greater than 900 °C to destroy the organic fraction of the waste.

The major difference between thermal desorption and incineration is that incineration oxidizes organic compounds, thereby destroying the hazardous material. Thermal desorption volatilizes contaminants, then concentrates them. Thermal desorption reduces the volume of contamination, but the concentrated waste stream still requires treatment. Disposal or treatment of residual waste stream, ash, and concentrated VOC effluent is not covered by this directive. Options such as off-site disposal/regeneration or reuse should be considered.

including field experience from the Superfund, Resource Conservation and Recovery Act (RCRA), and Underground Storage Tank (UST) programs. In addition, EPA conducted an analysis of FY86 to FY91 Records of Decision (RODs) for sites where VOC contamination drove remedy selection. The results of this analysis, which are provided in Appendix A, demonstrate that these three technologies represent over 90% of the remedies selected in the RODs analyzed.

USE OF DOCUMENT

This directive is primarily intended for use by Superfund site managers. However, site managers in other programs (such as RCRA corrective action, the UST program, States), and the private sector, may also use this directive.

This directive is not a "stand alone" document. To ensure a full understanding of VOC site characterization and remedy selection, site managers should refer to all documents cited in the directive. For assistance in understanding complex site conditions, an experienced site manager, the presumptive remedy expert team, the Superfund Technical Assistance and Response Team (START) team, or the Environmental Response Team should be consulted.

ANTICIPATED BENEFITS OF PRESUMPTIVE REMEDIES

Use of this directive will reduce cost and time in remedy selection at VOC sites in the following ways:

1. The directive facilitates identification of the presumed or likely remedial options early in the investigation process, hence allowing for a more focused collection of data during the remedial investigation (RI) or removal site evaluation. In addition, knowledge of the presumptive remedy may facilitate collection of some remedial design data before the ROD or action memo, thereby allowing the action to proceed more quickly after signature of the decision document.

2. This directive eliminates the need for the initial step of identifying and screening a variety of alternatives during the Feasibility Study. Additionally, it will reduce the number of technologies identified and analyzed in the EE/CA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Section 300.430(e)(1)) states that "the lead agency shall include an alternatives screening step, when needed, (emphasis added) to select a reasonable number of alternatives for detailed analysis." EPA's analysis of feasibility studies for VOC-contaminated soil sites (see Appendix A) found that certain technologies are routinely screened out based on effectiveness, implementability, or excessive costs, consistent with NCP Section 300.430(e)(7). Accordingly, EPA has determined that, when using presumptive remedies at VOC-contaminated sites, site-specific identification and screening of alternatives is not necessary. However, this directive and supporting documentation (see "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils") should be included in the Administrative Record for all sites that use the presumptive remedy(ies) to document the basis for eliminating the "site-specific identification and

TABLE 2
Typical VOCs Addressed by this Directive

Halogenated Volatile Organics

Carbon Tetrachloride
Chlorobenzene
Chloroethane
Chloroform
1,1-Dichloroethane
1,1-Dichloroethylene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloroethylene
1,2-Dichloropropane
1,4-Dichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
Ethylene Dibromide
Methylene Chloride
Tetrachloroethylene
Trichloroethylene
Vinyl Chloride

Non-Halogenated Volatile Organics

Ketones/Furans
Acetone
Methyl Ethyl Ketone
Methyl Isobutyl Ketone

Aromatics
Benzene
Ethyl Benzene
Styrene
Toluene
m-Xylene
o-Xylene
p-Xylene

Note: Other compounds that have physical/chemical characteristics similar to the compounds listed may also be addressed by the presumptive remedy process.

screening of technologies" section. In addition, other supporting materials (e.g., FS reports included in the analysis, technical reports) will be made available at EPA Headquarters and are available for inclusion in the Administrative Record if needed.

3. This directive streamlines the detailed analysis portion of the FS. Remedial alternatives developed for a site must be evaluated against the nine criteria (required under NCP Section 300.430(e)(9)). Under this presumptive remedy approach, the detailed analysis can be limited to the three presumptive remedies (in addition to the no-action alternative), thereby streamlining that portion of the FS. Appendix B provides a generic evaluation of the presumptive remedies for seven of the nine criteria. This evaluation may serve as a basis for each detailed analysis conducted under the presumptive remedy process and should be augmented, as needed, to address site-specific conditions.

One of these presumptive remedies is expected to be used for all VOC sites except under unusual circumstances. Such circumstances may include unusual site soil characteristics, demonstration of significant advantages of alternate (or other innovative) technologies over the presumptive remedies, or extraordinary community and state concerns. If such circumstances are encountered, additional analyses may be necessary or a more conventional detailed RI/FS may be performed.

PRESUMPTIVE REMEDIES PROCESS

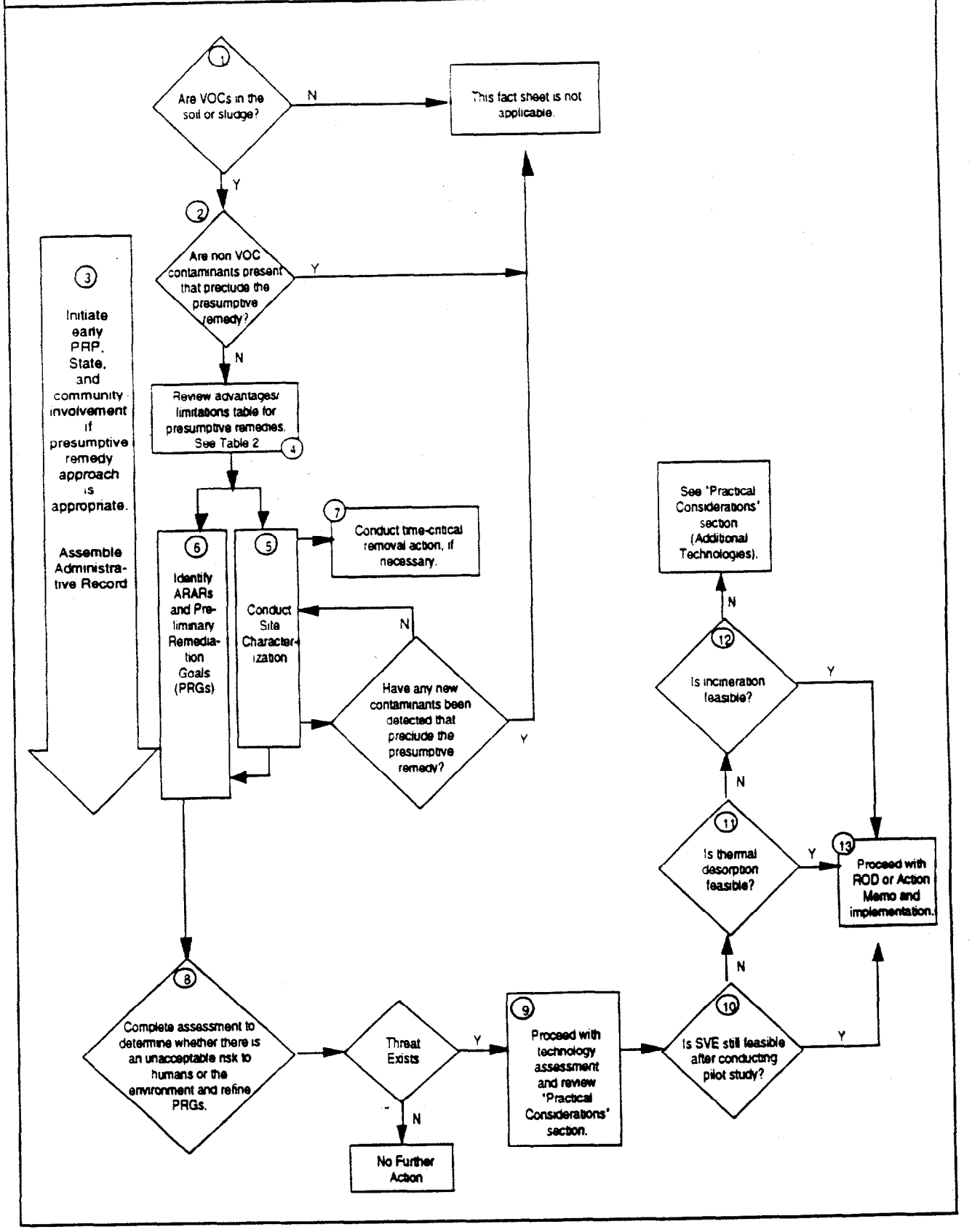
This section and the accompanying diagram (Figure 1) describe the sequence of steps involved in the presumptive remedy process (site characterization and technology selection) for sites containing soil contaminated with VOCs. While the process is not mandatory, EPA believes that following the steps outlined below will expedite the clean-up process for this category of sites.

SVE is the primary presumptive remedy. SVE has been selected most frequently to address VOC contamination at Superfund sites and initial performance data indicate that it effectively treats waste in place at a relatively low cost. In cases where SVE will not work or where there is very highly concentrated contamination, thermal desorption may be the more appropriate response technology. In a limited number of situations, incineration may be more appropriate.

The numbered paragraphs below correspond to the numbered steps in Figure 1 and provide a detailed discussion of each step.

1. *Are VOCs Present in the Soil?* The first step is to determine whether VOCs are the major contaminant present in soil at the site. Table 2 lists the VOCs that are amenable to the presumptive remedies outlined in this directive. If VOCs are present at levels of concern (see forthcoming guidance on soil screening levels), then the presumptive remedies outlined in this directive may be applicable. However, if it is confirmed (at this point or at any later point during the presumptive remedy process) that there are no VOCs present in the soil, then this directive is not applicable for use in technology selection at the site.

FIGURE 1
Decision Tree for Investigating and Selecting a Remedy at Solvent Sites



Most likely, this analysis will occur during scoping of the RI/FS or EE/CA. However, there may be only limited information available at that time about the site. Therefore, whatever information is available should be used to determine whether VOCs are present or suspected in the soil based on prior use. Chemical use at a site can be ascertained from a number of sources such as facility records, previous sampling efforts by local or State agencies or through Information Request letters.

2. *Are Non-VOC Contaminants Present That Preclude the Use of Presumptive Remedies?* In addition to determining whether VOCs are present in the soil, it is also necessary to identify other non-VOC contaminants, if any, present in the soil.

   The site characterization and technology selection procedures outlined in this directive are recommended for use primarily on soil containing VOCs only. See Table 2 for VOCs that are amenable to the presumptive remedies.

   For sites containing a mixture of VOCs and other contaminants in soil, the presumptive remedies should be considered only if they can also be effective in removing the non-VOC contaminants or combined with other, non-presumptive remedies in a treatment train, assuming the presumptive remedies do not exacerbate the problems presented by the non-VOCs. For example, sites with VOCs and metals commingled in soil may be effectively remediated by employing SVE to remove VOCs followed by fixation or solidification to address the metal contamination. In contrast, a VOC and polyaromatic hydrocarbons (PAHs) contaminant combination may be treated more appropriately with a single biological treatment scheme that would be effective for both the VOCs and PAHs. Note that sites containing mixtures of VOCs and non-VOCs are varied, and, for this reason, remedy selection may be more complicated than the framework presented in this directive; therefore, the presumptive remedy analysis may need to be supplemented or modified on a site-specific basis.

3. *Initiate Early Community, State, and Potentially Responsible Party (PRP) Involvement.* As early in the clean-up process as possible, EPA should notify the community, State, and any PRPs that a presumptive remedy is being considered for the site. It is important for all stakeholders to understand completely how the presumptive remedy process varies from the usual clean-up process and the benefits of using the presumptive remedies process.

   Early identification of State applicable or relevant and appropriate requirements (ARARs) also is a critical part of this process. Because the presumption set forth in this directive is national in scope, it does not take into account State ARARs. For this reason, State ARARs relating to the presumptive remedies should be considered on a site-specific basis. Regions may want to supplement this directive by compiling the requirements of the States in their Regions that are likely to be associated with the use of the presumptive remedies and placing them in the administrative record for a site where presumptive remedies are being considered. This directive along with the "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils" should be included in the administrative record for the site if one of the presumptive remedies is proposed for a particular VOC-contaminated site.

4. *Review Advantages/Limitations of the Presumptive Remedies.* During initial site characterization, Table 3 should be reviewed to consider the advantages and limitations of the presumptive remedies. This information may be useful in preparing for and/or modifying the site characterization or alternatives analysis process. The "Practical Considerations" section of this directive should also be reviewed at this time to ensure a comprehensive site characterization and remedy evaluation.

5. *Conduct Site Characterization.* Site characterization for sites using VOC presumptive remedies should be designed to:

   - Positively identify the site type (i.e., VOC site);
   - Obtain data to determine whether the presumptive remedy is feasible for the site;
   - Focus (and possibly streamline) site characterization by collecting data to support the selection of presumptive remedy(ies) only (e.g., volume and cost information); and,
   - Collect some design data (i.e., pilot studies to determine radius of influence and flow rates of SVE), thereby streamlining data collection during the remedial design stage.

   Table 4 lists the data that are required for characterization of sites with soil contaminated with VOCs. This table also includes the rationale for collecting these data and references for established collection methods. Note that bench-scale and pilot/treatability studies should be performed whenever possible concurrent with site characterization to define the parameters that will be important to designing the system.

   In areas with low organic content soil (e.g., alluvial basins), or where there are impediments to obtaining soil samples (e.g., under buildings), soil gas sampling

is highly recommended as a site characterization technique. In addition, the use of soil gas sampling during implementation of SVE and confirmatory soil sampling afterward is less expensive than constantly installing new soil borings, especially for deep contamination.

If incineration or thermal desorption is under serious consideration, bench-scale treatability studies may be conducted, especially if metals or other inorganic compounds are present. Thermal desorption generally should be considered if concentrations of VOCs are less than 5 to 10 percent; incineration may be appropriate if VOC concentrations exceed 5 to 10 percent. Note that excavation and mixing of soil can produce a desorber input of less than 10 percent contaminant concentration and allow thermal desorption to be chosen.

Additionally, the feasibility of excavation should be determined by evaluating surface conditions and depth of contaminants as well as the potential for any air emissions associated with the excavation. Test digs should be monitored closely to assure protection of the public and the environment.

It is important to note that during the site characterization, the volume and concentration of waste constituting the principal threats at the site should be identified. The NCP (Section 300.430(a)(1)(iii)(A) and *A Guide to Principal Threat and Low Level Threat Wastes*, Superfund Publication: 9380.3-06FS, November 1991, define principal threats as source materials, including liquids, that are highly toxic or highly mobile wastes which generally cannot be reliably contained or would present a significant risk to human health and or environment should exposure occur. In accordance with NCP expectations, waste constituting "principal threats" posed by a site generally are expected to be treated. The site manager is encouraged to characterize the site in terms of principal and low-level threat areas to determine materials to be targeted for treatment and containment.

6. *Identify Potential ARARs, To Be Considered (TBCs), and Preliminary Remediation Goals (PRGs).* Potential Federal and State ARARs and pertinent TBCs information should be identified on a chemical-, location-, and action-specific basis concurrent with site characterization. For a more detailed ARARs discussion, refer to the various ARARs fact sheets. (See *Compendium of CERCLA ARARs Factsheets and Directives*, EPA Publication 9347.3-15, October 1991).

   At this step, PRGs should also be identified (NCP Section 300.430(e)(2)(c)). Note that different health risk-based PRGs are often set for soils, depending on depth. Shallow soil levels are usually based both on direct contact exposure and protection of ground water, while levels for deeper soils are generally based only on mass transport modeling of effects on ground water. Ecological effects may also be important to consider in setting PRGs.

7. *Conduct Time-Critical Removal Action (if necessary).* During initial site characterization, data will be gathered to determine whether a time-critical removal action will be needed and to determine whether the contaminants present are amenable to the presumptive remedies. Time-critical removal actions, such as drum removal or actions addressing highly contaminated (typically small volumes) of soil, should be conducted in accordance with current guidance and regulations. The decision to take a time-critical removal action may be made by the Regional Decision Team (RDT) or if time does not permit, by an On-Scene Coordinator (OSC) or a Remedial Project Manager (RPM) in consultation with an OSC.

8. *Is There a Threat Posed by the Site?* A risk assessment must be conducted to determine if a sufficient health or environmental threat exists to warrant a removal or remedial action. (Refer to *Risk Assessment Guidance for Superfund, Volumes I and II*, EPA/540/1-89/002 and EPA/540/1-89/001). Where it is determined that such a threat exists, site-specific exposure data can be used to modify the PRGs identified in Step 6 (NCP Section 300.430(e)(2)(i)). If it is determined that such a threat does not exist, no further action at the site will be required.

9. *Proceed With Technology Assessment and Review "Practical Considerations" section.* If the analysis described in step 8 confirms that the contaminants are a threat to human health and/or the environment, a proposed remedy should then be identified.

   If this project is a remedial action, a detailed analysis using the nine criteria will be required under NCP Section 300.430(e)(9)) to justify the selection of remedy decision. Appendix B provides an analysis of SVE, thermal desorption, and incineration against seven of the nine selection criteria. In addition to the seven criteria discussed in Appendix B, community, and State acceptance must also be evaluated. If a non-time critical removal action is planned, the streamlined analysis described in the EE/CA guidance will be required that uses the three criteria of effectiveness, implementability, and cost. During the technology assessment, the factors listed in the "Practical Considerations" section of this directive should be reviewed to ensure a comprehensive evaluation of alternatives.

10. *Does the Pilot /Treatability Study Indicate that SVE is Feasible?* SVE is the primary presumptive remedy. Pilot/treatability study testing of SVE should be conducted prior to final remedy selection. Such testing will provide information on the rate of removal of contaminants. EPA/540/2-91/091A cited in the References section of this directive provides guidance on conducting the pilot/treatability study. Removal efficiencies and treatment effectiveness must be carefully considered alongside the PRGs identified in the FS to estimate the potential for successful remedial action using SVE.

11. *Is Thermal Desorption Feasible?* If SVE will not be sufficiently effective in achieving PRGs due to low permeability, lithology or insufficient removal of contamination during the pilot study, thermal desorption should be considered as the primary ex-situ presumptive remedy.

    Thermal desorption technologies cover a variety of vendors and processes. However, ample data are available to substantiate remedy selection of thermal desorption for soil contaminated solely with VOCs.

12. *Is Incineration Feasible?* If contaminant concentrations and bench-scale testing indicate thermal desorption will not achieve desired PRG levels, incineration is the second ex-situ presumptive remedy.

    If incineration is planned, and a substantial number of inorganic contaminants are expected to be present based on site characterization data, materials handling problems, or slagging problems are likely.

    If none of the three presumptive remedies is considered to be feasible at a particular site, it will be necessary to consider other technologies. (For more information, refer to the Practical Considerations section below.)

13. *Select Remedy for Remedial/Removal Action.* At this point, there should be enough data to identify a preferred remedy in the proposed plan and distribute the plan for public comment. Once the remedy has been selected in the ROD, the user can proceed to do a limited design which relies largely on the substantial amount of design-related data collected during the RI. The extent of additional or supplemental data required will be determined on a site-specific basis.

Practical Considerations

The following factors should be considered prior to taking any remedial action.

Enforcement: This directive applies to fund-lead sites as well as to sites where a PRP is conducting the investigation and/or response action. In the event that there is an ongoing PRP-lead RI/FS, the scope of work may be amended to reflect the presumptive remedy approach to site characterization and remedy selection. The potential savings in time and money to be gained by using the presumptive remedy approach are expected to outweigh the burden of modifying the scope of work in many cases.

Initial Site Actions: If the VOC material is still in original, intact containers, it may be returned to the manufacturer (if the manufacturer is willing to accept these containers), assuming this response is a cost-effective and feasible action as opposed to treating the material. Reuse of material (i.e., process liquids and relocation of equipment to other permitted facilities) should also be considered. Further, phase separation should be conducted and recycling considered depending on the purity of the recovered phase or for any existing liquids that are high enough in concentration. Refer to Appendix C for a list of the currently recognized waste exchanges.

Site Characterization: Site characterization should proceed as a single, multi-media activity whenever possible. Field screening methods should be integrated into the sampling and analysis plan in order to accelerate information gathering. Data quality must reflect the ultimate use of the information.

Ground Water: The decision maker should consider the ground-water strategy for the site since soil clean-up levels are often set to protect ground-water quality. Therefore, ground-water clean-up levels may have a direct impact on the selected clean-up levels for soil. (See forthcoming guidance on Soil Screening Levels and the directive entitled *Presumptive Remedies: Remedial Strategy and Treatment Technologies for CERCLA Sites with Contaminated Ground Water.*) It should be noted that, of the VOC-type contaminants, listed in Table 2, the halogenated volatiles are dense nonaqueous phase liquids (dense NAPLs or DNAPLs) and many of the others are light NAPLs (LNAPLs) in their pure liquid form. If LNAPLs are present, it may be possible to address them by lowering the water table, removing free product (if present), and applying SVE. To address DNAPLs contamination, refer to the above mentioned ground-water guidance.

Management of Different Soils: A situation may arise where highly contaminated shallow material cannot be addressed by SVE. The action to address this contamination may differ from the rest of the soil contamination and will most likely involve incineration or thermal desorption. If it is suspected that soil contamination existing at greater depths will also be treated in this manner, then the excavated shallow material should be staged and stored in order to treat it with the deep material.

Another situation may arise where VOCs are mixed with metals, and none of the presumptive remedies can address both sets of contaminants. The action to address this situation may consist of a treatment train where VOCs are

addressed through SVE or thermal desorption and the metals are addressed through fixation.

Finally, the site manager should be aware of situations where a mixture of principal and low-level threat wastes call for the use of treatment (i.e., SVE or thermal treatment) of principal threat waste and containment (capping) of low-level contamination. (See *A Guide to Principal Threat and Low-Level Wastes* in Reference Section).

Off-Site Disposal: In general, it may not be cost-effective to ship quantities of contaminated soil in excess of 5,000 cubic yards for off-site disposal. For this reason, pretreatment of soil and water may be required prior to shipment or discharge to another treatment facility.

Capping: Capping alone is not recommended to control the migration of VOCs. However, capping can improve the effectiveness of SVE by decreasing the rate of infiltration of residual VOCs through the vadose zone into the ground water as well as possibly increasing the radius of influence and preventing "short circuiting" of air pathways in the vicinity of the extraction well. Capping can also be used to address non-principal threat waste unless it is more cost-effective to treat this waste along with more highly contaminated materials.

Patents: SVE is a patented technology. Royalty payments may be required under certain conditions of implementation.

Attainment of Remediation Goals: It should be noted that, like other in-situ technologies, it is difficult to ascertain with confidence whether SVE will attain remediation goals until the action is actually implemented. However, the lower cost and ease of SVE implementation will often weigh heavily in its favor, as long as protection of human health and the environment is ensured.

Additional Technologies: If for some reason none of the presumptive remedies is applicable to a particular site, the site manager is encouraged to refer to EPA's forthcoming document entitled *Contaminants and Remedial Options at Solvent Sites* for a discussion of additional VOC treatment technologies. It should be noted that this comprehensive document, which identifies additional VOCs and technologies, may be appropriate to consider on a site-specific basis.

Thermal Treatment Technologies: The site manager should refer to EPA's Draft Strategy for Combustion of Hazardous Waste (May 18, 1993) when considering any thermal treatment technologies at a particular site.

Conclusion

For sites containing VOC-contaminated soil and appropriate soil characteristics, SVE is a relatively inexpensive and efficient technology. If material needs to be excavated, thermal desorption is preferred. In a few cases, incineration may be the most appropriate remedy -- for example, where SVE and thermal desorption will not meet clean-up criteria based on contaminant concentrations or composition.

As remedies other than SVE, thermal desorption and incineration become more widely used in the future, this directive may be modified to reflect these trends. For further assistance on presumptive remedy related activities consult the Regional Presumptive Remedies contact.

Notice:

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change this guidance at any time without public notice.

TABLE 3
Comparison of Technologies for VOC Sites

	PERFORMANCE[1]	ADVANTAGES	LIMITATIONS	COSTS[1]
Soil Vapor Extraction	Can be as high as 99% removal of VOC contaminants but is typically lower than other technologies with range of 85-99%	• High level of effectiveness in removing VOCs. • Relatively inexpensive. • Little site disturbance; no excavation required. • Effective for waste under buildings or other construction.	• Soil that is tight or has high moisture content (>50%) has a reduced permeability to air, hindering the operation of SVE. • Soil with a high degree of heterogeneity has highly variable permeabilities, resulting in uneven delivery of gas flow to the contaminated regions, which in turn reduces removal rates by SVE. • Soil with high organic content or that is extremely dry has a high sorption capacity for VOCs, which results in reduced removal rates. • SVE may require treating residual soil tailings, liquids, and spent activated carbon. • Air emissions must be controlled to eliminate possible harm to the public and the environment. • SVE is not effective in the saturated zone. However, lowering the aquifer can expose more media to SVE (this may address concerns regarding LNAPLs).	$10 - 150/ton
Thermal Desorption	95-99% removal of VOCs	• All compounds that are listed on Table 2 are readily treated by thermal desorption. • Because of lower treatment temperatures and often lower oxygen levels, thermal desorbers should produce less nitrogen oxides and sulfur dioxide than incinerators. • Process can be performed onsite or offsite. • Lower temperatures produce fewer products of incomplete combustion (PICs).	• Requires excavation. If contamination is very deep or below the water table, excavation may be difficult and expensive. • Mercury, if present, can be removed from soil by thermal desorption and impose additional treatment costs for the offgas. • Soil containing high fractions of clay or silt may result in a high percentage of particulate carry-over from the desorber into downstream treatment devices. • Soil that contains constituents greater than 1 to 2 inches in diameter will require screening or crushing to prevent jamming the mechanical equipment. • Soil with a high moisture content (>30%) can result in low processing rates, high operating costs, and difficulty in materials handling. • High or low pH wastes may corrode the metal components of the system, requiring pretreatment. • Potential process residuals are treated solids, oversized debris, condensed contaminants and water, particulate control system solids, and contaminated activated carbon. • Air pollution control system required.	$200-300/ton
Incineration	>99% removal of VOCs	• Capable of accepting a wide range of media. • Processes can be performed onsite or offsite. • Metals can be concentrated in the residuals.	• Requires excavation. If contamination is very deep or below the water table, excavation may be difficult and expensive. • Soil containing high fractions of clay or silt may result in a high percentage of particulate carry-over from the incinerator into downstream treatment devices. • Air pollution control equipment is required. • High treatment temperatures, as compared to thermal desorption, can produce nitrogen oxides, sulfur dioxides, and PICs. • Solids with volatile metals may require additional treatment or more elaborate air pollution equipment.	$200 - 1700/ton

NOTES:

(1) Actual performance and cost for any remediation technology is highly site specific. Both depend upon the original and target clean-up level concentrations of contaminants, soil quantity to be treated, soil characteristics, and the design and operation of the remediation technology equipment used.

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
All Technologies:		
Site Geology	SVE is most effective in porous, permeable, homogeneous soil. Highly heterogeneous soil (i.e., fractured porous rock or sands interspersed with clay lenses) may exhibit air flow channeling through highly permeable soils. Also, desorption kinetics may be slow in some situations (i.e., high organic content or high clay content soil). In these cases, mass transfer kinetics may reduce the rate of removal of SVE below that which is expected by calculations with a local equilibrium model or pilot scale experiments carried out for only a few days. Often diffusion kinetics limitations can be substantially reduced by proper design of the SVE facility.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
USGS Soil Classification	For SVE to be effective, the soil must have sufficient pneumatic permeability ($>10^{-6}$ cm^2) to permit air to move through the medium. Sandy, gravely soils are the most conductive to SVE, while clays and silts are less conductive. However, remediations using SVE in clays and silts have been successful. Soil permeability may need to be measured in the field.	ASTM D 2487 ASTM D 2488
Soil Moisture	High moisture content in soil may drastically decrease its air permeability and, thus, the effectiveness of SVE. The site must be sufficiently well drained to prevent the severe reduction in air permeability, which occurs when the percent water saturation of the soil is greater than 50%. Conversely, organics can be strongly adsorbed onto extremely dry soils, which also impedes SVE. The moisture content of the soil will affect the amount of energy required to heat the soil, the target temperature and the handling properties of fine-grained soil. Thermal desorption requires that the moisture content of the soil be less than 30%.	ASTM D 2216 ASTM D 3017
Depth to Ground Water	SVE is not effective in saturated soil. However, the water table can be lowered by pumping. Thermal desorption and incineration are more expensive for high moisture soil.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Contaminant Identity and Properties	Boiling Point - Thermal desorption target temperature is dependent on contaminant boiling point. Vapor Pressure - SVE is effective for compounds with a vapor pressure greater than 0.5 mm Hg at soil temperatures. Dimensionless Henry's Constant - SVE is effective for compounds with a dimensionless Henry's constant higher than 0.01 at soil temperatures. Water Solubility - SVE is more successful for compounds with lower solubilities. Liquid and Vapor Density - A contaminant with a density greater than water may form a DNAPL. A contaminant with a density less than water may form an LNAPL. The flow characteristics of a compound's vapor for SVE is a function of its vapor density.	CRC Chemical Handbook

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites
(Continued)

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
All Technologies: (continued)		
Contaminant Concentration, Location, Volume, and Depth	These data can be gathered via soil matrix and/or soil gas sampling. Soil gas sampling, both shallow and at depths, may be more appropriate, given depth to ground water and stratigraphy.	Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
Presence of Pipes or Subsurface Material	The presence of water or electrical conduits, soil fracture lines, debris, or any other objects that are more permeable than the surrounding soil will be the preferred pathway for the advecting gases.	Geotechnical Techniques
SVE Only:		
Soil/Air Filled Porosity	Porosity should be less than 40% for SVE to be effective.	Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
Soil/Air Permeability	Soil/air permeability should be greater than 10^{-6} cm^2 for air to move throughout the contaminated soil. SVE is potentially effective in less permeable soil (i.e., between 10^{-6} to 10^{-10} cm^2), but further pilot-scale testing and/or mathematical modeling is recommended to better predict the time for cleanup (which is likely to be prolonged for lower permeability soil).	Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
Soil Temperature	Contaminant vapor pressure, dimensionless Henry's Law constant, water solubility, and phase density are strong functions of temperature.	Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
Soil Humic Content	Solvents adhere strongly to soil with high humic content, which decreases the effectiveness of SVE.	Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
Contaminant Soil Sorption Coefficient Kd (Since Kd is less readily available, Koc, the equilibrium between contaminants sorbed onto organic carbon versus the ground water is used.)	This parameter describes the tendency of the solvent to sorb onto soil or organic matter in the soil. Higher Koc's indicate that a subsurface is more likely to bind to carbon rich media (i.e., soil) than to remain in water.	RREL Treatability Database
Contaminant Adsorption Characteristics on Activated Carbon	This parameter is related to the feasibility of removing contaminants from residuals by carbon adsorption. This parameter is important since compounds such as MEK become unstable as they are adsorbed onto carbon.	RREL Treatability Database

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites
(Continued)

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
Incineration and Thermal Desorption Only:		
Soil Plasticity	Plastic soil, when subjected to compressive forces, can become molded into large particles that are difficult to heat.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil BTU Content	The soil BTU content determines the fuel requirements for thermal desorption and incineration.	ASTM D 3286
Contaminant Combustion Characteristics	Information on combustion characteristics of a VOC is required in order to determine the combustion characteristics of the incinerator.	Bench/Pilot Testing
Soil Particle Size Distribution	Thermal desorption usually requires that soil be pretreated to a maximum soil particle size ranging from 1 to 2 inches.	ASTM D 422
Alkaline Metal Salts (e.g., $NaSO_4$, KSO_4)	Alkaline metal salts may cause refractory attack and slagging at high temperatures	Percentage of Na, K
Volatile Metals Content (e.g., Hg, Pb, Cd, Zn, Sn)	High metal content may cause ash leaching and stack emissions problems.	Heavy Metals Analysis

BTU = British Thermal Units
LNAPL = Light Nonaqueous Phase Liquid
DNAPL = Dense Nonaqueous Phase Liquid
mm Hg = millimeters of mercury pressure
NAPL = Nonaqueous Phase Liquid
PIC = Products of Incomplete Combustion

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summarizes the analyses that EPA conducted of Record of Decision (ROD) and Feasibility Study (FS) data from VOC-contaminated sites which led to establishing soil vapor extraction (SVE), thermal desorption, and incineration as the presumptive remedies for Superfund sites with VOC-contaminated soil. The analyses consisted of:

- Identifying VOC-contaminated sites
- Determining the frequency of technology selection for VOC sites
- Identifying sites for the feasibility study (FS) analysis
- Conducting the FS analysis.

Results of these analyses, along with the scientific and engineering analysis of the performance data on technology application (Primary Reference document), provide a support for the decision to eliminate the initial alternatives identification and screening step for this site type. These technical reviews found that certain technologies are appropriately screened out based on effectiveness, implementability, or excessive costs. Review of technologies against the nine criteria led to elimination of additional alternatives. Provided below is a discussion of each analysis.

Identification of VOC-Contaminated Sites

The first analysis involved generating a list of signed Records of Decision (RODs) (post-SARA), documenting VOC contamination, from which data could be used for subsequent analyses. The ROD Information Directory database was used for this purpose. Of the 821 signed FY86-FY91 RODs, 418 are identified in the database as containing VOC contamination in source material. This list of RODs was subsequently divided into two lists: RODs where VOCs were the only contaminants of concern identified in the source material and RODs containing VOCs, as well as other contamination, in source material. For those RODs involving VOC plus other contaminants, a review of the ROD document was conducted to identify cases where only VOCs were driving the selection of remedy. To make this determination, the Remedial Response Objectives and Selected Remedy sections of the ROD were reviewed to identify specific language indicating that the remedial action was designed to address only the VOCs at the site. In addition, if cleanup goals were specified only for VOCs, the assumption was made that VOCs were driving the remedy.

As a result of this analysis, 88 RODs were identified as VOC-only RODs or VOCs plus other contaminants RODs where a clear determination could be made that VOCs were driving the selection of remedy.

Frequency of Technology Selection for VOC-Contaminated Sites

Table 1 presents the distribution of the 88 FY86-FY91 RODs among the treatment technologies used to address VOCs in soil. This table demonstrates that the three presumptive remedies (SVE, thermal desorption, and incineration) together were selected more often (over 90% of the RODs analyzed) than the other applicable technologies. Presumptive Remedies were also those remedies where a fair amount of performance data on technology implementation was available. Furthermore, SVE, chosen in over two-thirds of the RODs analyzed, was the primary presumptive remedy selected.

Identification of Sites for Feasibility Study Analysis

The purpose of the FS analysis was to document the technology screening step in FSs of VOC-contaminated soil/sludge sites and identify the principal reasons given for eliminating technologies from further consideration. To achieve a representative sample of FSs for the analysis, sites were selected using ROD data according to the following criteria:

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES
(Continued)

Table 1

Presumptive Remedy VOC Site Treatment Summary Table, FY86-FY91*

TECHNOLOGIES USED TO ADDRESS VOCs IN SOIL	TOTAL
Bioremediation (1)	3
Incineration	11
Soil Flushing/Washing (1)	3
Soil Vapor Extraction	62
Thermal Treatment (2)	9
Total	88

Source: ROD Information Directory (RID), FY86 - FY91

Notes:
(1) Relatively limited amount of performance data available for these technologies versus the presumptive remedies.
(2) Thermal treatment includes RODs employing thermal desorption, thermal aeration, low-temperature thermal desorption, and the generic remedy "thermal treatment".

* A population of 418 RODs was identified for this study based on the parameters: FY 1986-1991, and VOC contamination of source media.

- Sites were chosen, based on the selected remedy, to ensure an even distribution among the five treatment technologies for VOCs in soil (i.e., bioremediation, incineration, SVE, soil flushing, and thermal treatment).
- Whenever possible, both VOC-only sites and VOC and other contamination sites were represented under each technology.
- Sites were selected to ensure an even distribution in geographic location, ROD signature date, and site size.

Feasibility Study Analysis

The FS analysis involves a review of the technology screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases in each FS and ROD. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this directive. (See "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils", September 1993, available at EPA Headquarters and Regional Offices.)

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES
(Continued)

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the screening criteria: cost, effectiveness, or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table (Table 2).

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the nine NCP criteria was documented on the site-specific data collection forms. The advantages and disadvantages associated with each clean-up option were highlighted. In some cases, a VOC technology was combined with one or more technologies that address minor site contaminants into one or more alternatives. Only the component of the alternative which addressed the VOC contamination was evaluated in this analysis. The disadvantages of a technology/ alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. All summary tables are available for review as part of the Administrative Record.

The FS analysis has been completed for 21 sites (representing approximately 25% of universe studied). The information from these FSs has been compiled and summarized in Table 2. Additional FS analysis is planned and will be added to the Administrative Record, when available. Table 2 demonstrates that technologies, other than the presumptive remedies, are consistently eliminated from further consideration in the screening phase due to effectiveness, implementability, or excessive costs. In addition, the analysis indicates that, although certain technologies routinely passed the screening phase, these technologies were selected infrequently because they did not provide the best overall performance with respect to the nine criteria. Together these analyses (Appendix A to this directive and "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils"), along with the scientific analysis of performance data (USEPA (In Progress) Contaminants and Remedial Options at Solvent Sites) will support the decision of using presumptive remedies and bypassing the technology identification and screening step for a particular site. As previously indicated, this factsheet and accompanying analysis should be part of the Administrative Record for the site. Further supporting materials, not found in the Regional files, can be provided by Headquarters, as needed.

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES[1]

Remedial Technology Or Treatment [2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out [3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Longterm Effect	Shortterm Effect	Cost	Implem	State [4] Concerns	Community [4] Concerns
Capping	21	8	7	6	1	6	2	0	8	5	3	7	6	6	3	1	--	--
Offsite Nonhazardous Landfill	4	0	2	2	0	2	1	0	0	0	0	0	0	0	0	0	--	--
Offsite RCRA Disposal	18	12	4	2	1	3	3	2	10	3	6	7	3	9	5	7	--	--
Onsite Encapsulation	3	1	2	0	1	1	0	0	1	0	0	1	0	0	0	0	--	--
Onsite Nonhazardous Landfill	2	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	--	--
Onsite RCRA Landfill	14	1	11	2	0	8	7	0	1	0	0	1	0	1	1	0	--	--
Activated Sludge	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	--	--
Composting	4	1	3	0	0	3	0	0	1	0	0	0	0	1	0	1	--	--
Land Farming	3	0	3	0	0	1	1	0	0	0	0	0	0	0	0	0	--	--
Bioremediation (unspecified)	6	0	6	0	0	5	4	0	0	0	0	0	0	0	0	0	--	--
Ex-situ Bioremediation	7	1	6	0	2	5	2	1	0	0	0	0	0	0	0	0	--	--
In-situ Bioremediation	11	1	10	0	2	9	4	0	0	0	0	0	0	0	0	0	--	--
Dechlorination/ APEG	3	0	3	0	0	3	1	0	0	0	0	0	0	0	0	0	--	--

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

Remedial Technology Or Treatment[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect	Short-term Effect	Cost	Implem.	State Concerns[4]	Community Concerns[4]
Other Chemical Destruction	3	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	--	--
Reduction	7	0	6	1	0	5	1	0	0	0	0	0	0	0	0	0	--	--
Neutralization	6	0	6	0	0	5	0	0	0	0	0	0	0	0	0	0	--	--
Oxidation	6	1	5	0	0	4	0	0	1	0	0	0	0	1	1	1	--	--
Offsite Incineration (unspecified)	16	7	8	1	5	5	2	0	7	2	0	1	0	7	6	2	--	--
Onsite Incineration (unspecified)	7	1	6	0	2	3	5	0	1	0	0	0	0	1	1	0	--	--
Fluidized Bed	5	0	4	1	3	1	2	0	0	0	0	0	0	0	0	0	--	--
Infrared	5	1	4	0	2	2	1	1	0	0	0	0	0	0	0	0	--	--
Pyrolysis	3	0	3	0	2	1	1	0	0	0	0	0	0	0	0	0	--	--
Multiple Hearth	5	0	4	1	2	4	1	0	0	0	0	0	0	0	0	0	--	--
Rotary Kiln	11	6	3	2	3	2	3	2	4	1	0	0	0	5	3	4	--	--
Other Incineration	13	1	12	0	5	6	5	1	0	0	0	0	0	0	0	0	--	--
Other Thermal Treatment	6	0	6	0	2	4	3	0	0	0	0	0	0	0	0	0	--	--

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

Remedial Technology Or Treatment[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect	Short-term Effect	Cost	Implem	State[4] Concerns	Community[4] Concerns
Vitrification	12	0	11	1	2	8	5	0	0	0	0	0	0	0	0	0	--	--
Wet Air Oxidation	6	1	5	0	1	4	3	0	1	0	0	0	1	1	1	0	--	--
Low Temperature Thermal Desorp/ Stripping	13	10	3	0	1	1	2	3	7	2	1	1	2	7	3	4	--	--
In-situ Steam Stripping	3	2	1	0	0	1	0	2	0	0	0	0	0	0	0	0	--	--
Soil Flushing	15	3	12	0	0	9	5	0	3	1	1	1	2	2	1	3	--	--
Soil Washing	14	2	12	0	1	10	9	0	2	0	0	1	0	2	2	1	--	--
In-situ Vacuum Extraction	17	11	6	0	0	6	2	10	2	0	0	0	1	0	0	2	--	--
B.E.S.T. Process	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	--	--
Liquified Gas	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	--	--
Other Physical Extraction	4	0	4	0	0	3	0	0	0	0	0	0	0	0	0	0	--	--
Fixation	7	1	6	0	0	6	0	0	1	0	0	1	1	0	1	1	--	--
Stabilization/ Solidification	13	2	7	4	0	6	2	0	2	0	0	2	2	2	0	2	--	--
Aeration	12	2	10	0	1	9	2	1	1	0	0	0	1	1	1	0	--	--

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

Remedial Technology Or Treatment[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect	Short-term Effect	Cost	Implem	State[4] Concerns	Community[4] Concerns
In-situ Hydrolysis	4	0	4	0	0	3	2	0	0	0	0	0	0	0	0	0	--	--
Soil Slurries	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	--	--

[1] This study was conducted on 21 RODs and their corresponding FSs.
[2] This does not the include the no-action or institutional control only alternatives. No RODs selected either of these as remedies.
[3] FSs and RODs may contain more than one criterion for screening or non-selection of technology. Also, some FSs did not fully explain the criteria for screening out a technology. Thus, the totals for screening and non-selection criteria are not equal to the number of FSs and RODs considered.
[4] Information on State and community concerns was not included in this analysis because FSs do not contain this information and RODs generally only reference supporting documentation (i.e., State concurrence letter and responsiveness summary).

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [1]
SOIL VAPOR EXTRACTION	• Provides both short- and long-term protection by reducing concentration and exposure to VOCs in soil. • Depending on site-specific conditions, prevents further ground water contamination.	• Does not trigger LDRs because it does not involve placement of waste. • Because waste is removed in place through limited construction and no excavation, few impacts to wetlands, floodplains, or water quality are likely. • Depending on site-specific conditions, treats wastes to levels that will prevent exceedance of groundwater clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Requires some treatment of residuals (spent carbon or concentrated VOC waste stream) generally through regeneration or disposal. • Hazardous wastes left in place will require 5-year review.	• Significantly reduces toxicity, mobility, or volume through treatment. • Produces few waste streams.	• Does not present substantive risks to onsite workers or community; potential for some dust generation during well installation. • Potential air emissions are easily controlled through activated carbon adsorption or other technologies. • Generally involves relatively short time frame to achieve clean-up levels; however, difficulty in estimating timeframe may exist due to site uncertainties (e.g., irregular soil permeabilities). • Effective for treating waste under buildings. Can be performed on active facilities. • Hardware, such as vacuum blower, is readily available from many sources, but SVE system performance is highly dependent upon the lithology of the site and system design.	• Few administrative difficulties. Technology is readily available from many sources. • Used successfully at numerous Superfund sites to address VOC contamination. • Installing and operating extraction wells requires fewer engineering controls than other technologies (i.e., excavation and incineration). • Requires series of soil gas sampling to determine when clean-up levels are achieved.	$10 - 150/ton $50/ton avg

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
(continued)

	CRITERIA						
	Overall Protection of Human Health and the Environment	**Compliance With Federal ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost (1)**
THERMAL DESORPTION	• Provides both short- and long-term protection by eliminating exposure to VOCs in soil/sludge. • Prevents further groundwater contamination and offsite migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation (if offsite treatment), and land disposal regulations (if a hazardous waste). • Excavation, construction, and operation of onsite treatment unit may require compliance with wetlands and other location-specific ARARs. • Treats hazardous waste to BDAT levels; thus, there is no LDR problem with residuals. • Generally, treats wastes to levels that will prevent exceedance of ground-water clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Involves some treatment or disposal of residuals generally through use of carbon adsorption/ regeneration or disposal.	• Significantly reduces toxicity, mobility, or volume of contaminants through treatment. • Generally requires test runs to ensure effective treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment (if onsite treatment). • Involves potential short-term risks from handling and transporting waste (if offsite treatment). • Relatively short timeframe to achieve clean-up levels.	• Construction and substantive permit requirements of an onsite treatment unit may present some difficulties. Mobile incineration units for onsite treatment are available. • Limited offsite treatment capacity exists. • Used successfully at other Superfund sites to address solvent contamination. • Requires engineering measures to control air emissions, fugitive dust, run-off, erosion and sedimentation, site access, and transportation.	$200 - 300/ ton $250/ton avg.

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil (continued)

	CRITERIA						
	Overall Protection of Human Health and the Environment	**Compliance With Federal ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost (1)**
INCINERATION	• Provides both short- and long-term protection by eliminating exposure to solvent contaminants in soil. • Prevents further ground-water contamination and offsite migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation (if offsite treatment), and land disposal regulations (if a hazardous waste). • Excavation, construction, and operation of onsite incinerators may require compliance with wetlands and other location-specific ARARs. • Treats hazardous waste to BDAT levels; thus, there is no LDR problem with residuals. • Treats wastes to levels that will prevent exceedance of ground-water clean-up levels. • Emission controls may be needed to ensure compliance with air quality standards during excavation and construction.	• Effectively destroys source of contamination. • Is a well-demonstrated technique for treating VOCs in soil/sludge. • No organic residuals contamination will exist if treating soil/sludge contaminated only with VOCs.	• Sign[illegible]ntly reduces toxicity, mobility, or volume of contaminants through treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment (if onsite treatment). • Involves potential short-term risks from handling and transporting waste (if offsite treatment). • Relatively short timeframe to achieve clean-up levels.	• Construction and substantive permit requirements of an onsite incinerator may be somewhat difficult. Mobile incinerators are readily available. • Limited offsite incineration capacity exists. • Used successfully at other Superfund sites to address VOC contamination.	$200 - 1700/ton $400/ton avg

1. Note: Actual cost of a remediation technology is highly site-specific and dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX C
U.S. Waste Exchanges

CALIFORNIA WASTE EXCHANGE
Robert McCormick
Department of Health Services
Toxic Substances Control Division
400 P Street
Sacramento, CA 95812
(916) 324-1807

INDIANA WASTE EXCHANGE
Environmental Quality Control
1220 Waterway Boulevard
P.O. Box 1220
Indianapolis, IN 46206
(317) 232-8188

INDUSTRIAL MATERIAL EXCHANGE SERVICE
Diane Shockey
2200 Churchill Road, #31
Springfield, IL 62794-9276
(217) 782-0450
FAX: (217) 782-9142

INDUSTRIAL MATERIALS EXCHANGE
Bill Lawrence
172 20th Avenue
Seattle, WA 98122
(206) 296-4899
FAX: (206) 296-0188

PACIFIC MATERIALS EXCHANGE
Bob Smee
1522 North Washington Street, Suite 202
Spokane, WA 99205
(905) 325-0551
FAX: (509) 325-2086

NATIONAL WASTE EXCHANGE NETWORK
1-800-858-6625

RENEW
Hope Castillo
Texas Water Commission
P.O. Box 13087
Austin, TX 78711
(512) 463-7773
FAX: (512) 463-8317

INDUSTRIAL WASTE INFORMATION EXCHANGE
William E. Payne
New Jersey Chamber of Commerce
5 Commerce Street
Newark, NJ 07102
(201) 623-7070

MONTANA INDUSTRIAL WASTE EXCHANGE
Don Ingles
Montana Chamber of Commerce
P.O. Box 1730
Helena, MT 59624
(406) 442-2405

NORTHEAST INDUSTRIAL WASTE EXCHANGE
Lewis M. Culter
90 Presidential Plaza, Suite 122
Syracuse, NY 13202
(315) 422-6572
FAX: (315) 422-9051

SOUTHEAST WASTE EXCHANGE
Maxi May
Urban Institute
Department of Civil Engineering
University of North Carolina
Charlotte, NC 28223
(704) 547-2307

SOUTHERN WASTE INFORMATION EXCHANGE
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Tallahassee, FL 32313
(904) 644-5516
FAX: (904) 574-6704

APPENDIX D
GLOSSARY

Applicable or Relevant and Appropriate Requirements (ARARs) - CERCLA Section 121(d) and the NCP require that onsite remedial actions must attain (or justify a waiver of) requirements of environmental laws that are determined to be Federal or more stringent State applicable or relevant and appropriate requirements.

Dense Non-Aqueous Phase Liquid (DNAPL) - DNAPLs are immiscible hydrocarbon liquids that are denser than water, such as chlorinated solvents (either as a single component or as mixtures of solvents), wood preservative wastes, coal tar wastes, PCBs and some pesticides. DNAPLs can sink to great depths, can penetrate into bedrock fractures, can move as a liquid in a direction different from the flow of groundwater and can act as a continual source of groundwater contamination over time.

Engineering Evaluation/Cost Assessment (EE/CA) - An analysis of removal alternatives for non-time critical removal actions.

Ex-Situ Treatment - Removal of material from the ground for treatment.

Feasibility Study (FS) - A description and analysis of the potential clean-up alternatives for a site. It is generally conducted concurrently with the remedial investigation (RI); together the studies are referred to as an RI/FS. (See remedial investigation.)

In-Situ Treatment - The treatment or remediation of media occurring in-place.

Innovative Treatment Technologies - Technologies that have been tested, selected, or used for treatment of hazardous substances or contaminated materials but lack well-documented cost and performance data under a variety of operating conditions.

Land Disposal Restrictions (LDRs) - The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) include specific restrictions on the land disposal of RCRA hazardous wastes. These restrictions, known as LDRs, prohibit the land disposal of restricted RCRA hazardous wastes unless these wastes meet treatment standards specified in 40 CFR 268 or other compliance options.

Light Non-Aqueous Phase Liquids (LNAPL) - Like DNAPLs, LNAPLs are immiscible liquids, but are lighter than water and therefore float on water. As they are lighter than water, they are most frequently found at the groundwater table/vadoze zone interface.

Record of Decision (ROD) - A public document that explains the basis for selecting the clean-up alternative(s) that will be taken or served under CERCLA.

Remedial Design (RD) - The remedial action that involves designing and testing to determine whether the remedy will be effective at a site.

Remedial Investigation (RI) - An in-depth study designed to gather the data necessary to determine the nature and extent of the threat posed by contamination at a Superfund site. It also helps to establish the preliminary criteria for cleaning up the site in the FS and supports the technical and cost analyses of the alternatives. It is generally completed and combined with the FS and referred to as the RI/FS.

Risk Assessment - The qualitative and/or quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by actual and potential exposures to specific pollutants in air, water, soil or other media.

Superfund Accelerated Cleanup Model (SACM) - An initiative designed to accelerate all aspects of the Superfund clean-up process.

Vadose Zone - The zone in soil that lies above the permanent water table.

Volatile Organic Compounds (VOCs) - Any organic compound which readily dissipates into the air.

REFERENCES

Primary Reference:

U.S. EPA (In-Progress). Contaminants and Remedial Options at Solvent Sites.

Compound Properties:

RREL Treatability Data Base - Available through ATTIC (Contact Glenn Shaul (513) 569-7408)

General Site Investigations:

U.S. EPA, 1986. A Compendium of Superfund Field Operation Methods. EPA/540/87/001.

U.S. EPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004, October.

U.S. EPA, 1989. Guide for Conducting Treatability Studies Under CERCLA, Interim Final. EPA/540-2-89/058.

U.S. EPA, 1991. Soil Sampling and Analysis for Volatile Organic Compounds. EPA/540/4-91/001.

Incineration:

Dempsey, C.R. and Oppett, E.T., "Incineration of Hazardous Waste: A Critical Review Update", International Journal of Air Pollution Control and Hazardous Waste Management, Volume 43, January 1993, pp. 25-73.

U.S. EPA, 1990. Mobile/Transportable Incineration Treatment Engineering Bulletin. EPA/540/2-90/014, February.

Presumptive Remedies:

U.S. EPA (In-Progress). Presumptive Remedies: Policy and Procedures.

U.S. EPA (In-Progress). Presumptive Remedies: Remedial Strategy and Treatment Technologies for CERCLA Sites with Contaminated Groundwater.

Soil Vapor Extraction:

U.S. EPA, 1991. Soil Vapor Extraction Technology Reference Handbook. EPA/540/2-91/003, February.

U.S. EPA, 1991. In-Situ Soil Vapor Extraction Treatment Engineering Bulletin. EPA/540/2-91/006, May.

U.S. EPA, 1991. Guide for Conducting Treatability Studies Under CERCLA: Soil Vapor Extraction. EPA/540/2-91/091A, September.

U.S. EPA, 1992. A Technology Assessment of Soil Vapor Extraction and Air Sparging. EPA/600/R-92/173, September

Thermal Desorption:

U.S. EPA, 1991. Thermal Desorption Treatment Engineering Bulletin. EPA/540/2-91/008, February.

U.S. EPA, 1991. Guide for Conducting Treatability Studies Under CERCLA: Thermal Desorption Remedy Selection - Interim Guidance. EPA/540/R-92/074A, September.

Additional References:

U.S. EPA, 1991. A Guide to Principal Threat and Low Level Threat Wastes. Superfund Publication 9380.3-06FS.

U.S. EPA, 1991. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part A. EPA/540/1-89/002, December.

U.S. EPA, 1989. Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual. EPA/540/1-89/001, March.

U.S. EPA, 1991. Compendium of CERCLA ARARs Factsheets and Directives. EPA Publication 9347.3-15, October.